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FoPIA-SURE-Farm 2 Case Study Report Poland

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1 Introduction

1.1 Main indicators, resilience attributes and challenges

The farming system in Mazovian case study area (including two NUTS2 regions: PL92 - Mazowieckie and PL81 - Lubelskie) is predominated by several farming systems, among which is the horticultural farming system. This system is determined by the local diversified landscape, land fragmentation and historical traditions. Depending on the particular area of the region the key cultivated hard fruits are: apples, pears, plums, cherries, sweet cherries, and to a less extent peaches and apricots; among the soft fruits there are: strawberries, raspberries, currants (black and red), and gooseberries. Most popular vegetables chosen for cultivation by farmers are the following: onions, carrots, cabbages, cucumbers, tomatoes, and sugar beets.

As defined in the process of first evaluation (during the FoPIA-SURE-Farm 1 workshop carried out in March 2019 and described in Krupin et al. 2019), the key functions delivered by the farming system are mainly focused on maintaining the economic viability, carrying out food production and ensuring quality of life (all private goods). Most representative indicators (function indicators) describing these most important functions are presented in Table 1, which reveals their below average to low performance.

While the data collected in the FoPIA-SURE-Farm 1 workshop was quite diverse, it was decided to modify the input data for the FoPIA-SURE-Farm 2 workshop in order to achieve more structured and focused responses. One of the reasons for this was the structure of expected participants. Therefore in regard to main function indicators analysed during the FoPIA-SURE-Farm 2 workshop, the following four indicators were outlined and discussed:

- 1) *Utilized agricultural area* (merging the previous indicators of “Area of ecological farmland with a certificate (ha)”, and “Share of fruit cultivation (% of sown area)”),
- 2) *Purchase prices for agricultural products* (merging the previous indicators of “Purchase prices for apples (PLN/kg)”, “Purchase prices for onions (PLN/kg)”, and “Price relation of agricultural products to agricultural production costs (%)”),
- 3) *Income dynamics* (reflecting the previous indicator of “Dynamics and relations of nominal incomes per capita of rural and urban residents (%)”),
- 4) *Labor costs*.

Resilience in the case study area is mainly supported by the resilience attributes listed in Table 2, while their performance is evaluated as average to low.



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Table 1. Main function indicators, level of their performance and current development in regard to horticulture farming system in Poland (revealed within the FoPIA-SURE-Farm 1 workshop; Krupin et al. 2019)

Function indicators (ranked according to their importance)	Current level of performance (score 1:5)	Current level (explanation)	Current development
Price relation of agricultural products to agricultural production costs (%)	2.3	Prices for agricultural products are fluctuating, while the costs are steadily rising (inputs, such as fertilizers, pesticides, but also agricultural land, labor).	The goal is to maintain profitability and find reserves to increase the income. Yet as production costs are exogenous, farmers tend to adapt by looking for cheaper substitutes. State support is expected to secure the farmers' profitability.
Purchase prices for apples (PLN/kg)	2.2	Fluctuation of prices and general uncertainty in regard to sale volumes are perceived as rather negative. Small farmers lack the market strength and stable distribution channels. Same applies to most fruits and vegetables. Evaluated as low due to relatively small scale of organic farming in Poland, yet perceived as positive trend for the future of Polish agriculture.	Overall the creation of producers groups is perceived as solution for the future, as the past experience of many farmers prove its efficiency in face of economic and environmental challenges.
Area of organic farmland with a certificate (ha)	1,9		Area of organic farmland was expected to constantly rise, yet recent years show its decline, which farmers explain by lack of state support and low domestic demand.
Dynamics and relations of nominal incomes per capita of rural and urban residents (%)	2.5	Rural inhabitants generate less income (per capita) than the urban population, causing gradual outflow of workforce from rural areas.	The goal is to even the income levels for rural and urban population, which is in part the aim of the Common Agricultural Policy. Developments of the recent years show gradual decrease in income divergence, therefore the gap is expected to decrease farther.
Labor costs (PLN/hour)	1.9	Shortage of available labor (primary seasonal) is strongly influencing farm activities and economic results. Currently labor costs are considered high by farmers, but perceived as low by workers (both local and foreign).	Workers expect rises in wages, which would attract more labor to farms, especially in the harvest time, which is critical. Yet farmers don't see the potential for wage increases, as they consider their profits low as it is. At the same time farmers struggle with the lack of workers and eventually face losses due to this.

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Table 2. Main resilience attributes and their presence in the horticulture farming system in Poland (revealed within the FoPIA-SURE-Farm 1 workshop; Krupin et al. 2019)

Resilience attributes	Current performance level (score 1:5)	Current level (explanation)	Current development
Production coupled with local and natural capital	3.0	Local and natural capital is evaluated as average, yet best among other resilience attributes. Average soil quality (fertility) is sufficient for the horticulture. The variety of inputs is not evaluated highly as the list of available pesticides (not restricted by the state) is decreasing, making farmers choose from less efficient and more costly substitutes (at least in the farmers' perception).	Water becomes an issue in the past years due to climate change, thus affecting local conditions. Farming system's actors seek for cheaper and more efficient inputs' substitutes, as well as new markets for their products. Cooperation is perceived as the solution for the high market entry levels.
Functional diversity	2.3	Income sources in rural areas are not considered to be diversified, as well as entry level to domestic and foreign markets is high for small-scale farmers.	
Response diversity	2.0	Facing more frequent and severe extreme weather conditions farmers suffer losses. The available risk management strategies are not diversified.	Diversification of risk management strategies is too slow to improve in the near future. Weather insurance for farmers is feasible, yet currently too complex and costly, therefore they expect state support (e.g. in terms of compensating insurance premiums). There's no possibility to predict the profitability, as the prices of inputs grow and there's not understanding of what the new CAP would bring.
Reasonably profitable	1.5	Profitability is the issue emphasized upon as unsatisfactory. Fluctuation of prices of agricultural products leave farmer profit margins low, making them rely on subsidies (primarily direct payments).	Farmers expect equal or larger subsidies, which affects rural income in general, not just particular farmers.

Main challenges for the farming system are:

- Fluctuation of prices of agricultural products,
- Extreme weather conditions,
- Lack of seasonal workers,
- Bureaucracy and variability of regulations.



1.2 Participation in the workshop

12 people participated in the workshop, of which 7 were farmers, while the other participants represented the agricultural advisory services (3), regional authorities (1) and socio-economic NGO expert (1). Some of the farmers were also members of the regional agricultural chamber (one being its chairman), as well as one researcher in the field of agriculture. There were 5 female and 7 male participants.

Participants were presented with the above (Section 1.1.1) findings, received on the basis of prior SURE-Farm research activities in the framework of FoPIA-SURE-Farm method. There was an overall agreement to the presented indicators, challenges and resilience attributes. Participants especially emphasized on the listed challenges, which they perceive as having a growing effect on the farming system and individual farmers.



2 Results

2.1 Maintaining the status-quo

2.1.1 Introduction

In order to keep the current system as it is, participants provided the minimum or maximum levels of the following function indicators, resilience attributes and challenges.

2.1.2 Indicators

Utilized agricultural area

Unavailability of agricultural land (both in economic and institutional terms) is perceived as the limitation for agricultural development. Lack of agricultural land turnover (which was enacted in April 2016 in Poland) creates negative preconditions for development of production for new farmers, while the current farmers don't have the resources to purchase additional land at the current price level.

In order to maintain the status quo farms should keep expanding their production based on economies of scales. Yet the current agricultural land prices and availability of land to be purchased by the farmers are already restricting such possibilities. One of the reasons for this is that some rural inhabitants keep their agricultural land in order to receive CAP direct payments, even though they do not use it for growing any specific crops, therefore deepening the agricultural land deficit. It was noted that even in case of land availability the prices per hectare is quite high (60-100 thousand PLN/14-24 thousand EUR per hectare). This price level was regarded by the stakeholders as the maximum threshold.

Purchase prices of agricultural products

The overall trend perceived by the participants is the gradual and steady growth of input prices alongside frequent and drastic fluctuation of prices for agricultural products delivered by the farming system. The prices for particular horticulture products have been fluctuating to such high extent in the past years that it creates the risk of losses and brings constant uncertainty.

In order to maintain the status-quo the purchase prices need to be more stable and predictable. In the participants opinion, the state should regulate the prices in case of their drastic decline. As two post-its indicated, the status quo can be maintained if the purchase prices for their agricultural products in a year don't drop by more than 3-5%, compared to the average.

The input prices need to be lowered too, according to one of the post-its at least by 5-10%, yet ideally by 30%. This had a direct impact upon the reply provided by another post-it, which outlined the average net profit should be increased by at least 20%, yet preferably by 30%.

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One of the post-its pointed out the importance to increase marketing efforts through intensifying promotion strategies (e.g. labelling regional products), which would influence the demand and therefore the prices. The threshold of minimal representation for each voivodeship is indicated at the level of 20 local products with the aim of 60 at optimal level per voivodeship.

Decrease of the number of intermediaries (shortening of supply chains) has been also pointed out as a measure to decrease the costs of end-products.

Prices of apples have been defined as a good representation of situation in the horticulture farming system as being of the key products in the region. Participants agreed that the prices of apples in the recent years have fluctuated reaching various levels causing uncertainty. It has also been agreed that due to this there was a problem with planning of production processes.

One of the participants noted down the problem of para-legal imports of apples, where apples are being imported through legal channels, yet cargo labelling indicates a higher quality products than it is in reality. This para-legal import is being one of the reasons for price fluctuations. The same participant pointed out there should be more rigorous controls conducted on the Eastern EU border.

Income dynamics

Income of rural residents is an issue that has longstanding impact upon the development of both rural areas and agriculture. The horticulture farming system is suffering from the outflow of the local workforce to the urban areas and to employment in various other economic sectors beside the agricultural sector. Yet discussion revealed that the level of life in urban areas doesn't differ too much from the level of life in rural areas.

One of the participants (a farmer) stated that during the past 15 years the quality of life increased, yet the work intensity has been increasing simultaneously. Therefore the income is comparatively not increasing, as the effort needed to obtain it has increased proportionally.

One participant noted down that the perception of welfare is lower among inhabitants of rural areas compared to inhabitants in the cities. In the following discussion, participants agreed this perception of poorness can impact the farming system's efficiency, eagerness to keep working on the farm or stay in the rural area, especially in case of young population.

One participant noted down that there's not really a difference between the income level of rural and urban areas, if perceived through the possession of various home appliances (e.g. washing machines, dish-washers, home entertainment systems). These things, describing overall quality of life, have levelled between the rural and urban areas, therefore indicating the income dynamics in rural areas have improved.



Labor costs

Labor costs are directly associated with one of the challenges of the farming system, as the wages in agriculture are comparatively low (in comparison to other economic sectors), yet in the sense of production costs (being the farmer's perception), are already high.

Several post-its confirmed current high labor inputs in terms of costs. One of them defined the optimal level wage level at 5 PLN/hour (ca. 1.2 EUR/hour), yet keeping the status-quo is feasible up to the level of 10 PLN/hour (ca. 2.4 EUR/hour). It should be noted the current average hourly wage in agriculture (namely the harvesting processes in horticulture) is ca. 8 PLN/hour (1.9 EUR/hour), while the official minimal wage is 14.7 PLN/hour (ca. 3.5 EUR/hour).

2.1.3 Resilience attributes

Production coupled with local and natural capital

While no particular thresholds were defined by the participants, yet the availability of agricultural land was stressed upon as crucial. At the same time the soil fertility is considered in the case study area as average (class 3-4 out on scale of 6 according to state classification, according to the responses).

Intensification of droughts has been mentioned numerous times, and each year the negative effects increase. There is a tax on failing to restore (ground) water levels with rain water since January 2018. It applies to large real estate owners (over 3,500 m²) and affects them due to rain water not reaching the direct ground, but goes into sewage system. This, of course, applies only to large-scale farmers and processors. In farmer's opinions it is yet another environmental tax, which does not improve the real situation. Not much is being done to fight the growing water deficit issues. Stakeholders express expectations that the executive authorities (e.g. Ministry of Agriculture) should at least provide financial support to farmers in regard to this problem (especially in case of extreme conditions).

Functional diversity

Consumer awareness and preferences were pointed out as having a positive influence on the status quo. Current threshold is perceived as too low, as domestic consumers don't pay attention at the product origin (according to participants 2 out of 10 consumers pay attention and choose domestic or locally produced products).

Labelling of products has been emphasized upon as important, yet no thresholds were defined in regard to this issue. The general opinion was that the current situation with product labelling does not sufficiently support the distribution.

Response diversity

According to the participants, providers of financial services (banks, insurance companies) have little knowledge about production processes on the farms and in many cases they grant loans only to a very limited list of investments. One participant gave an example, where he has not received a loan to build a foil-based greenhouse, because those companies which he applied to, gave loans only for glass-based greenhouses.

Regarding weather conditions and market fluctuations, participants agreed that it is very hard to predict the future and adopt actions to mitigate possible negative impacts. They agreed that even if they have a lot of different information from various sources (internet, advisors, etc.) it is not sufficient to introduce strategies which would proof their farms to future threats.

Participants agreed that diversified production may be helpful to mitigate risk however they also expressed negative opinions about forced diversification by various CAP/national programs. According to them, the usual time period imposed by those programs is too small to give farmers enough time to learn how they can properly produce new products, buy new machines or equipment and at the same time make and keep the new production profitable.

Reasonably profitable

One of the opinions regarded the profits. Currently average profit was defined by the participant as 20% of input, and it is considered as minimal to continue agricultural activities. Any drops would be endangering the production processes.

An interesting opinion was also voiced out that the profitability allowing to maintain the status quo is the domestic consumer income level. The appropriate level of such income was defined at 2,500 PLN (ca. 600 EUR) per person per month.

2.1.4 Challenges

Fluctuation of prices of agricultural products

Several post-its indicate the increase in costs of production factors is causing uncertainty and fluctuations in the prices of end-products. One post-it indicates the increase in costs of production (maximum threshold value of 30%) might endanger the status-quo. Several post-its mention the costs of labor and indicate the maximum threshold level of 20%.

Competition of agricultural goods imported from Eastern Europe (primarily from Ukraine) was indicated as influencing the market, the post-it refers to the maximum value of 10-20% increase of such goods, which might influence the local production in a negative way (breaking status-quo).

One of the post-its pointed out at the danger of price relation of agricultural products to agricultural production costs if it would increase more than 10% from the current value.

Extreme weather conditions

Increase of extreme weather conditions was indicated by many participants. Participants noted down the possibility of heavy rains having negative implications for the harvesting process, spring and autumn frosts, droughts, hail, extreme winters.

Occurrence probability of spring and autumn frosts were revealed by the post-its. For the spring frosts the issue is both frequency and prolongation of period of their occurrence (typically only in April in the past, now possible even in May). The maximum threshold is defined at the level of 30% (regarding frequency of occurrence) as farmers can prepare for the spring frosts and mitigate their effects by implementing particular farming practices. As for the early autumn frosts the situation is slightly different, as their occurrence brings danger in earlier month than before (now in early October). In regard to this issue the post-it indicated the level of 20% is the breaking point for the status-quo.

Post-its indicated the increase in occurrence of hail destroying the crops (one participant has written 10% and another – 20%) would endanger the status-quo. Same concerning the drought conditions, which are lately increasingly occurring.

Extreme winters in the horticulture production bring danger to orchards when they occur more often than twice per a 10-year period (according to one of the post-its).

Lack of seasonal workers

The supply of Polish workforce is not sufficient for local needs as due to the differences in wages between Poland and Western Europe (e.g. Germany, the Netherlands) a large share of workers prefers labor migration. Participants stated that even currently there's a serious lack of workforce for production and harvesting processes. According to one of the post-its a further outflow of local workforce by 20% could break the status-quo.

To mitigate the negative effects of this process producers have been able to attract the workforce from Ukraine, but in recent years it has become increasingly difficult due to low wages in agriculture and shift of Ukrainian workforce either to other sectors of economy, or their labor migration farther to the West. Few post-its indicated the problem of the prolonged process of hiring labor due to bureaucracy/regulations.

One post-it specified critical thresholds for dessert fruits and hard fruits due to a lack of labor. For the production of dessert fruits (primarily strawberries, raspberries, currants, gooseberries), a lack of labor longer than 2-4 days during the harvesting season could lead to extreme losses. In the case of hard fruits (e.g. apples, pears) this period is ca. 7 days.

Bureaucracy and variability of regulations

In the farmers' perception there is a high level of bureaucracy in EU legislation and frequent legislation changes occur (concerning regulations, requirements), which creates a constant sensation of uncertainty for the farmers and other farming system actors.

One of the post-its focused on the problem of cooperation between the state authorities and removing the incompatibilities in regulations. Another participant has noted the increasing EU regulations limiting the list of allowed plant protection products without proposing alternative solutions to help farmers in their production processes and achievement of desired yields.

One of participants has pointed out the frequent control visits conducted by several state agencies, including the Agency for Restructuring and Modernisation of Agriculture. This participant has defined that the current level of controls are the maximum he is able to withstand without breaking.

The issue of acquiring financial support has been outlined in one of the post-its as a stressful and prolonged process.

2.2 System decline

2.2.1 Introduction

Participants were divided into four small groups. Every group discussed over one unique challenge and its impact on main indicators and resilience attributes.

2.2.2 Performance of indicators and resilience attributes

Fluctuation of prices of agricultural products

After short discussion participants agreed that “utilized agricultural are”, “purchase prices for agricultural products” and “income dynamics” have strong relation with this challenge. A longer discussion took place over the labor costs. The group decided that if the prices of products drop further, the farmers could theoretically mitigate the negative effects on their income by further lowering labor cost (e.g. hiring less workers or doing more work by themselves). On the other hand, feasibility of such actions seems unrealistic, especially in some farms, where dependence on labor attracted from the outside plays the key role.

As for the resilience attributes, the group agreed that if “response diversity” would develop in a positive way (e.g. by intensification in creation of cooperatives), it would have positive impact on the risk related with the price fluctuations. Additionally, participants decided that “response

diversity” also correlates strongly with the “functional diversity”, as it can be used to further mitigate the risk related with uncertainty of product prices.

In the final discussion, participants agreed that the challenge of price fluctuations is a very complex issue and all indicators and resilience attributes have some direct and indirect effects, which depend on the given situation.

Extreme weather conditions

The group started the discussion with the first indicator of “utilized agricultural area”, they agreed that if this area is large in the farm, then it is hard to protect this field from extreme weather events (e.g. frosts). One of the participants pointed out that the large crop area can also work in an advantage of a farmer if the area is dispersed. He explained that if there is some distance between different fields not all production might be affected by the same extreme weather events (e.g. hail, rain). Nonetheless, the group overall agreed that this relation is very negative.

As for the second indicator “purchase prices for agricultural products” the group unanimously agreed that in most cases extreme weather conditions would rather have strong effects on purchase prices (usually bringing them up).

In case of the third indicator – the “income dynamics”, the group stated that it is the same situation as in case of purchase prices as those two indicators are directly correlated.

The fourth indicator “labor costs” sparked a discussion, during which participants decided that extreme weather conditions could affect costs of labor in both ways – costs could rise and drop, depending on the situation. First example was referring to a situation in which crops are flooded, which causes rise in labor cost as it will be harder to harvest those crops. On the other hand when, for example, an orchard is affected by frosts the cost of labor will be lower as there will be less fruits to harvest (which will also affect farm income).

After the discussion about indicators, the group continued to discuss the resilience attributes, deciding that only two of them have relations with the given challenge. The group agreed that “response diversity” is directly connected to the extreme weather challenge as, if given weather conditions are increasingly frequent, farmers will look for solutions to mitigate their negative effects. The second attribute connected to the challenge selected by the group was “functional diversity”. Participants agreed that if mitigation of negative weather effects would not be sufficient, farmers would change the production to avoid losses. Extreme weather conditions have (at some point in time) direct influence over choice of production. An example given by one of the participant was referring to the situation of winter crops, where due to warm winters, crops

are more susceptible to harmful fungi, which could force farmers to change production to spring crops.

Lack of seasonal workers

Group decided that all indicators have direct relations with this challenge. For the first indicator “utilized agricultural area” the group agreed that lack of seasonal workers highly negatively affects proneness of a farmer to develop his production by expanding his crop areas.

The second indicator “purchase prices for agricultural products” according to participants is causing an even greater problem with lack of seasonal worker. When it is not profitable for a farmers to harvest apples they cannot pay workers attractive wages, hence the problem deepens.

Regarding the third and fourth indicator the group agreed that they are directly related. Lack of seasonal workers is causing rise in labor costs, which in turn causes changes in income dynamics.

As in regards to the resilience attributes group marked the relation between this challenge and “Production coupled with local and natural capital” attribute. In the discussion they agreed that there are many factors, which can affect potential of the region, but ultimately no matter what those factors are, the potential of the region affects the availability of seasonal workers. Second attribute chosen by the participants as having a strong relationship with the challenge was the “response diversity”. After the discussion the group decided that proper “response diversity” could mitigate the negative effects of insufficient number of seasonal workers.

Bureaucracy and variability of regulations

Group started the discussion with “utilized agricultural area” indicator and its relation to the challenge. Participants agreed that bureaucracy and regulations have significant impact on the area of production. An example given in this matter was related to limitations in purchases of agricultural land (in Poland purchase of agricultural land is regulated by restrictive legislation).

Second indicator marked by participants was “labor costs”. Group agreed that there is too much regulation regarding hiring foreign workforce. They also pointed out high costs of hiring employees in general (taxes, social securities, minimal wage regulation, additional paperwork for foreigners, etc.).

Participants agreed that bureaucracy and regulations negatively affect the attribute of “Production coupled with local and natural capital”. The example provided referred to the situation in the Lubelskie voivodeship, where local administration is running a promotional campaign “Taste Lubelskie, Taste life” in order to boost consumption of local products. At the same time there is little support for local producers, who are struggling to compete with immense inflow of Ukrainian products. Participants also pointed out that Lubelskie voivodeship is located

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at the border of the European Union, but they are not supported (protected) enough by regulations as producers, and what's more important - the people in the Western of Poland and the EU in general do not understand the problems they are experiencing. As an example one participant referred to unregulated and not controlled to an adequate extent (according to his opinion) inflow of Ukrainian products.

The last topic in the discussion concerned “functional diversity” which, according to the group is restricted to a large extent by too much bureaucracy and an excess of regulations.

2.3 Alternative systems

2.3.1 Introduction

Participants were divided into three groups, each with a goal to generate an alternative system for the case study area. After a short discussion the following three alternative systems were formalized by the participants, namely: 1) *horticulture production: Polish fruits and vegetables*, 2) *shelter farming: soft fruits production*, and 3) *local organic production*. While all of the three have similar characteristics, the participants argued they have distinct specialization and could all be implemented in the area, while having the ability to merge some of the same features in each of them.

Final results of discussion and information filled in the spreadsheets by the participants suggest that alternative systems could improve main essential functions and resilience attributes of the farming system (Table 3). Boundary conditions that are relevant for maintaining the status quo are also likely to be relevant in alternative systems. Most boundary conditions are shared between different alternative systems and their improvement would be beneficial for farming systems developments as foreseen by the participants.

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Table 3. Current perceived performance of main functions and presence of resilience attributes (FoPIA-SURE-Farm 1) and their expected change in future systems. → implies no change, ↗ implies moderate positive change, ↑ implies strong positive change, ↘ implies moderate negative change, ↓ implies strong negative change, V implies that a boundary condition is relevant for a future system. Arrows and tick marks in bold font are results obtained in the workshop. Arrows and tick marks in normal font are deductions from what has been said in the workshop.

Indicator	Current level	Status quo	System decline	Future systems		
				Horticulture production	Shelter farming	Local organic production
1) Utilized agricultural area	Moderate	→	↘ ↓	↗	→	→
2) Purchase prices for agricultural products	Low	↘	↘ ↓	→ ↗	→ ↗	↑
3) Income dynamics	Moderate	↘	↘ ↓	→ ↗	→ ↗	→ ↗
4) Labor costs	Low	↘	↘ ↓	→ ↗	→ ↗	→
Resilience attributes						
1) Production coupled with local and natural capital	Moderate	↘	↘ ↓	↗	↗	↗ ↑
2) Functional diversity	Low	→	↘ ↓	↘ →	→	↘ →
3) Response diversity	Low	→	↘ ↓	→ ↗	↘ → ↗	↘ →
4) Reasonably profitable	Low	↘	↘ ↓	→	→ ↗	↘ → ↗
Boundary conditions						
Domain						
Stability in prices of agricultural products	Economic	V		V	V	V
Limited number of extreme weather conditions	Environmental	V		V		V
Availability of seasonal workers	Social	V		V		V
Transparent and consistent regulations	Institutional	V			V	V
Expansion of UAA	Economic			V		V
Locally suited organic crop varieties	Environmental					V
Increase of profit margin	Economic			V	V	V
Accessibility of agricultural land (physical and value terms)	Institutional			V		V
Increase of horizontal cooperation (producer groups, joint storage facilities)	Social			V	V	V
Improve consumer preferences and raise awareness	Social			V		V
Increase of vertical cooperation (sorting, processing)	Social/Institutional			V	V	V
Increase implementation of origin labelling	Institutional			V		V

2.3.2 Horticulture production: Polish fruits and vegetables

While the region is already quite focused on production of fruits and vegetables, it is seen as the potential primary specialization of the region. One of the reasons is exactly the high number of existing producers, which could be a catalyst to the creation of producer groups able to unite efforts to maintain contracting with processors, supermarket chains, large-scale customers. This is also seen as the way to minimize the existing risks: weather (e.g. by building storage and cold-storage facilities), financial (e.g. receive better loan offers), market (e.g. insure price fluctuations, supply shortages).

This alternative system could also increase the farmers' competitiveness due to distinct labelling of product origin. Participants have noted that currently too few Polish products have such labels, even though extensive efforts are being made by authorities and non-governmental entities. In the opinion of one participant, at least 60-100 original local products with proper labelling should appear in every region of the country.

Focus on quality is determined as a key competitive advantage of Polish fruits and vegetables. Product variety is important, as introduction of such diversity would help minimizing various risks (e.g. withstanding plant diseases). Yet introduction of more product variety has been pointed out as difficult, as new high quality fruit and vegetable varieties are costly.

New approaches to foreign trade are needed in order to make this system efficient. According to opinions, current the EU tariff system doesn't support domestic producers and makes foreign products (primarily from Eastern Europe) flood European markets with lower quality products. One of the participants indicated that according to his knowledge there are cases of low quality agricultural products being imported across the Eastern border into Poland without proper inspection (as it is in case of cargo of under 5 tonnes, for which actually no inspection is required, according to the participant).

This alternative system requires finding and entering new outlets, which the participants see primarily in the European Union, but also countries outside the EU (e.g. Egypt).

The area of the case study is perfect for horticulture as it is highly fragmented and because of the hilly terrain. Thus large-scale production of many other crops is limited, either physically, or economically. Due to this such alternative system could improve the situation with a lack of utilized agricultural area. As for the prices of agricultural products, participants expected that in this alternative system, prices would either stay at the current level or even increase (due to higher quality, costs due to improved varieties, utilized technologies). Income dynamics (perceived in this case through the prism of profits) as would either be same or increase. Due to changes such as introduction of new varieties the production dynamics are expected to change.

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If consumers would be eager to react positively to these new varieties and show the needed demand, the supply with time would also follow in growth dynamics. This would allow farmers to achieve the goal of expanding their income and profits. Labor costs are expected to rather increase, as potential workers (unskilled manual labor) currently have the possibilities to be employed either in other developing sectors of the Polish economy (e.g. construction, sales), or tend to temporary (seasonal) economic migration to the West of Europe (e.g. Germany, the Netherlands), where they have higher remuneration. Therefore, currently, the agricultural sector in Poland is facing a shortage of workers at the current level of wages. In the alternative system there are options to either adapt to this situation or to increase wages and attract the necessary workforce.

As for the resilience attributes, the local and natural capital have a positive influence upon potential implementation of this alternative system. In the case of functional diversity the impact is either neutral or unfavourable as such specialization on horticulture rather brings more risks in terms of lower income diversification and markets. Response diversity might not be a strengthening factor as the insurance products are not adjusted (in many cases, according to participants) to actual needs of particular farms, thus either not covering their specific needs, or being too complex and expensive.

2.3.3 Shelter farming: soft fruits production

In this alternative system, farmers focus on risk mitigation, as currently they are increasingly facing extreme weather events, which put pressure on the production of soft fruits. Therefore complex measures to withstand growing risks can be implemented through a completely new approach to soft fruits production by shifting to shelter farming thus directing investments into construction of such. These constructions not only protect from weather risks, but also provide technical means for smart (advanced and complex) farming techniques. This would allow to rethink and rebuild the farming system on this new approach, thus transforming the current soft fruits production to a level that is suitable to the new alternative system.

Utilized agricultural area is expected to stay the same, as this alternative system deals with solely soft fruits. Prices would rather stay the same, but it would depend on the desired period of investment return. If farmers turning to shelter farming would rather target quick investment return, they might go towards the price increase, and on the contrary – the prices could stay at the same level if the risk management costs would equal the investment expenses, therefore levelling them. Income dynamics would either stay at the same level or increase, depending on

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the particular time in regard to necessary investments (until the investment is at the break-even point or after it).

According to the participants the key issue is the current construction legislation (building code) in Poland, as obtainment of necessary building permits is perceived as lengthy in terms of time and overly bureaucratic.

As for the resilience attributes, they are to either improve or stay the same. In case of local and natural capital – the key positive change is the increase of efficiency, for example, in utilization of water resources. Functional diversity is not expected to show major changes. Current response diversity has a rather negative influence as farmers experience some obstacles with the building code and funding (investment) opportunities. Upon transformation to this alternative system the response diversity is to improve, as the numerous risks are being limited due to increased protection of crops, high level of control over the production processes, reduced need for exogenous support in farmer's risk management). Reasonably profitable is expected to either stay at the current level or to improve, as the farmers' profits will be more predictable.

2.3.4 Local organic production

Shortening the supply chains has a potential to lower the prices and along with increased eco-awareness could lead to transformation of the entire farming system. Currently there are already farms in the area focused on organic production, yet the scale is still relatively low. Participants pointed out it may be due to low state support, poor labelling system, and underdeveloped indication of the product origin. Yet in perspective, local organic production could be the alternative system beneficial for the producers, consumers and the environment.

Utilized agricultural area is not expected to change.. Organic production is overall land-intensive, as achieving the level of production volumes comparable to intensive production (use of mineral fertilizers, pesticides) needs larger areas. Yet if transformation would assume adoption of ecological approaches on current areas utilized under conventionally produced crops, in result we could expect structural replacement within the current UAA boundaries (without needs for expansion). Overall prices for agricultural products are expected to increase, as the traditionally-produced crops would be replaced by the organic products. There is also a regional differentiation, as locally these organic products would be available at lower prices than for products that have been transported. Assuming the demand for organic products would be at the level of conventionally-produced crops, the income would either stay at the same level or increase. Labor costs are not expected to change.



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Production was assessed to become more coupled with local and natural capital, as soil fertility, water resources and existing nature are to be maintained well. Available local resources would be utilized locally to a higher extent, as organic production would be based on natural means of production (e.g. organic manure). Functional diversity could either decline or stay at the current level, as in organic production limits the variety of available inputs (fertilizers, plant protection products, etc.), narrows the farmer to specialization in organic production (which is not possible to combine with conventional production). Response diversity has rather a declining trend due to narrow options of farmers in regard to risk management (limited availability of pest controls). Participants perceive that state support in regard to risk management in organic farming is crucial (e.g. refunding insurance premiums).

The resilience attribute “reasonably profitable” is highly dependent on consumer behaviour and preferences. Thus at the current moment it is perceived as rather risky and unpredictable, as Polish domestic consumers are not attracted to organic products at the current price levels. In case of changes of consumer behaviour and dietary habits the consumption of organic products is expected to increase, thus making this type of agricultural production more profitable.

2.4 Strategies towards the future

The next step is to define the future strategies within each alternative system and compare it with the current strategies (Table 4). The current strategies are based on FoPIA-SURE-Farm 1, while the future strategies for different future systems were the result of FoPIA-SURE-Farm 2 framework. Important to note there is a slight difference in strategy aggregation, as the FoPIA-SURE-Farm 1 is more generic and to fulfil its research goals was aimed to aggregate specific strategies into more general dimensions with following descriptions, while the FoPIA-SURE-Farm 2 elicits more detailed information because for each defined strategy a particular future scenario is taken into account.

All discussed alternative systems are perceived as beneficial for the rural areas in general and farmers in particular, as they potentially lead to improvement in incomes, more efficient and environmentally-safe farming approaches. Maintaining adequate profit margins and increasing cooperation (both horizontal and vertical) were often mentioned as crucial boundary conditions, which would have a positive effect upon the farming system’s development.

According to participants the alternative system defined as “horticulture production” requires implementation of the following strategies: entering new foreign markets, simplification of regulations (e.g. quicker processing of applications submitted in the framework of CAP financing



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programs), education campaigns for consumers (e.g. supporting consumption of domestic products, increasing the share of fruits and vegetables in the daily diet).

The alternative system “shelter farming” define several strategies important for implementation in order to achieve this alternative state: additional dedicated action in the Rural Development Programme framework targeting quality and profitability of agricultural production, preferential taxation system for shelter farming, creation and promotion of locally recognized brand “Sheltered strawberry”.

The “local organic production” was defined to require the following strategies: 1) increase the number of farms adopting ecological approaches and gradually (yet steadily) switching to organic farming, increase the use of mechanization in organic farming, target and support organic farming by the state policies and funds, 2) intensification of vertical cooperation (“farmers – wholesalers” relation), 3) diversifying outlets: direct sales to consumers supported by promotion and educational campaigns.

In most cases the resilience attributes benefit introduction and development of alternative systems. “Production coupled with local and natural capital” was rather beneficial for all systems, with the highest positive return relationship in case of “local organic production”. “Response diversity” is most unpredictable and dependent on economic situation and investment conditions in case of “shelter farming”, while the “reasonably profitable” is hard to predict for “local organic production” due to numerous possibilities in terms of prices and consumer behavior.



D5.5 Impacts of future scenarios on the resilience of farming systems across the EU assessed with quantitative and qualitative methods

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Table 4. Current strategies and future strategies for different future systems. Current strategies are based on FoPIA-SURE-Farm 1. Bold font indicates that these strategies were mentioned during the workshop for a specific system. Normal font indicates that, based on the discussions during the workshop, it seems likely that strategies will be applied in certain systems.

Strategy	Domain	Current system	Status quo	Future systems			Source of information
				Horticulture production	Shelter farming	Local organic production	
Simplification of regulations	Institutional			v			FoPIA 2
Education campaigns for consumers	Economic/Social			v			FoPIA 2
Additional actions in the RDP targeting quality and profitability of agricultural production	Institutional				v		FoPIA 2
Preferential taxation system for shelter farming	Institutional/Economic				v		FoPIA 2
Creation and promotion of a locally recognized brand	Institutional/Economic				v		FoPIA 2
Increase in the number of ecological farms	Social					v	FoPIA 2
Intensification of vertical cooperation	Social/Economic	v		v		v	FoPIA 2/FoPIA 1
Diversifying outlets (entering new markets)	Economic					v	FoPIA 1
State support	Institutional	v					FoPIA 1
Horizontal cooperation	Social/Economic	v		v	v	v	FoPIA 1
Marketing	Economic	v		v	v	v	FoPIA 1
Insurance	Economic	v					FoPIA 1
Enduring	Economic	v					FoPIA 1
Diversification	Economic	v					FoPIA 1

3 Interpreting results

3.1 Tipping points

In the perception of participants, the current situation is close to the tipping points, especially in case of profitability (derived from fluctuating prices – confirmed, among other, by Świetlik 2019), weather conditions (extreme events as hail, droughts, frosts – analysed by Hamulczuk et al. 2016, Czakowski 2016), bureaucracy and administration (number and frequency of controls, complexity application for CAP payments – confirmed by studies of Drygas et al. 2019). Many of them express the feeling that if the situation with some of these issues worsens, they wouldn't be able to continue their business as usual. But they have quite clear understanding of their resilience capacities, mostly regarding adaptation. For example, in case of early weather forecasts warning them about an upcoming extreme event, farmers believe they can introduce measures aimed at reducing their losses. Participants believe they have the ability to transform their activities by diversifying and adding small-scale processing and direct sales. Important to point out that since the beginning of 2019 (according to new legislation) farmers are allowed to sell their products directly to consumers and restaurants.

Among the resilience attributes the primary one that would support the strengthening of resilience, as well as the realization of alternative systems, is "Production coupled with local and natural capital". This is especially valid in cases of "horticulture production" and "local organic production" alternative systems, as they depend highly on soil quality and well-functioning surrounding eco-system.

3.2 Thresholds exceeded

Utilized agricultural area is one of the restricting factors in farming, especially in Poland there is high land fragmentation, relatively high land prices and state restrictions on turnover of agricultural land (enacted April 2016). If the land prices increase even further (beyond 60-100 thousand PLN/ha (14-24 thousand EUR/ha), depending on the land class/quality), adaptation (increasing the scale of farming) and transformability (diversification through adding new crops) for current farmers would be endangered. Profitability of horticultural production due to constant price fluctuations is endangered and has a highly negative effect both on farmers' economic situation and their well-being. Adaptation possibilities are limited as it is difficult for farmers to predict market situation and therefore plan accordingly without having the relevant information and knowledge ahead of time. As purchase prices are being the basic factor influencing the farmers' income level, the market uncertainty and frequent operation near the zero-profit point



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(valid, for example, for raspberries and currants) drains the farmers economic potential and limits their ability for adaptation/transformation measures (for example, lack of own savings which could be used either for financing the changes on their own or to at least cover their own loan contribution). Farther increase of labor costs could make farming permanently non-profitable. Exceeding the thresholds for these indicators brings the danger of farming system's failure, permanent emigration of rural inhabitants, and decline in domestic supply of horticulture products.

In terms of resilience attributes, the influence of exceeding thresholds is diversified. In case of the local and natural capital, the impact is rather beneficial, as the soil fertility and existing nature are maintained well. The only exception is the water availability, which is becoming problematic in the recent years nationwide due to climate change and anthropogenic influence. It's important to note the actions taken by individual farmers enhance collective resilience through their positive impact upon local and natural capital. Therefore further improvements in farming practices and limiting the use of mineral fertilizers and pesticides are expected to have a lasting positive effect. The functional diversity is already at a poor level due to narrow availability of income sources in rural areas and undiversified markets for horticulture products and is expected to further decline. In the case of response diversity, there is a potential for improvement through vertical and horizontal cooperation, in which case exceeding the threshold could eventually improve resilience. Profitability seems to be the key factor determining farm resilience. Profitability is also related to the eagerness to invest in innovations and change. Exceeding critical thresholds, however, have a big impact on the resilience attribute "reasonably profitable".

In terms of interacting thresholds (Figure 1), the key factors influencing the production processes are the extreme weather conditions and purchase prices for agricultural products. In case of the weather conditions, the extreme events impact the yield and harvested output, therefore influencing the farm income dynamics, which was constantly emphasized upon by the participants. On the economic side, the fluctuations and frequent drops in purchase prices for agricultural products affect economic viability, as harvested outputs may be lower due to two reasons: 1) expecting lower prices farmers tend to cultivate less, thus not supplying the demanded product volumes (there's a substantial time lag in agriculture which limits possibility of quick farmers' responses to demand changes), 2) understanding the potential losses, farmers might not harvest the cultivated crops in order to avoid additional labor expenses (in such cases the harvest is just left on the field to rot, thus not enabling the farmers to make expected profits). Lower yields in combination with price drops lead to a decreased income at farm level. Low income at farm level results in lower remuneration of laborers. This directly affects labor shortage. The lower remuneration level in the countryside, also leads to further reduction of the rural population,

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which further impacts the availability of labor at the farm level (and in perspective increasing production obstacles for farmers).

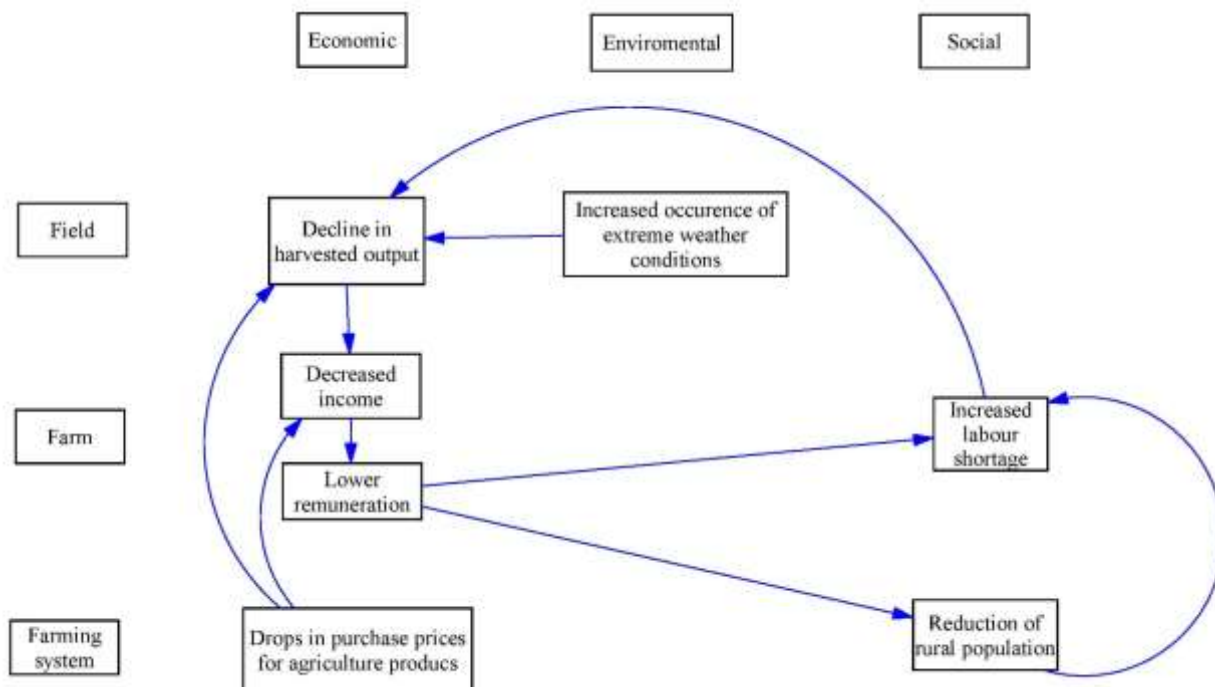


Figure 1. Interacting thresholds in the Polish horticulture farming system in the case of a system decline due to increased occurrence of extreme weather events and increased drops in agricultural product prices.

3.3 Alternative systems

All of the indicators have the potential for improvement in all three alternative systems. In the case of horticulture production and shelter farming the key changes seem to be using adaptability to improve the current system, as the horticulture farming system is adapting to changing conditions by expanding regional production and entering new markets, while maintaining the same products. Shelter farming is adapting to negative influence of the weather challenges by switching to production technologies targeting the protection of crops (although from a landscape perspective this alternative system would be a transformation). The “local organic production”, however, seems a transformation compared to the current system because agricultural practices need to be radically changed (as farmers stop utilizing the use of chemical fertilizers and plant protection products, as well as production methods, crop rotation and overall farm management approaches).

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Coupling with local and natural capital is improved in all of the alternative systems, as in the horticulture production rather extensive use of land resource is being utilized (less fertilization compared to other key local crop products), and in the shelter farming intensive use of land is present, yet the land coverage needed to achieve intensive yields is relatively smaller, thus leaving land areas for other greening purposes (e.g. grassland). The most beneficial influence upon the local and natural capital has the third alternative system - “local organic production”, which due to lack chemical fertilization and plant protection measures has the best potential for eco-systems protection and improvement. Robustness is expected to improve in all alternative systems, as the local and natural capital would be utilized more efficiently and sustainably. Adaptability would be improved, but to a lesser extent, same with transformability. This is basically a continuation of the FoPIA-SURE-Farm 1 findings, which have pointed out to similar conclusions in case of the current state of the farming system.

In regard to this resilience attribute the expected changes in resilience capacities of alternative systems are as follows. 1) Horticulture production – with the improvement of local and natural capital the robustness is definitely expected to improve, as the new more efficient utilization of resources would create the reserves available in case of exogenous shocks; adaptability is improved to the same reasons, as with new approaches more possibilities and techniques should be available (e.g. land utilization, water management). Transformability is the least improved attribute as narrowing specialization is a limitation in general. 2) Shelter farming – robustness is improved, especially in terms of environmental challenges. Adaptability and transformability are limited to quite high extent, as the costs of shelter constructions might have depleted the farmers resources and limit from, for example, land expansion. On the other hand water resources are managed more efficiently, yet only in the framework of the current system, thus only adaptability benefits from it. 3) Local organic production highly limits the robustness, even though the local and natural capital is to increase. This alternative system is aimed at transformation as it requires from the farmer to comply with strict requirements, which often is related to high risks and requires deep transformation of production processes. In the result in the new alternative system farmers will be more vulnerable and having less options to farther withstand, adapt or transform, but themselves having a positive influence upon this resilience attribute and its features.

Functional diversity is directly influenced by horticulture production as one of the main strategies in this alternative system is entering new markets (e.g. west of Europe). Its impact is either neutral or unfavorable as such specialization on horticulture rather brings more risks in terms of income diversification and markets. Similarly, with “local organic production”, as it limits the variety of available inputs (fertilizers, plant protection products, etc.), narrows the farmer to specialization in organic production (which is not possible to combine with conventional production). Only in case of “shelter farming” no major changes are expected.



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In regard to functional diversity the expected changes in resilience capacities in proposed alternative systems are the following. 1) In case of horticulture production the robustness is either not expected to change or might slightly/significantly improve due to cooperation (intensity of change depending on the farmers' readiness to cooperate). At the same time the inputs, outputs and income sources are to stay the same. Adaptability may improve as the cooperation and search for new markets may open new possibilities, construction of sorting facilities and cold-storage facilities will further improve it. Transformability is rather limited, as the continued specialization and cooperation would decrease the possibilities to diversify, especially in case of deep cooperation between farmers and possible contracting (which would create legal expectations to deliver strict types and volumes of products). 2) Shelter farming – robustness in terms of functional diversity is not expected to change, while the adaptability could increase due to availability of different inputs and decreased needs for plant protection products. Transformability is rather limited, as such type of farming implies narrow specialization. 3) Local organic production is an alternative system with distinct features, therefore a completely different set of functional diversity elements are presumed (inputs, outputs, markets). Robustness is expected to be limited, at least at the time of conversion to organic farming and especially at the early stages, yet at the “experienced” stage it is to improve significantly. Same applies to adaptability, as it would highly depend on the farmer's readiness and understanding of current/opening opportunities. Thus search for new alternative inputs, new techniques and knowledge would strongly aid farmers in their ability to adapt. Transformability is the most uncertain issue at this point, just as described in case of the previous resilience attribute (coupling with local and natural capital).

Response diversity would be improved in case of all alternative systems, as with more efficient systems the abilities of farms would increase to implement additional measures targeting risks. Among other, horizontal and vertical cooperation present in all alternative systems would help minimizing risks through cooperation and gives opportunities for investments in joint assets (storage and cold-storage facilities, sorting plants). Various insurance plans would be more available to farms, as due to their cooperative efforts, as well as due to expected increased profit margins and overall income level. This could help to deal with both environmental and economic issues the farms in the farming system are currently struggling with. In terms of resilience capacities the response diversity would benefit robustness in all of the alternative systems, while also increasing their adaptability potential. Yet the latter depends highly on the cooperation intensity, as individual farmers would not benefit the same as the ones joining in tight cooperation. Transformability is rather questionable.

Exactly the same applies to the attribute of “Reasonably profitable”, with few additional aspects. For example, in case of “local organic production” the entry costs are relatively higher (e.g.



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certified biological plant protection products) and might take longer (e.g. for certification, selection of varieties, finding markets) to achieve a stable income level. The expected changes in resilience capacities in regard to particular alternative systems are similar as well, as in case of “Horticulture production” and “Shelter farming” the robustness and adaptability are improved due to higher income levels and higher security perception. Transformability is enhanced due to the same reason, but might be limited institutionally due to agreements and connections with other farming system actors.

Maintaining the status quo in the future is expected to result in a lower presence of resilience attributes, thus eroding the resilience capacities of the system. Overall, development of resilience attributes in “Local organic production” seems least favourable among the alternative systems (Table 3), but is still an improvement to maintaining the status quo. Based on expected developments of presence of resilience attributes, it seems that alternative system “horticulture farming” will show highest degrees of robustness, adaptability and transformability.

3.4 Causal loop diagram

Figure 2 presents a causal loop diagram (CLD) reflecting relations between main indicators, challenges and resilience attributes in the farming system, as well as strategies defined as relevant for implementation of alternative systems.

There are three central points in the CLD, namely: income and demand for agricultural products. Regardless of the strategies these two points are interconnected with all other elements in the farming system. After adding the strategies the direct relations may not be that visible, yet they still exist influencing the farming system through other elements.

Threshold defined by the participants orbits primarily around the “income dynamics indicator, which is directly related with the income and the demand for agricultural products. Attributes which directly influence income dynamics are the “response diversity”, “functional diversity” and “reasonably profitable”. Response diversity also impacts income dynamics indirectly through labor costs, while also helping to cope with risks connected to extreme weather conditions.

Strategies directed towards creation and promotion of locally recognized brand and consumers’ education are originating from the scenario of “local organic production” alternative system and increase in numbers of organic farms. These actions have influence upon the demand. Educated consumer consciously chooses products to purchase. Promotion of local brands influences their recognisability and therefore the demand.

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Workshop participants defining the alternative system focusing on shelter farming have pointed out such strategical measures as lowering of taxation and discovering new markets. It is important to note that these strategies should ensure the reasonable profitability to the producers. At the same time it was emphasized that these could influence the soil quality and spatial planning (use of agricultural land and yield levels).

A strategy directed at the policy-makers have also been pointed out, which through both tax regulations and Rural Development Programmes can influence the improvement in income-costs relations, therefore aiming the reasonable profitability.

Changes in mentality of farmers and creation of prerequisites for development of cooperation have been emphasized by the workshop participants. Intensification of horizontal and vertical cooperation could help to educate a wider choice threshold in the farming system within “functional diversity” and “response diversity”. Yet first of all cooperation would strengthen the farmers’ bargaining power on the market and would help to improve price/costs relations.

Despite the fact that the workshop participants have noted the third alternative system as the horticulture production and defined three corresponding strategies (entering new foreign markets, simplification of regulations and education campaigns for consumers), the research team in the process of CLD creation have concluded they are related to all alternative systems proposed and would play an important role in their developments.

Added by the participants were also the three indicators, which in their opinion serve an important role in understanding relations with utilized agricultural area, through fertilization intensity, soil quality and crop yields. Same three indicators, according to participants, are affected by weather condition, as well as influence the quality of local and natural capital. Added was also the demand for agricultural products, serving an important balancing factor for the produced goods, being the supply side.

A more detailed description of the key loops is needed for understanding of primary and most influential impacts. To have a clearer understanding of the relations the following descriptions have been aggregated, with each loop part having distinct interrelations.

Part 1. Lack of seasonal workers influences the labor costs thus impacting the income dynamics. Income dynamics has influence upon the uptake of additional employment by potential seasonal workers. The availability of labor force can be one of the factors influencing the decision-making by farmers to convert to organic farming, thus leading to increase in the number of ecological farms.



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Increasing number of ecological farms could have impact upon the increase of labor costs, as it generates additional demand for labor. It also has impact upon the demand for agricultural products, as well as consumer educations (shifts in their behaviour – it is a two-way loop as by shifts in consumer behaviour it is also possible to increase the number of ecological farms). Increasing the number of ecological farms could intensify creation of new locally recognized brands.

Consumer awareness influences the demand for agricultural products, just as emergence of new brand on the market could shift the structure of demand. Changes in demand influence the shifts in prices for agricultural products, which in turn influence the farm income and income dynamics in the country.

Level of farm income influences its financial abilities concerning the costs of inputs, including the fertilization intensity. The latter feeds the soil fertility (quality) and influences the quality and volume of outputs (crop yields). Achieved yields feed the farm income, but also the manner in which utilization of agricultural land is being conducted. Utilized agricultural area (e.g. particular farm area determines farming practices and crop rotation techniques, especially vivid in case of Eastern Poland, where farm land is highly fragmented) affects the level of fertilization, both influencing the soil quality, the fertilization intensity thus affecting the local and natural capital.

Production being coupled to local and natural capital affects the price relation of agricultural products to agricultural production costs.

Demand for agricultural products influences emergence of new locally recognized brands, with the education campaigns for consumers further strengthening these relations (this is represented by reinforcing feedback loop; R1 in Figure 2).

Part 2. Actions in the RDP influence the price relation of agricultural products to agricultural production costs, as well as on the reasonable profitability, which in turn affects the level of farm income and income dynamics in the country.

Diversification of markets (outlets) affects the demand for agricultural products, simultaneously influencing the prices for agricultural products, thus also affecting the price relation of agricultural products to agricultural production costs. Diversification of markets (outlets) also influences the eventual focus on shelter farming, which is supported by the preferential taxation. This is a two-way relation.

Tax liberalisation (e.g. for shelter farming) has its consequences in utilized agricultural are, the reasonable profitability, as well as response diversity. Development of shelter farming has its impact upon the fertilization intensity and crop yields.

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Part 3. Extreme weather conditions are a variable impacting the fertilization intensity (as it can lead to severe losses of organic matter in the soil and washing-out of nutrients in the soil), the level of yields (e.g. hail or frosts can cause loss of crops, draughts decrease yields, while the excessive rains lead to plant disease intensification).

Frequency of extreme weather conditions in the region impacts its local and natural capital. The natural capital (in other words local conditions) are most likely to influence the level of prices in local trade (e.g. in areas with frequent hail producers quit cultivating soft fruits and the local price for these products would be most likely higher compared to other regions).

Part 4. Simplification of regulations influences the response diversity and functional diversity. It is important to emphasize that the relation between the procedures' simplification and lack of seasonal workers is reversible (two-way). Such simplification can impact the labor supply, at the same time current availability of labor force can lead to pressure upon policy-makers to simplify procedures regarding employment and labor markets (e.g. employee registration or unemployment support). Of course, indirectly such simplification could farther lead to costs of employment. Overall primarily the income dynamics in the economy influences the lack of seasonal workers, which in turn affects the availability of labor force (being a balancing feedback loop; B1 in Figure 2).

Part 5. The weakness of Polish farms, as it was mentioned by the stakeholders, is the cooperation. Development of both horizontal and vertical cooperation influences the functional diversity and response diversity – there will also be reversible relations, as in the search of various solutions the farming system actors would be interested by either intensification or minimisation of cooperation. Intensification of cooperation also impacts the price relation of agricultural products to agricultural production costs, as united they can achieve additional benefits from the scale of production and negotiate the wholesale prices for production inputs.

The issue of prices appears in several places, therefore it was a challenge to define both price relation of agricultural products to agricultural production costs, as well as the price changeability of agricultural products. These variables are depending on the price levels in the stores, yet also influencing demand for agricultural products and income levels.



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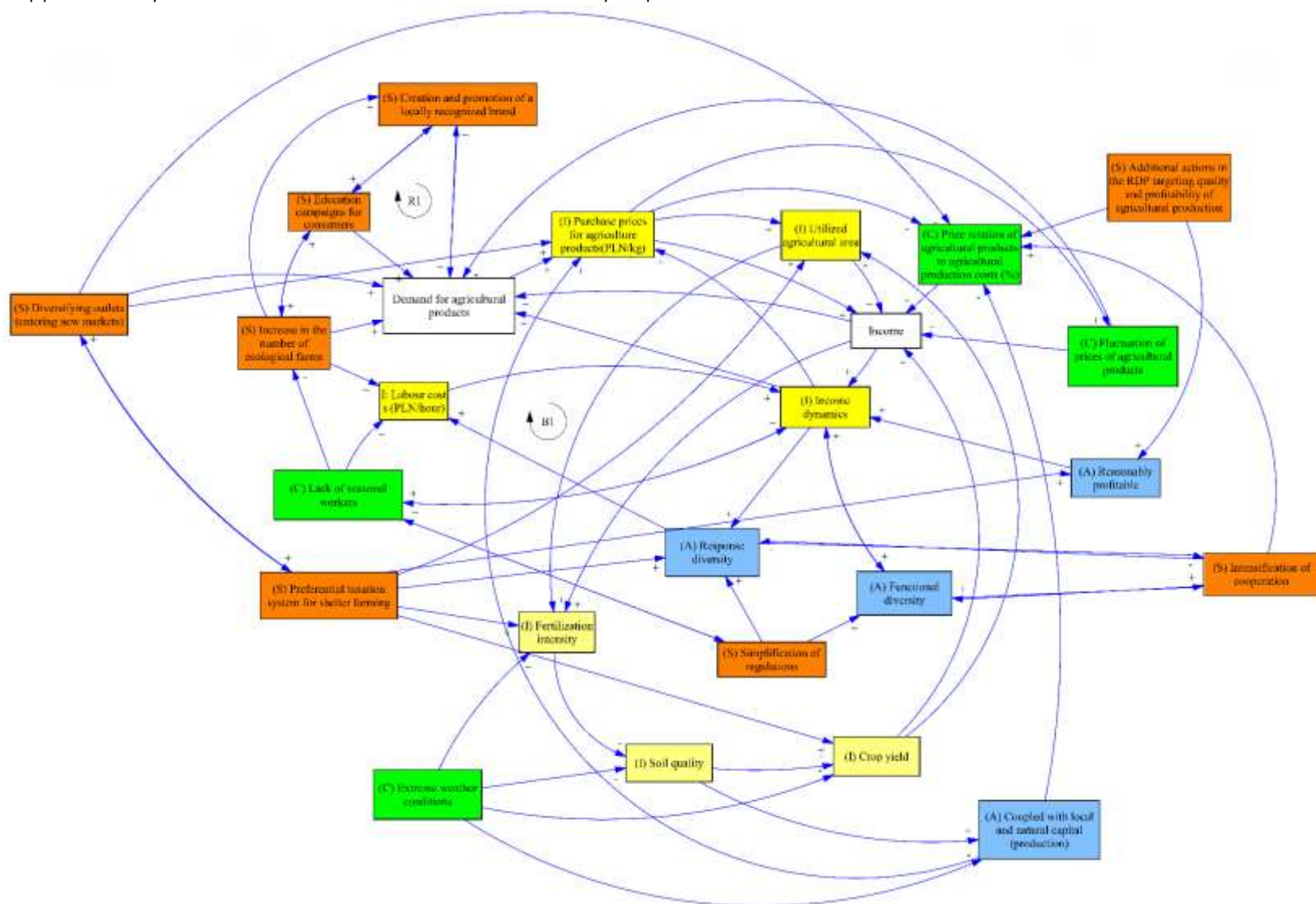


Figure 2. Causal loop diagram depicting the relations between indicators, challenges, resilience attributes and possible strategies in the horticulture farming system in Poland

3.5 Linking alternative systems to scenarios

Next step is linking the defined alternative systems for Polish horticulture to “Shared socio-economic pathways for European agriculture: Eur-Agri-SSPs”, which are based on Mitter et al. (2019) (Table 5).

Table 5. Compatibility of alternative systems with different Eur-Agri-SSPs. Where values -1 to -0.66: strong incompatibility, -0.66 to -0.33: moderate incompatibility, -0.33 – 0: weak incompatibility, 0-0.33 weak compatibility, 0.33-0.66: moderate compatibility, and 0.66-1: strong compatibility.

Systems	Scenarios				
	SSP1	SSP2	SSP3	SSP4	SSP5
Maintaining status quo	0.48	0.31	-0.69	0.18	0.31
Horticulture farming	0.48	0.34	-0.69	0.25	0.39
Shelter farming	0.56	0.28	-0.72	0.19	0.29
Local organic farming	0.52	0.37	-0.69	0.21	0.35

Maintaining the status quo requires the current system to not exceed the tipping points of the thresholds, many of which were pointed out by the participants. Firstly, land prices, land availability and land fragmentation are at the point where the situation cannot worsen any farther in the perception of stakeholders, as it could lead to either system decline or be a catalyst for quicker changes. Then purchase prices for agricultural products need to be more stable and predictable for the status quo to remain as well, while the input prices should either stay at the same level or be lowered. Thirdly, the income of rural residents and labor supply are to be maintained at least at the current level, as they are perceived as insufficient as it is, yet as something farmers and the farming system can withstand.

Basically maintaining the status quo goes in line with the SSP2, if no larger shocks appear. Due to growing focus of CAP on environmental issues and tending to direct the European agriculture towards more sustainable approaches, many of which have already been implemented by Polish farmers, maintaining the status quo goes well in line with the SSP1, as sustainability and sustainable agricultural development is increasingly more understood and expected.

The alternative system of “horticulture production” is expected to thrive the most in case of SSP2, as it reflects continuation of current farming system’s specialization with expansion over other types of agricultural production (basically steadily replacing them). In case of SSP1 it could also be

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implemented and would use the positive elements of this pathway. It could help shift Polish horticulture sectors towards lower emission and lesser pesticide use.

“Shelter farming” is quite similar to the previous alternative system, as it doesn’t change pillars of the current agricultural system, but changes the production and technological approaches to horticulture farming. In case of SSP1 shelter farming is beneficial due to efficient water management and use of agricultural area, therefore with slight modification of technologies it could be easily adapted to more sustainable production. As for the SSP2, currently the shelter farming is already developed, yet has only a minor share in overall production technologies. Therefore, in case of SSP2 pathway it would thrive the most without any modifications.

“Local organic production” would thrive mainly in SSP1, as it fits perfectly to its goals and assumptions. However, participants mentioned that SSP2 would also be relevant for the development of this alternative system in its adaptation stages.

Stakeholders’ expectations tend to either SSP1 or SSP5 and think both of these pathways might be interconnected and elements of them both might be present in the future agricultural systems. This is a rather positive development scenario, which would be beneficial for the farmers, the public and the society as a whole. The greatest concern among these pathways was related to part of SSP5 connected to liberalization of production and total reduction of public payments. There is a strong feeling the Polish horticulture might not withstand harsh global competition (which is of course just a chance, but still too risky). On the other hand, since the Polish horticulture brands are well recognized (e.g. Polish apples in China), such liberalization could lead to overall positive transformations in the agricultural production and processing structure, even though currently unwanted by individual farmers. Also currently, the public payments allow to maintain some level of profitability, which was constantly emphasized upon during the discussion, therefore farmers are so used to receiving payments (subsidies), that they count on it in their production planning.

Combination of all proposed alternative systems could be possible, in fact such outcome is the most rational to expect, as they each of the offers different solutions to existing issues and aid in minimizing the negative outcomes of listed challenges. Therefore, the local increase of horticulture production could be easily combined with expansion of shelter farming, while both these systems could be implemented not only for conventional farming frameworks, but also organic. The question remains on what would be the shares of each of proposed alternative systems in the future farming system, yet it is possible to assume with high probability that elements of each one would be implemented. Such merging of elements would still be in line with



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the selected and somewhat expected development scenarios, being either SSP1 or SSP5, out of which the SSP1 seems to be most beneficial.

The feedback on SSPs was rather positive, yet with some comments. Especially the SSP5, defined as “agriculture boosted by technology” was not fully understood by the participants, as they perceived it as rather positive and innovation scenario, yet some elements raised concerns. Namely the boost of economic growth due to large dependence on fossil energy sources was not in line with the rest of elements. Participants believed that technology can boost economic growth and at the same time it can be a key element to achieve sustainability goals. Also in line with recent developments, the renewable energy sources are considered as most progressive and large emphasis is put on them when predicting future economic and environmental developments.

3.6 Strategies

Connecting all the alternative systems is the strategy of cooperation, which is beneficial for farms in regard to three of the key challenges: environmental (withstanding extreme weather events), economic (levelling and increasing the profits level), as well as jointly dealing with institutional (bureaucratic) issues. It is also easier to search for and enter new markets as a cooperative (most spread type of which in Polish agriculture is a producer group).

Implementation of educational campaigns was emphasized upon by the participants in regard to “horticulture production” and “local organic production” alternative systems. The changes invoked by active informational approaches in the society could influence the consumer behaviors and improve dietary habits, thus serving at least two important roles: 1) supporting production of domestic fruits and vegetables (including healthy organic products), and 2) having a positive effect upon well-being (health, longevity) of population.

The case of labor shortage seems to be the most difficult to resolve at this time or in the near future. Regardless of the alternative system. Some of the participants we suggesting to focus on mechanization and automatization increase in farming in order to fill in for the labor deficit, at the same time increasing farming efficiency. Other participants have noted during the discussion that higher wages could be offered to farm workers and that would definitely attract more people (both local and from abroad) to work in Polish agriculture, yet there is an understanding that currently farmers are not able to pay higher wages with the price fluctuations and uncertain profits.

4 Conclusion

Currently the farming system shows the signs of robustness and to some extent – adaptability. The situation is not satisfactory to the farmers (primarily in terms of production profitability and income generation) and other stakeholders in the system, as the system seems to be very close to critical thresholds. However, adaptability of the system seems to be able to maintain the status quo, resulting in the absence of signs of further system decline. However, it should be noted that the system has the potential for interacting thresholds under pressure of market and weather conditions; income levels and availability of labor are key in this. Moreover, the causal loop diagram shows strong reinforcing feedback loops. Fortunately, the effects of challenges that influence these loops, could possibly be mitigated by strategies that were identified by participants.

Overall, as in the FoPIA-SURE-Farm 1 workshop, the farming system is perceived primarily through the prism of economic functions, while the key resilience attributes are the “Production coupled with local and natural capital”, “Functional diversity”, “Response diversity” and “Reasonably profitable”. The key challenges defined were the: “Fluctuation of prices of agricultural products”, “Extreme weather conditions”, “Lack of seasonal workers”, “Bureaucracy and variability of regulations”.

Local and natural capital as a resilience attribute is the most influential and beneficial for the horticulture farming sector, while the other three attributes are not currently having positive effects to the expected extent. Furthermore, horticultural production is not perceived as reasonably profitable, therefore it doesn’t strengthen this activity, even though it is stressed as being the most important for farmers. In case of implementation of substantiated alternative systems the resilience attributes are expected to improve to the highest extent in terms of robustness and adaptability. None of the proposed systems, after their development, are expected to have an improving influence upon transformability, as they are perceived as rather rigid and narrow, thus limiting the farmers to the types of selected production.

Key adaptability strategies (some defined solely for particular alternative systems, yet during the synthesis conducted by researchers defined as rather generally beneficial) are: vertical and horizontal cooperation, educational campaigns aimed to shift consumer behaviors and improve their dietary habits, simplification of regulations and entering new foreign markets. These strategies would be relevant for all potential alternative system defined by the participants, yet would benefit the most the “horticulture production” and “local organic production” systems. The defined strategies to large extent support the ones defined and aggregated in the FoPIA-SURE-Farm 1 approach, as they go in line with its aggregates (marketing, horizontal and vertical

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cooperation, state support, insurance and other). The other strategies defined by the workshop participants that are particular for specific alternative system included: additional dedicated action in the Rural Development Programme framework targeting quality and profitability of agricultural production, preferential taxation system for shelter farming, creation and promotion of locally recognized brand “Sheltered strawberry” (all in regard to “shelter farming”), as well as increase the number of farms adopting ecological approaches (proposed by participants in regard to “local organic production”).

The “local organic production” alternative system would be the transformation of the current system and would be most beneficial for sustainable development of the region. It would go in line with Eur-Agri-SSP1, being most environmentally-friendly and allowing to assure the same development fundamentals for the future.

Overall the compatibility of alternative systems with Eur-Agri-SSPs can be described as moderate, yet in case of “horticulture farming” and “local organic production” the compatibility is strongest with the SSP1 and weaker with SSP2 and SSP5. The “shelter farming” alternative system is compatible with the SSP1 and has rather weak relations with other scenarios. All of the proposed alternative systems show strong incompatibility with SSP3.



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