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FoPIA-Surefarm Case-study Report United Kingdom

Work Performed by Partner No. 4, CCRI – University of Gloucestershire

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Abstract

This report presents the results from a stakeholder workshop on current resilience of large-scale arable farming in the East of England, based on the Framework of Participatory Impact Assessment for the Sustainable and Resilient EU Farming systems (FoPIA-Surefarm). In FoPIA-Surefarm, stakeholders are asked to evaluate the system functions and their indicators for their significance for and performance in the farming system, defining main purpose of the resilience.

The key functions of the farming system in the UK were found to be: “the delivery of healthy & affordable products”; “ensuring economic viability”; and “maintaining natural resources in good condition”; showing the system to be production and economically driven. The average level performance of the systems functions indicates a medium level of sustainability. The indicators of the system functions further analysed were selected based on scoring and discussion with the participants, namely: “soil quality”, “biodiversity” and “productivity”.

During the workshop stakeholders identified strategies, to manage challenges that occurred in the past, by describing the historical dynamics of the selected indicators. The identified strategies were then scored on implementation and contribution to the robustness, adaptability and transformability of the system, giving an indication of the past resilience of the farming system. Stakeholders perceived past resilience to be low, due to the limited implementation of the strategies, to be mainly focussed on robustness and adaptability.

In the last part of the workshop stakeholders looked at resilience enhancers selected as part of FoPIA-SURE-Farm, labelled as resilience attributes. They scored them on performance level and contribution to the robustness, adaptability and transformability of the system, bringing insights on the current resilience of the farming system. Results indicate that the current resilience is perceived to be low, resulting from a low performance of the resilience attributes, with an even contribution to the robustness, adaptability and transformability of the system.

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1 Introduction

1.1 Case study area

The case study of the United Kingdom (UK) investigates resilience and sustainability of large-scale arable farming. The case study area is in the East of England region where this type of agriculture prevails due to fertile and extensive agricultural surface which results in high production of arable and horticultural crops (Deliverable 3.1 – Bijttebier et al. (2018)). These elements make the East of England the region with the most impact on the country's agricultural value, as it is responsible for one third of the country's cereal production. Wheat and barley are the main cereals cultivated in the region. Other non-cereal crops are grown as well, such as potatoes, mustard and squash. As a combined effect of population concentration in cities (and thus a desertion of the countryside) and of the local large flat open area, the farms are large-scale family or corporate farms. In the last ten years the size of farms grew considerably as the number of farming businesses decreased by more than 40% while the farmland surface area remained the same. In Deliverable 3.1 (Bijttebier et al. (2018)) of the SURE-Farm project three main farm types have been identified:

1. Large cereal farms with an increasing frequency of side specialisation of sheep and cattle production for the provision of manure. These farms have high labour requirements at the end of the growing season for harvest and land preparation for the next season.
2. Large general cropping farms, which are usually specialised in root crops. These farms have also high labour necessities at the end of the growing season. In addition, these farms have a need for more labour during the rest of growing season than the large cereal farms.
3. Smaller horticultural farms, which, despite their smaller surface compared to the abovementioned farm types, have a high economic output. These family or corporate farms are highly specialised, even within their own sector.

1.2 Main challenges

The agriculture of the East of England is at risk from the demographic trends that allowed them to grow to large scale farms, as there are less people involved in agriculture leading to an increased difficulty to find labour and successors. Reduced access and possibilities to use crop protection, due to policy changes or consumer preferences, have an expected impact on the viability of those farm types too. Climate change, price volatility and unpredictable seasonal weather are other examples of challenges affecting the agriculture of the region. As this case study is set in the UK, Brexit is also one of the major challenges, as it will result in many changes in the UK's agricultural policy, access to seasonal labour and uncertainty on future trade deals.

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Table 1 gives an overview of the identified main challenges of the typical farm types of the East of England. The challenges in Table 1 do not apply equally to all farm types, e.g. specific challenges as grain price volatility and blackgrass only apply to cereal farmers. Also, the needs for labour and possibilities for diversification are not the same for the different farm types. General cropping and horticulture can, for example, diversify by creating farm shops or farmers markets and cereal farms are more likely to diversify by renting out farm buildings or specialising in green energy.

Table 1. Overview of the main challenges identified for the UK case study area. The challenges are subdivided in two types: shocks and long-term pressures; and four categories: economic, environmental, social and institutional challenges.

Challenges	Economic	Environmental	Social	Institutional
(non-) permanent shocks	Loss of subsidy	New pest and disease outbreaks	Succession	Brexit - new agricultural policy
	Cost of succession / inheritance	Extreme weather events - e.g. dry summers, flooding		
	Volatility in grain prices			
Long-term pressures	Cash flow	Black grass	Environmental lobby groups	Changing focus of agricultural policy to public good provision
	High levels of debt	Flea beetle on oilseed rape	Availability of skilled labour is reduced	Bureaucracy (e.g. difference between government agencies, admin for grant applications)
	Increasing cost of labour	Maintaining soil health	Changing consumer preferences	Regulation (e.g. crop protection, GM)
	High input prices	Climate change	Farming is hard work	Trade relations and access to markets
	Exchange rates			
	Low profitability of farming (cost of food does not reflect true price)			

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1.3 Workshop details

The workshop itself was held on the 16th of January 2019 in Cambridge. The location was chosen as it is central to the case study area and well connected, allowing easy access for the stakeholders. The event lasted from 10 am until 3:30 pm and 15 stakeholders took part. Table A1 (Appendix A) gives an overview of the participating stakeholders. The stakeholders were divided in three categories: 1) five farmers, 2) seven NGO representants, and 3) others, three people two stakeholders coming as members of organisations representing the industry and one stakeholder from a research institute responsible for the farmers survey. Some of the stakeholders in the NGO category are also farmers but were placed in this category as they were invited as member of their organisation. The ministry of agriculture had to cancel their participation last minute as a result of the busy Brexit agenda. However, they showed interest in the workshop and asked for a report of the workshop to process the main discussion points.

During the workshop participants were seated at three tables of 5 participants accompanied by a person of the organisation ready to help in case there were any questions. The grouping at the tables was done randomly during the arrival of the stakeholders. When looking at the participants list no-one was moved as no table had an overrepresentation of a single stakeholder category. The three tables also served as division for the grouped exercise of mapping the most important indicators. During the workshop all tables participated in plenary discussion in a relatively equal way both when everyone took part in the discussion or when a person per table presented opinions and results of their grouped discussion.

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2 Farming system

The start of the workshop, on the topic of the farming system, was changed slightly compared to the guidelines. The actors of the farming system and the influence they have on each other were not listed and discussed by participants. The decision was made to only present the concept of a farming system. This was done to avoid too long discussion on actors that were missing or in the wrong place, and to avoid displeasing stakeholders as of the beginning of the workshop because they could have been wrongly excluded from the system. This new approach allowed for clear explanation of the concept and more importantly its role for the rest of the workshop.

The farming system was presented as a system with a geographical border (Figure 1a) and a social border (Figure1b). The geographical border was the East of England, which is the UK case study area. Then the social boundary delimiting the system's actors was introduced in the form of definitions illustrated by examples. There are three group of actors:

1. Actors who influence farms, and, conversely, farms also influence these actors. E.g. farmers, contract workers, farm household, …
2. Actors who influence the farming system, but who are themselves scarcely influenced by the system. E.g. suppliers, banks, technology providers, …
3. Actors with indirect influence on the farming system. E.g. consumers, media, environmental policies, …

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In Figure 1c the social visualisation of the farming system has been mapped out, with the different actors of the system placed in their respective groups defined in Figure 1b. This was done based on the system's demographics research executed for deliverables 3.1 and 8.2 for the SURE-Farm project (Bijttebier et al., 2018; IRWiR PAN, 2018).

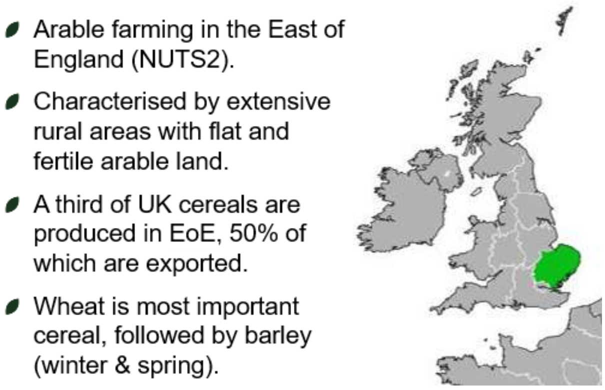

Figure 1a. Geographical visualisation of the farming system during the workshop.

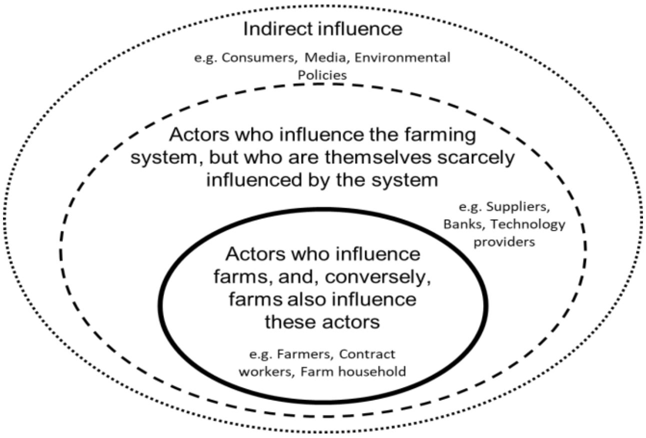

Figure 1b. Social visualisation of the farming system during the workshop.

Figure 1c. Social visualisation of the farming system

From this point on, participants were asked to make the exercises of the workshop considering the entire farming system; and not from the point of view of a single farm(er). In other words, consider everything within the geographical border and the social border when answering questions.

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3 System functions

In the first exercise stakeholders were asked to divide 100 points over the eight functions (Table 2) according to their importance for the farming system. These functions were expressed in full during the exercises of the workshop and were abbreviated (Table 2) for the creation of tables and graphs for clarity.

Table 2. Overview of the SURE-Farm system functions.

System functions (in full)	System functions (abbreviated)
Private goods	
Deliver healthy and affordable food products	Food production
Deliver other bio-based resources for the processing sector	Bio-based resources
Ensure economic viability (viable farms help to strengthen the economy and contribute to balanced territorial development)	Economic viability
Improve quality of life in farming areas by providing employment and offering decent working conditions	Quality of life
Public goods	
Maintain natural resources in good condition (water, soil, air)	Natural resources
Protect biodiversity of habitats, genes, and species	Biodiversity & habitat
Ensure that rural areas are attractive places for residence and tourism (countryside, social structures)	Attractiveness of the area
Ensure animal health & welfare	Animal health & welfare

The functions that were found most important by the stakeholders are (Figure 2):

a) the delivery of healthy & affordable products (21),
b) ensuring economic viability (20),
c) and maintaining the natural resources in good condition (17).

The functions that were regarded less important for the system are:

a) the delivery of other bio-based recourse for the processing sector (7),
b) improving quality of life in farming areas by providing employment and offering decent working conditions (8),
c) ensuring that rural areas are attractive places for residence and tourism (7),
d) and ensuring animal health and welfare (8).

The last function, “Protect biodiversity of habitats, genes and species”, was left in the middle. However, as one of the functions with the lowest standard deviation (Table A2 – Appendix B), its importance is more stable than the three top functions. The two top functions share also the highest standard deviations as several of the stakeholders tended to bring one in front of the other with large scoring differences. The overall balance of importance between private and public goods tends towards private goods (56:44). This is also reflected in the ranking of “maintaining natural resources”. There seems to be an agreement that “maintaining natural resources” is the third most important function, as stakeholders indicated that it is essential to

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the system once "economic viability" and/or "delivery of healthy and affordable food products" are secured.

Interesting to note is that economic viability of the system is very important to *Farmers* and *Others*; much less so to *NGO's*. They tended to bring forward the "delivery of healthy and affordable food products" and "maintenance of natural resources". The *Others* group did also bring the "delivery of healthy and affordable food products" forward. The "delivery of bio-based resources" was deemed as less important by most stakeholders as it generally gets in the way of food production. "Animal health and welfare" was mostly set aside as the case study area revolves around arable farming and attractiveness of the area was in general considered less important when put next to the other functions.

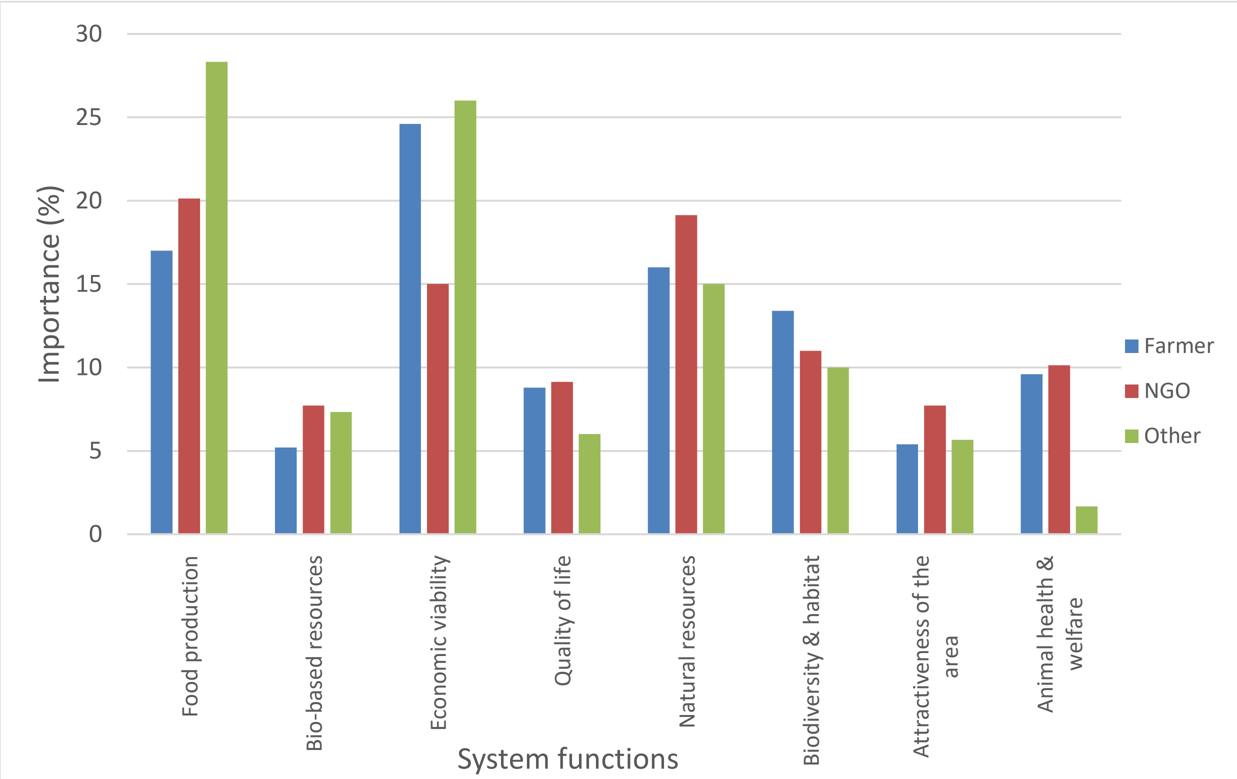

Figure 2. Bar graph with scoring per ***system function****, per stakeholder group. 100 points needed to be divided over 8 functions.*

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The stakeholders commented on the system functions while scoring and during the plenary discussion of the results of the first exercise. The most prominent comments were around the division of the system functions in private and public goods. Many disagreed on the division of “food production”, “bio-based resources”, “economic viability” and “quality of life” as private goods and the rest as public goods. The comments around this topic varied from moving certain system functions to one or the other, or to just get rid of the whole division as many functions could be linked with both private and public goods. As clarification for this issue the definition of public and private goods were brought forward to explain why the classification was done as such. Other repeated comments were on the separation or definition of the functions themselves, some or even all are so interlinked that they could be seen as one (e.g. “food production” – “bio-based resources” – “economic viability” together and also “natural resources” – “biodiversity & habitat” – “animal health & welfare” together), others can also be seen as by-products of the functions instead of being functions (e.g. “bio-based resources” and “attractiveness of the area”). However, while some stakeholders would judge these system functions as one, the variation of the scores attributed to these functions imply that they are sufficiently different to be judged separately.

Other interesting comments made are that natural capital accounting should ensure “economic viability”; that arable farming and livestock are very dependent on each other in both in- and outputs; that without “economic viability” the farmer is unable to take care of soil, environment, etc.

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4 Indicators of functions

During the preparation of the workshop, indicators were selected for the SURE-Farm system functions which could be representative for the UK case study area. The selection was made through discussion between the members of the organising team based on the knowledge acquired during earlier stages of the SURE-Farm project (Deliverable 1.1 – Meuwissen et al. (2018) – Appendix 1). Table 3 provides the complete list of indicators presented to the stakeholders paired with the system function they represent. Guidelines of the workshop advised to find minimum one to maximum four indicators per system function with a total range of 16-24 indicators.

Table 3. Overview of the indicators identified for the UK case study area for each SURE-Farm system function.

Functions (purpose)	Indicators
Private goods	
Deliver healthy and affordable food products	Productivity (e.g. ton/ha)
	Food quality (e.g. % under certification schemes)
	-
	-
Deliver other bio-based resources for the processing sector	% land used for biofuels
	-
	-
	-
Ensure economic viability (viable farms help to strengthen the economy and contribute to balanced territorial development)	Net farm income
	% farms that are owned/tenanted
	Debt/asset ratio
	-
Improve quality of life in farming areas by providing employment and offering decent working conditions	Income level for agricultural workers
	Number of on-farm & agribusiness jobs (e.g. working units/ha)
	Capacity development (trainings and opportunities for workers)
	-
Public goods	
Maintain natural resources in good condition (water, soil, air)	Water quality (e.g. pesticides and nitrates in rivers)
	Soil quality (e.g. erosion, stability, …)
	-
	-
Protect biodiversity of habitats, genes, and species	Diversity and abundance of key farmland animal, plant and insect species (e.g. birds, butterflies, meadow plants)
	Diversity of production
	% agricultural land under environmental conservation
	-
Ensure that rural areas are attractive places for residence and tourism (countryside, social structures)	Happiness index (OECD) of rural populations
	Regional agri-tourism offered
	Extent of public access (e.g. footpaths, bridleways etc.)
	-
Ensure animal health & welfare	Market share of products with certified higher levels of animal welfare
	-
	-
	-

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4.1 Indicator importance

The importance of the indicators (Table 3) depends on three elements:

1. how well they represent their system function,
2. the number of indicators per system function,
3. and the importance given to the system function themselves in Figure 3.

Figure 3 gives an overview of the scores given by the stakeholders; more detailed values can be found in Table A3 a, b in Appendix B. The highest scoring indicators within a system's function are evaluated the most important to represent their respective system's function. This means that for:

- Delivering healthy and affordable products: both indicators (productivity and food quality) have equal importance. However, the standard deviation of productivity indicates that even though the mean result is high, there were more varied opinions on its importance. While *NGOs* tend to find them both equally important, *Farmers* and *Others* tend to put the emphasis on quality above quantity while the industry prefers the opposite strategy.
- Delivering other bio-based resources for the processing sector: "% of land used for biofuels" is the only indicator here. The only observation that can be made is that scores are low in general as the three stakeholder groups were no big supporters of the function to start with, lowering the importance of the indicator as well.
- Ensuring economic viability: "net farm income" is clearly the preferred indicator for this function, followed by the "debt/asset ratio" with an above average score. The "% of farms that are owned/tenanted" received a unanimous low score from all stakeholder groups as they agreed that this implied that owning a farm instead of renting is necessarily better.
- Improving quality of life in farming areas by providing employment and offering decent working conditions: all three indicators received a similar total score with no extreme differences in preference for a specific indicator. The "income level of agricultural workers" came out as slightly more important than the other two indicators as a result of *NGOs* and *Others* bringing this indicator forward as more important. *Farmers* had a tendency to find the "income level of agricultural workers", "the number of on-farm & agribusiness jobs" and the "capacity development" equally important. The relatively low standard deviations show that there was little disagreement.
- Maintaining natural resources in good condition: the two proposed indicators, "water quality" and "soil quality" were considered very important. "Soil quality" did come forward as slightly more important, mainly by *Farmers* and *NGOs*. The *Others* tended to prefer "water quality" as a better indicator. Low standard deviation here as well show that the high importance attributed to both was shared by all participants.

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- Protecting biodiversity of habitats, genes, and species: "diversity and abundance of key farmland animal, plant and insect species" was considered the better indicator by all stakeholder groups. However, the "diversity of production" and the "share of land under environmental conservation" were still given a significant share of importance for that system function; especially by *Farmers*.
- Ensuring that rural areas are attractive places for residence and tourism: the "happiness index of rural populations" was considered a more important indicator, mainly by *Farmers* and *NGOs,* which found "regional argi-tourism" and "extent of public access" less important. The O*thers* stakeholder group scored the three indicators as equally important.
- Ensuring animal health & welfare: the only indicator, "market share of products with certified higher levels of animal welfare", was considered much more important by *Farmers* and *NGOs*. The O*thers* argued that in this highly arable system this indicator is not important, especially as basic certification already account for high levels of animal welfare.

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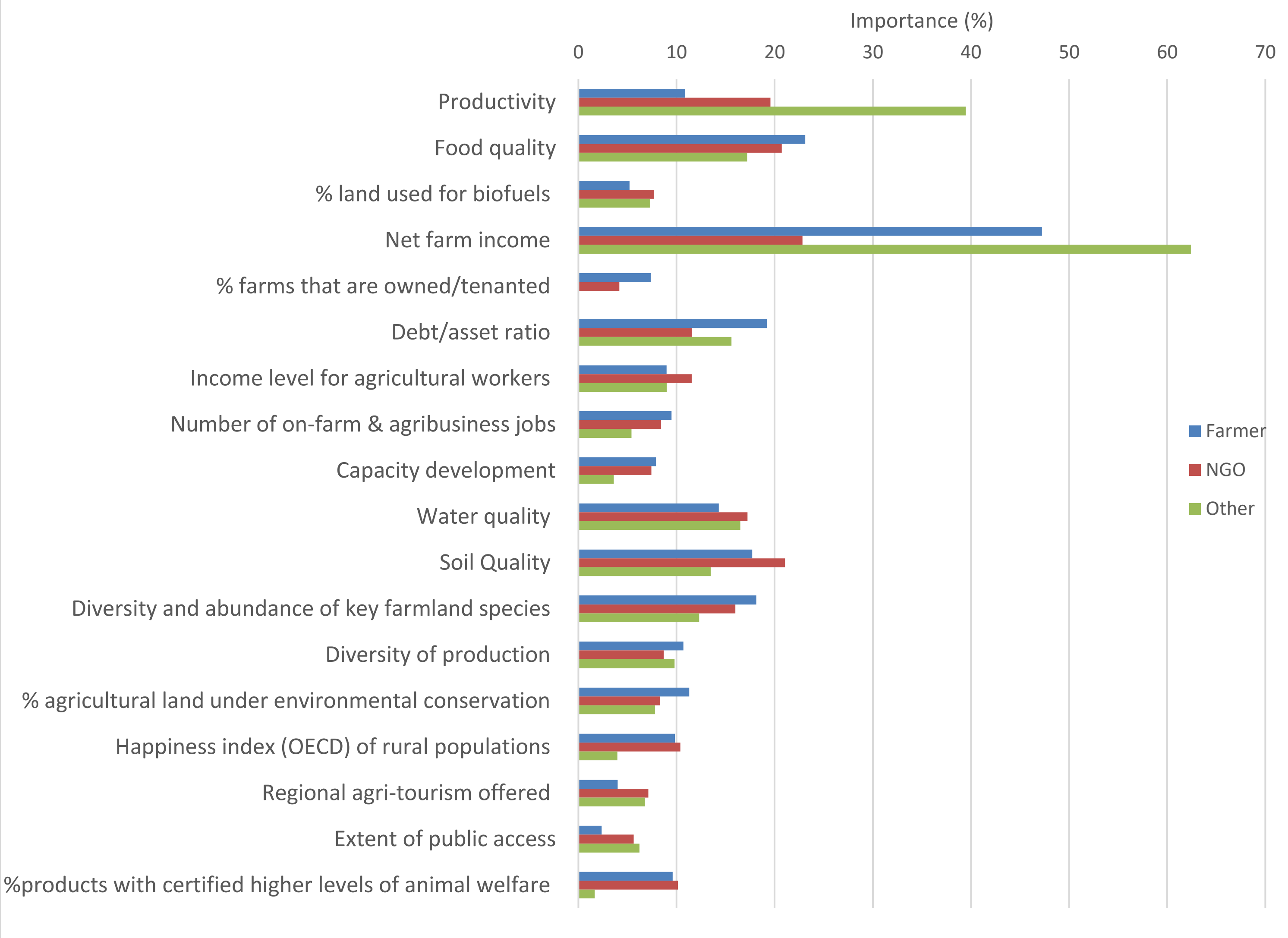

Figure 3. Bar graph with scoring of importance of the ***indicators*** *of system function, per stakeholder group. Per function, 100 points were divided over the indicators. Values are transformed (indicator importance score * number of indicators for specific function * importance given to corresponding function by stakeholder category / 100) to include the importance and number of indicators of the function that the indicators represent.*

Stakeholders added suggestions for different indicators to add to or replace the ones presented during the workshop. Also, amendments or comments on the presented indicators were given on how well they represent their system function.

- For delivering healthy and affordable products: it was suggested to change productivity from a ton/ha metric to an efficiency metric output/input. This would then give more insight in efficiency of the system and also serve as an indicator for sustainability (De Koeijer et al., 2002). It was also repeatedly suggested that productivity and food quality should not be considered as exclusive and they can both be high in importance. This was reflected in the scores given by the stakeholders where the total mean score of importance is the same (21) (Table A3(b) – Appendix B). It was also mentioned that productivity is not key and that a farmer's priority is to feed his family and not the world. This relates back to the private-public good discussion mentioned in section 3, showing that stakeholder consider this a private good. A third indicator was also suggested: nutrition level in the food product, both as a separate indicator or as a unit for food quality. Lastly, a stakeholder also pointed out that in many cases the system function itself is out of the farmers hands, as he has no control on healthiness or affordability of the processing beyond the farm gate. Both elements can be undermined during processing. To solve the issue around this point it was repeatedly reminded to the stakeholders during the workshop that when scoring they have to think of the whole farming system and not of a single farm.
- For delivering other bio-based resources for the processing sector: most comments on the indicator "share of land used for biofuels" pointed out that this means giving up land for food production. This can be considered on poorer soils where the growth of food products yields low results. This also can be found in literature (Solomon, 2010) that there is indeed a worry that large scale production of biofuels might reduce food production too much, however when using less productive lands for biofuels this issue can mostly be avoided. Furthermore, both functions "food production" and "bio-based resource" were given to the stakeholders resulting in in a preference for "food production" by the stakeholders (Figure 2). Some also argued that bio-based resources are not a sustainable practice, except for biomass from forestry or on-farm wood production.
- For ensuring economic viability, no extra comment was added.
- For improving quality of life in farming areas by providing employment and offering decent working conditions: the main comment came in the form of a discussion where on the one hand some argued that an increase of the number of on-farm & agribusiness jobs reduces productivity. On the other hand, that to improve calorific production per ha a greater workforce is needed and less automation. This shows that stakeholders had different ways of looking at additional labour: some were more focussed on productivity and some more

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on the importance of quality. This is also reflected in the spread between the scoring of the importance of the "productivity" and "food quality" indicators.

- For maintaining natural resources in good condition: several stakeholders added the indicator "air quality" to complete "soil quality" and "water quality". Other comments pointed out that the most important metrics for soil quality are organic matter content, microbial health, soil structure or carbon storage of soils. The choice of metric to define soil quality can indeed be quite varied and depend on several factors (Bünemann et al., 2018), for the workshop the attention was brought to 'general' soil quality. Stakeholders also questioned the nature of a good soil, which depends on the farming needs. For the "water quality" indicator, the stakeholders also mentioned that the quality of aquifers are to be looked at as well and not only surface water. Stakeholders underlined that water and "soil quality" are intrinsically linked as better soils help increasing "water quality". This linkage between the two indicators is also visible in the results of the importance scoring where they got a very close scoring with no clear preference for one or the other (Figure 3 and Table A3(b)) Also, the importance of the ability to keep farming in terms of healthy soils supporting wildlife was brought forward as paramount. The ecosystem services provided by soil biota can lead to increased productivity and reduced need for inputs (Barrios, 2007), giving them the paramount importance.
- For protecting biodiversity of habitats, genes, and species: stakeholders added soil health as an indicator for this system function as well. This indicator is already used for "natural resources" function, as there needs to be a certain variability of indicators this was not used again for this function. Stakeholders also underlined the importance of insect species abundance and diversity above other animal and plant species. This importance can be attributed to insects as they can serve as great indicators for biodiversity (Duelli et al., 1999). The contribution of "diversity of production" and "share of agricultural land under environmental conservation" to the "diversity and abundance of key farmland species" was also pointed out. The hierarchy mentioned by the stakeholders in this case are also reflected in the scoring of these three indicators, where diversity of production" and "share of agricultural land under environmental conservation" were attributed a very similar importance, while the "diversity and abundance of key farmland species" scored higher (Figure 3 and Table A3(b)). The latter indicator was considered more important even though stakeholders shared that that it is difficult to increase said species in diversity and abundance. Stakeholders also underlined that diversity needs to be the prominent notion in all aspects. An example given was that a diverse, mixed farming with massively reduced tillage and 20+ crops and multiple livestock species system would inherently allow lots of wildlife to flourish. Research indeed indicates that heterogeneity in crops, land use and time of the farming landscape does increase biodiversity (Benton et al., 2003).

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- For ensuring that rural areas are attractive places for residence and tourism: the only addition stakeholders made was that when looking at the happiness index, urban populations should as well be considered and not only rural populations. However, as the focus of the workshop is the farming system it makes this comment less relevant; this would only apply in studies that would analyse the attractiveness of the complete region.
- For ensuring animal health & welfare: many other indicators were proposed, such as reduction in antibiotics use, non-intensive production or improved animal housing leading to a reduction in the need for antibiotics. Stakeholders also commented that although, similarly to "water quality", "animal health and welfare" is defined as a public good it becomes a legislative requirement. This remark is mainly explaining one of the main functions of legislation, which is to protect public goods from private activities.

4.2 Indicator performance

The total performance of most indicators lies on average around a medium performance to slightly lower. This seems to fit with the stakeholders view on the matter, as in most cases they argued that there is no terrible performance, however, there is room for improvement. As can also be seen in Figure 4, *Others* had a tendency to give a higher performance score on most indicators than the other stakeholder groups, except when looking at the indicators for the "attractiveness of the area" and the "animal health & welfare" functions. *NGOs* rated a lower performance on the indicators for the "bio-based resources" and the "economic viability" functions, and for "the income level for agricultural workers" indicator. This opposes the *Farmers'* opinion, whom in this case followed the trend of the *Others*. For the other indicators, farmers and *NGOs* did agree on their performance.

The lowest performing indicator is the "share of farms that are owned/tenanted" because, as discussed earlier, many stakeholders disagreed with the use of this indicator which resulted in several stakeholders not scoring this indicator. The "diversity of production" had a low score, as well as many stakeholders agreed that in this large-scale arable system few choose to grow many different crops. The highest scoring indicators are the "extent of public access" as a result of the roads and trainlines connecting the region with the rest of the UK and the "market share of products with certified higher levels of animal welfare" as in the UK the required level of health and welfare for animals is already high.

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When looking at the standard deviations of the totals (Table A4 – Appendix B) there can be deduced there was most disagreement between the stakeholders for the performance of the "share of land used for biofuels", the "debt /asset ratio", the "capacity development", "the water quality" and the "diversity and abundance of key farmland species".

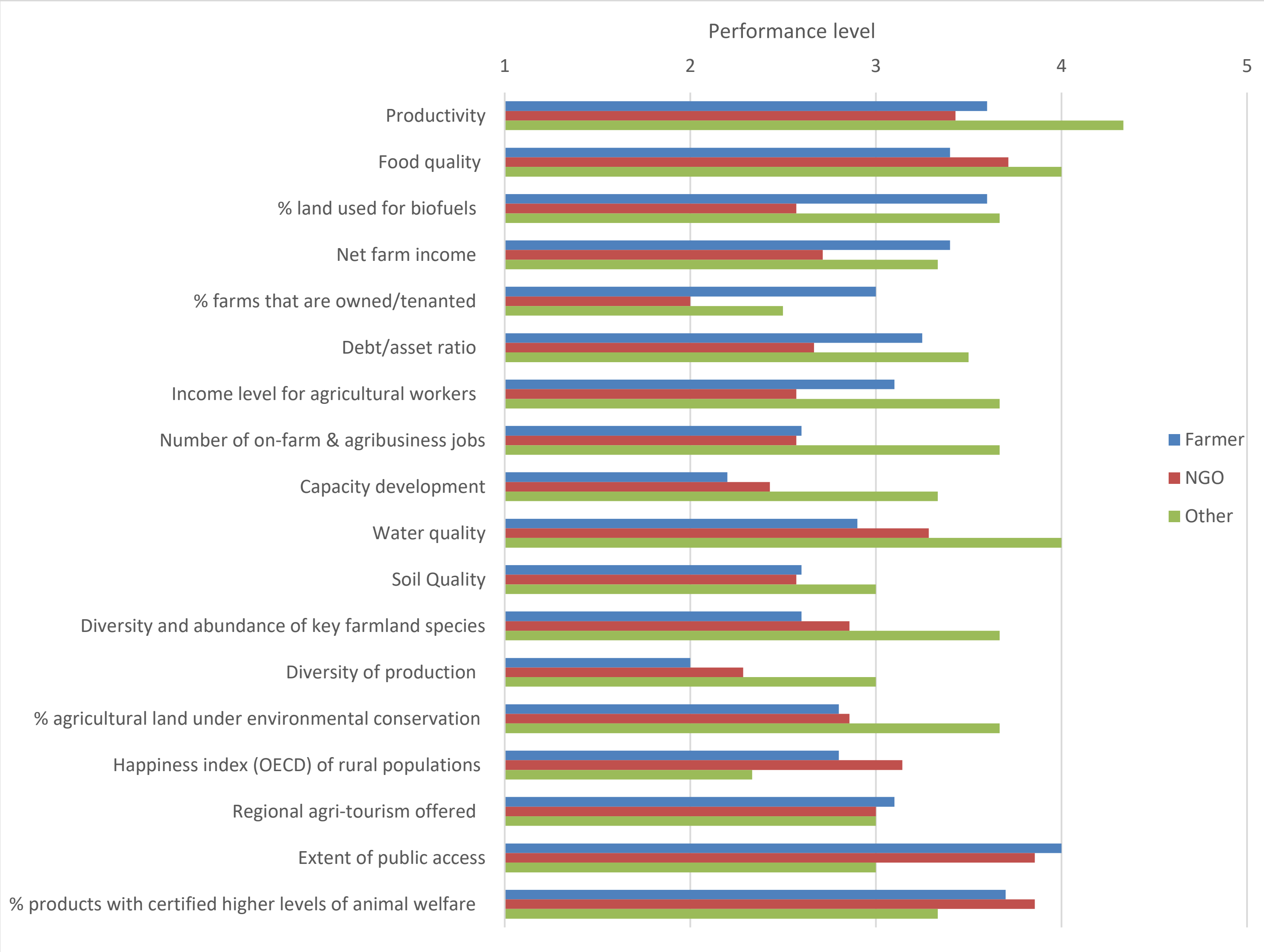

Figure 4. Bar graph with scoring of performance per ***indicator*** *from 1 to 5, where 1 = very low, 2 = low, 3 = medium, 4 = good, and 5 = perfect, per stakeholder group.*

Many of the comments made during this exercise were similar to the comments made during the previous exercise. E.g., the metric of the "productivity" could focus more on output/input instead of t/ha; "food quality" lies more in the hands of processing instead of the farmer, who incidentally is also subject to factors out of his control such as weather; and adding air quality as an indicator. Stakeholders agreed that the "share of farms that is owned/tenanted" is an indicator to not take into consideration as a corporate structure does not need to affect viability. Participants also stated that we should not divert good arable land to the production of biofuels. Some stakeholders argued that the "number of on-farm and agribusiness jobs" should be much higher. Lastly, they also brought forward that the "diversity of production" is heavily influenced by policy

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rules. Other comments stated in certain cases that the score given by a stakeholder is his/her impression, as he/she has no experience or clear view on the performance of the indicator. The FoPIA-SURE-Farm framework revolves around the perception of resilience by the stakeholders making the last comment not relevant.

4.3 Indicator selection

At this stage in the workshop, the results of the first three exercises were presented back to the stakeholders for a plenary discussion to select the indicators that would be considered as main indicators of the farming system. The bubble graph in Figure 5 shows a complete summary of the information given by the stakeholders. The size of the bubbles gives the importance of an indicator based on how well they represent their system function, the number of indicators per system function and the importance given to the system function themselves. The height of the bubbles comes from the performance score stakeholders gave to each indicator. Based on this graph six indicators could be selected for further discussion in the next exercises:

- Productivity
- Food quality
- Net farm income
- Water quality
- Soil quality
- Diversity and abundance of key farmland species

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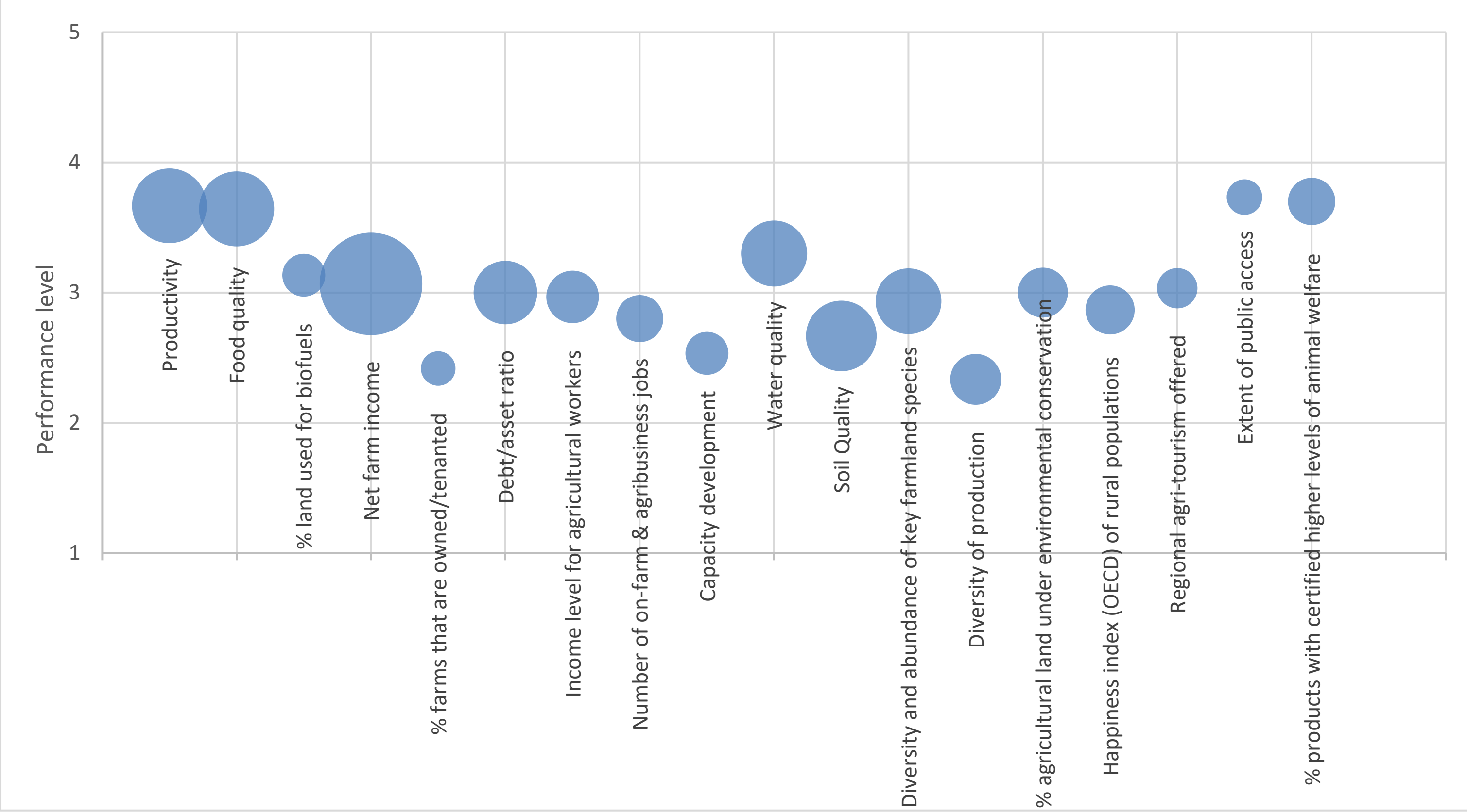

Figure 5. Bubble graph presenting averaged scores on performance of ***indicators*** *(from 1 to 5), while also indicating their importance (size of the bubbles), relative to each other.*

However, during the workshop the bubble graph in Figure 5 could not be produced; Figure 6 was presented instead where the size of the bubbles gives the importance of a system function based on the importance score given to the system function. The height of the bubbles comes from the performance score stakeholders gave to each indicator, which are then combined for their respective system function to create an importance score of the function itself.

When it came to the selection of an indicator to describe the historical dynamics, each group was asked to choose one of the indicators mentioned above, which were selected from Figure 4 instead. Based on how comfortable or knowledgeable they felt about the indicator the first group chose "productivity" as it was easier to map out and a clear indicator to work with. The second group opted for "soil quality" over "water quality" as it has a greater impact on the farmer. The last group chose to work on the "diversity and abundance of key farmland species" as they felt more comfortable working with it then the remaining three.

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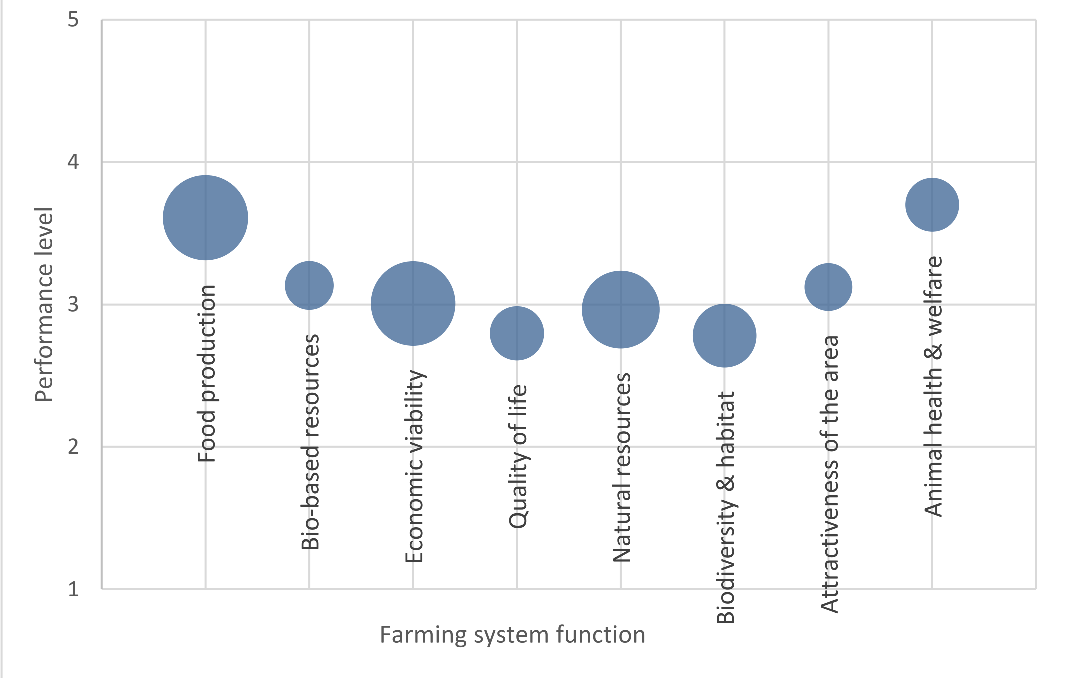

Figure 6. Bubble graph presenting averaged scores on performance of the ***system functions*** *(from 1 to 5) derived from the indicators performance, while also indicating their importance (size of the bubbles), relative to each other.*

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5 Resilience of indicators

5.1 Dynamics of the "biodiversity" indicator

The Biodiversity group worked around the "Diversity and abundance of key farmland species" indicator which was in the discussion simplified as biodiversity. During the discussion the decision was taken by the group to map out the dynamics of biodiversity with three lines (Figure 7). A first line indicated the continuous decline of general biodiversity in the farming system. Secondly an example of farmland animals was taken in greater consideration in the form of farmland birds (e.g. skylarks, buzzards, etc), which did not follow the decline of general biodiversity as some recovery of the populations could be noticed from 2007-2010. Lastly, the group showed the changes of environmental legislation, placing along the line various programmes and schemes put in place. The group also indicated that the height of the three lines did not represent their performance compare to each other, they have been placed one above the other for a better overview. The environmental impact of the legislation was observed when the environmental stewardship programme was put into place: the farmland bird population started to recover, albeit with delay. Similarly, when Owen Paterson took part in environmental policy and its quality lowered due to payment cuts, this lead again to a lowering of the farmland bird population. New improvements came in the last years in the form of new environmental schemes, however their further development has been affected by of Brexit. The initial effect just started to be apparent on the farmland bird population. However, as there is an expected delay between the instalment of new policy and the effect it is supposed to have, the full extent of the policies' influence is not known yet. Other elements which could have an effect on the effort done by farmers to preserve biodiversity were added along the x axis, such as:

- Good grain prices: which reduce the necessity for farmers to hunt for money from environmental schemes, and in bad years they provide a certainty of income. The effect of grain prices is debatable as it could be argued that in low years farmers tend to go into schemes and that in high years farmers have money to invest and want to do something for the environment;
- The introduction of single payment schemes (SPS): these provide a new source of revenue for farmers;
- The introduction of entry level stewardship (ELS) schemes: which provide a new source of revenue for farmers, and together with SPS had a positive effect on biodiversity;
- The introduction of ecological focus areas (EFAs): these force farmers to set aside a part of the land for ecological purposes;
- The introduction of the three-crop rule: this forces farmers to diversify their crop selection;

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- The introduction of the basic payment scheme (BPS): this is meant to replace the SPS, and together with EFAs and the three-crop rule is expected to have a positive impact on biodiversity.

The group also highlighted the following attention points that are important for biodiversity. Not all species respond in the same way to agri-environmental schemes, leading to partial improvement of biodiversity when they are applied. Uncontrollable factors such as climate change also heavily affect biodiversity. The ban of neonicotinoids is not necessarily good for biodiversity, as a new tool for agriculture it could potentially lead to practice changes with positive effects on their own. However, as their detrimental effects to pollinators so vast they are likely to outweigh the advantages gained elsewhere. Furthermore, the ban of glyphosate can also have negative effects, as some farmers that do large efforts to improve environmental impact do rely on glyphosate, which would be disrupted without access to them. This improvement of environmental impact is established in long-term studies with the use of glyphosate (Brookes & Barfoot, 2013). Illustrating this is the ability to practice reduced tillage or zero tillage farming, which would become difficult without glyphosate. These tillage practices improve environmental impact by reducing greenhouse gas emissions and improve carbons sequestration (Brookes & Barfoot, 2013). Additionally, for most soil biota zero tillage allows them to increase in abundance with greater effects on larger organisms (Wardle, 1995). The East of England agricultural system heavily relies on glyphosate, leading to heavy disruption if it gets banned, resulting in many farmers focussing on recovering from the disruption instead of focussing on the environment.

Lastly the group summarised the main strategies they identified during this process that were used over the analysed period to cope with the aforementioned challenges:

- agri-environmental schemes were adopted improve biodiversity;
- conservation farming was adopted to improve biodiversity independently from agri-environmental schemes;
- farmer led exchange was applied as communication, exchange of knowledge and collaboration leads to improvements on farming system level.

The performance of farmland birds line encapsulates the same trends as data of the performance of Skylarks summarised in Figure A3 (Appendix C) from the British Trust for Ornithology. The main differences are the time frame of the recovery, which seems to have been earlier than the stakeholders indicated, and the decline of the performance after the recovery is stronger than estimated by stakeholders.

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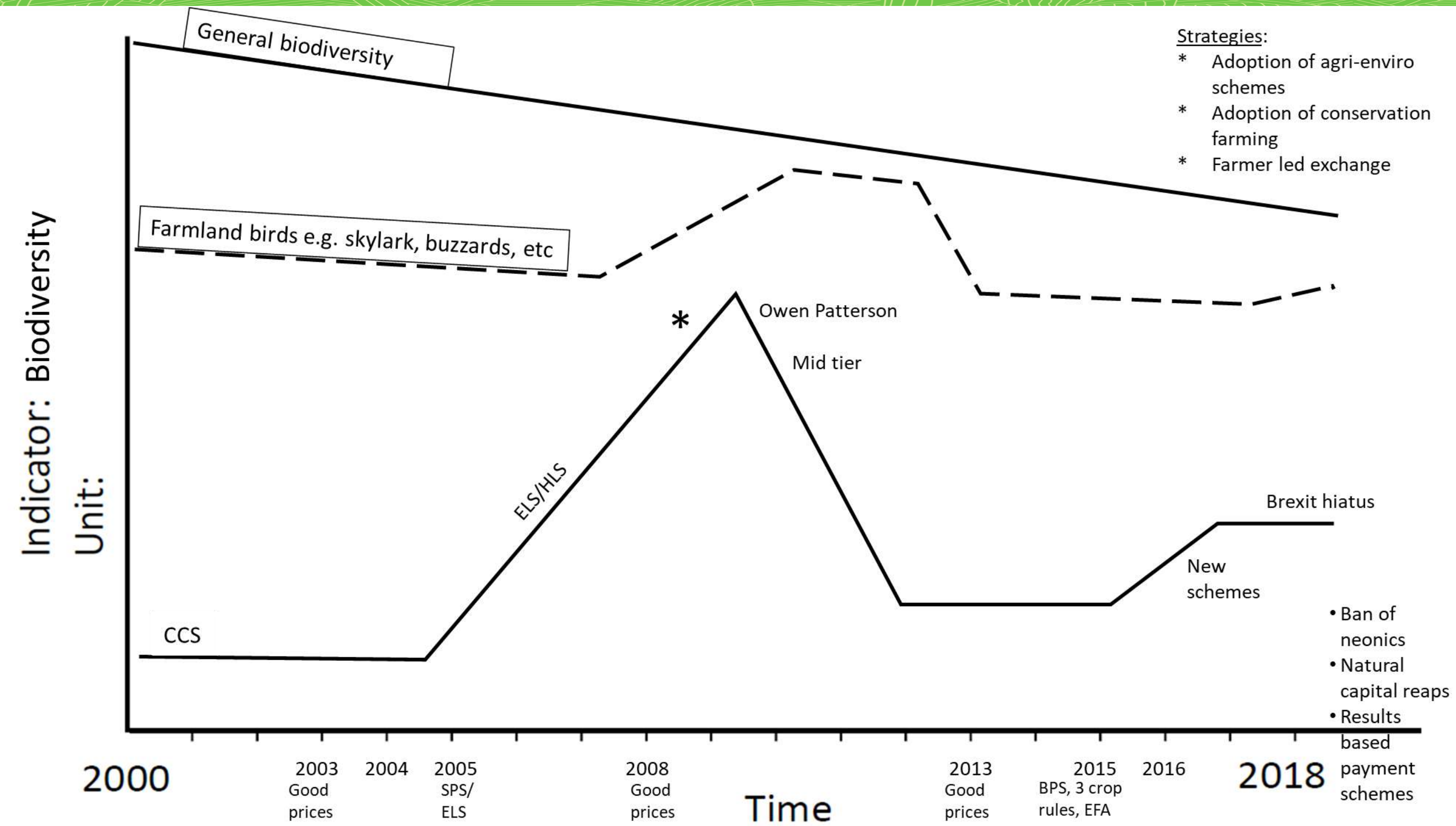

Figure 7. Digitalised graph of the "Biodiversity" indicator. The top line represents the performance of general biodiversity, the middle line represents the performance of farmland birds e.g. skylarks & buzzards, and the bottom line represents the performance of legislation. Abbreviations used are: CCS – carbon capture and storage, ELS – entry level stewardship, HLS – high level stewardship, SPS – single payment scheme, BPS – basic payment scheme, EFA – ecological focus area.

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5.2 Dynamics of the "productivity" indicator

During the discussion, the decision was taken by the group assigned to the "productivity" indicator to map out the dynamics of productivity with three lines (Figure 8). A first line (black) depicts the total productivity variable, showing increasing yields since 1960 as a result of: increased availability and usage of fertilisers and plant protection products (PPPs) in the 70's; focussed breeding on yield traits in the late 80's; and a decreased investment in training and education leading to generations of farmers with the unique goal of yield increase. A second line (blue) shows the nutrient content of agricultural products, which decreased since 1960 as a result of: focussed plant breeding on yield instead of a balance between yield and nutritional value, following the principle of a rise in yield leading to dilution; and a disconnection between farmers growing commodity crops and a consumer decline in attention to nutrition, resulting in farmers growing more instead of better food. Both lines are mirroring each other based on the dilution principle mentioned above. The levelling off of the total productivity variable is a consequence of production approaching potential production which is the maximum production possible in the area. This also leads to a levelling off of the nutrient content line approaching the minimum. The third line is another way of depicting production in the form of output/unit of labour. The main shape of the line follows the output (or total productivity line), and the rate at which the graph levels off depends on the reduction of labour. The main factor reducing labour is the increase of the area farmed by a single farmer. This was made possible by machinery improvement and in the mid-90's with Farm Business Tenancies (FTBs) and collaboration resulting from economics of scale being applied, meaning that farmers start to share costs, equipment, etc.

The main challenge the group identified was low prices, leading to the main response by farmers to increase production coupled with efforts to reduce costs of farming. The team then subsequently added that a good strategy would be the creation of a subsidy that stops the previous strategy to increase productivity, pushing farmers to work on more sustainable or long-term solutions. The group then also indicated that in the future there will be a need to get rid of glyphosate and to change the subsidy structure together with breeding for other traits than yield and increased use of robotics for farming.

Lastly, the group summarised the main strategies they identified during this process that were used over the analysed period to cope with the aforementioned challenges:

- Increased area farmed by a single farmer was used to increase the output/unit of labour over the years, and which also contributed to the reduction in costs of farming;
- Collaboration resulted through the economics of scale to the reduction of costs through shared investments in tools to increase productivity;
- Peer learning allowed for a spread of the necessary knowledge to increase productivity;

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- Agricultural diversification was used for increasing productivity by for example improving soil conditions which increases productivity of the land;
- Non-agricultural diversification increases productivity increasing farmland biodiversity which in turn provides ecosystem services to crops allowing for increased productivity.

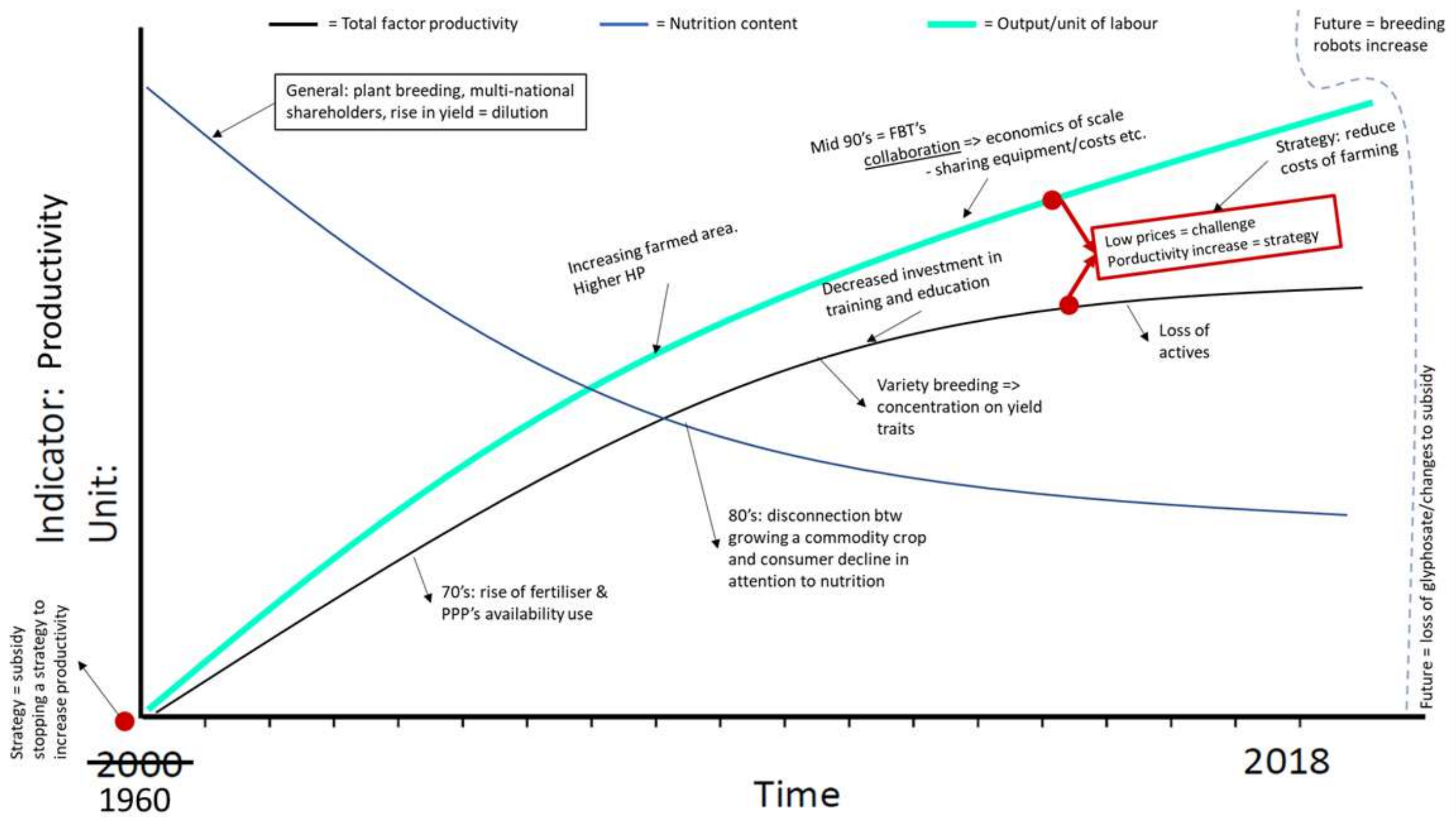

Figure 8. Digitalised graph of the "Productivity" indicator represented by: output per unit of labour (turquoise line), nutrition content (blue line) and total factor of productivity (black line). Abbreviations: PPP – plant protection products, FBT – farm business tenancy

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5.3 Dynamics of the "soil quality" indicator

During the discussion, the decision was taken by the group assigned to the "soil quality" indicator to map out the dynamics of productivity with two lines, namely: soil quality and soil awareness (Figure 9). The soil quality line shows a gradual decline of soil quality reaching what the stakeholders judged to be 'rock bottom' a couple of years ago, since then there is a slight improvement. The decline is mainly caused by the use of manufactured fertilisers, which add nutrients without organic matter; the use of winter crops, such as wheat and oilseed rape; and the decrease in livestock tenancy. The recovery in the last few years is mainly due to a groundswell in soil awareness, leading to a change in mindset, causing farmers to make new efforts to improve soil quality. The groundswell of soil awareness is the result of a gradual build-up of soil awareness in the last decade. Initial improvement of awareness started with the soil protection reviews required for the single payment schemes, setting the political sphere in motion to try to stop current trends. This resulted in the creation of ecological focus areas (EFAs) increasing the soil awareness by supporting different management techniques such as cover crops, direct drilling, no-till farming; and by underling the importance of soil parameters such as organic matter or the presence of earthworms. This caused, in turn, a groundswell in soil awareness leading to the aforementioned change in mindset and improvement of the soil quality. Interesting to note as well is that the stakeholders are likely to not consider the productivity of the soil as its only indicator for quality. This can be seen from the units proposed by the group, earthworms and carbon content (Figure 9), or by the greater performance of the "productivity" indicator than the "soil quality" indicator (Figure 4).

Lastly the group summarised the main strategies they identified during this process that were used over the analysed period to cope with the aforementioned challenges:

- Education + awareness: advice, events, farmers clusters
- Technical: e.g. glyphosate
- On-farm management of organic matter
- Responsible management of maize biofuels
- Tenure + contracting arrangements
- Re-introducing livestock

These were then simplified by the group for the next stages of the workshop into:

- Knowledge exchange resulted in the increase of soil awareness and spread of practices that improve soil quality;
- Land tenure arrangements allowed for the spread of soil conservation practices;
- Reintroduction of livestock was used for the possibility to apply fertiliser which additionally to nutrients add organic matter back in the soil;

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- Responsible management lead to a more integral approach of farming including application of practices that improve soil quality.

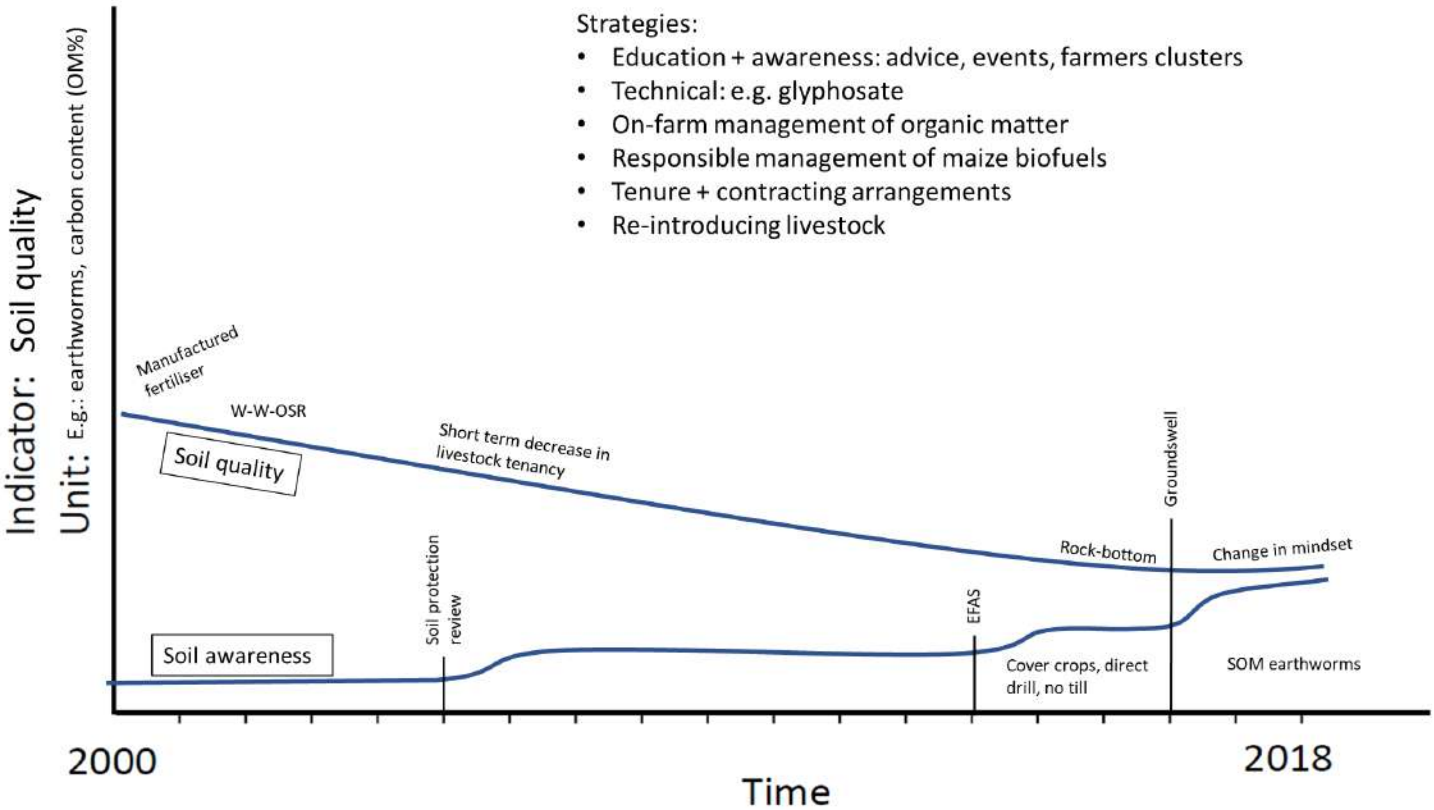

Figure 9. Digitalised graph of the "Soil quality" indicator depicted by a soil quality line and a soil awareness line. Abbreviations: W-W-OSR – winter wheat-oilseed rape, EFAS – ecological focus areas (S)OM – (soil) organic matter.

6 Resilience attributes

6.1 Case-study specific strategies

After the exercise of Section 5, each group was asked to identify a list of strategies that were used in the past to handle the various challenges that influenced the dynamics of the investigated indicator. Those strategies were scored on how well they were implemented in the case study area, by the stakeholders who identified them in the previous exercise. Strategies inviting to collective action were mentioned in all groups, namely “farmer led exchange”, “peer learning”, “knowledge exchange” and “collaboration”. This shows that, in many situations, farmers did not handle a challenge on their own. However, as implementation levels of these strategies are relatively low it shows that there is much room for improvement to further benefit from them. A recurring aspect of diversification was identified by most groups as part of conservation farming, (non-)agricultural diversification and reintroduction of livestock are all brought forward.

Most strategies were scored to be less than moderately (3) implemented (Figure 10); only the size of the area farmed by one farmer and the non-agricultural diversification are scored above a moderate level of implementation. During the discussion the perceived impression was that stakeholders gave lower scores to the strategies to emphasise that there is room for improvement. The productivity group indicated through scoring that they were particularly dissatisfied with agricultural diversification as it scored lowest of all; this shows they want to diversify large-scale arable farming which tends to focus on large monocultures.

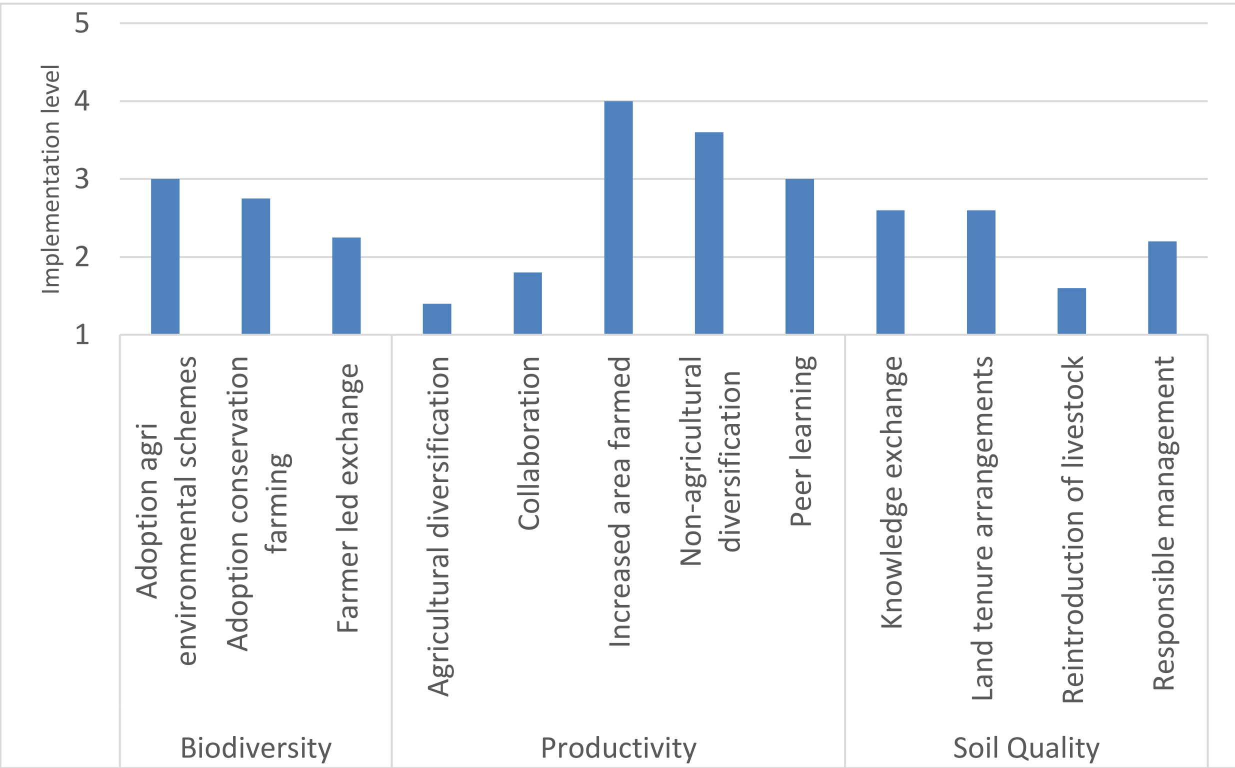

Figure 10. Bar graph showing level of implementation of strategies. 1 = not or very badly implemented, 2 = badly implemented, 3 = moderately implemented, 4 = well implemented, 5 = very well implemented.

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Adding to the scores, the participants also commented on several of the strategies they identified. The Biodiversity team commented on the agri-environmental schemes and said that in the new post Brexit world they may be the only source of support and it therefore will be extremely important to demonstrate good practice. Agri-environmental schemes tend to tie farmers into fixed approaches: new schemes need to be flexible to allow farmers to react to external stresses. Stakeholders mentioned as well that the outcome of the adoption of those schemes was directly affected by public interventions that are changing all the time. About the adoption of conservation farming, members of the group highlighted that this happens sporadically and with no specific agenda. The productivity team added to the strategy of increased area farmed a by single farmer, that even if larger farms seem good, they tend to lead to less diversity, big investment in capital for e.g. larger machinery, capital costs causing lock-in situations and more limitations in the future to shift suppliers. Some members of the group underlined that even if in the past this was a suitable strategy, that the future lies in smaller farms that give more flexibility to farmers. This also increases the enterprise mix and diversity in the area. Lastly some of the stakeholders said that collaboration is the answer to most challenges. The members of the soil quality group did not add any comments during the scoring exercise of their strategies.

In Figure 11 the average contribution of the identified strategies to the resilience capacities is shown. The stakeholders saw little negative relationships between the various strategies and the resilience capacities. The soil quality group saw no negative relationships at all (Figure A6 – Appendix D). Additionally, the contribution to the different capacities was considered relatively equal for the soil quality group. The productivity group disagreed the most on the positive and negative relation of their strategies with the resilience capacities (see Figure A6 and the relatively high standard deviations in table A6, Appendix D). This is most noticeable for the increased area farmed and non-agricultural diversification strategies; the biodiversity group had this type of disagreement mostly with the adoption of agri-environmental schemes strategy. The “increased area farmed” strategy is also the only strategy that has exclusively negative mean relationships with the resilience capacities. Most contribution to the standard deviations of the other strategies of the different groups was not due to a disagreement between positive or negative relationship, however, it mostly came from the disagreement in the intensity of the relation in one direction or the other.

The strategies related to collective action, “knowledge exchange”, “farmer led exchange” and “peer learning” were unanimously voted as positively related to the three capacities by all groups with the soil quality group scoring this the highest. This shows that the effectiveness of the contribution of these exchanges to the resilience capacities also depends on the subject of these exchanges. Depending on the subject, the exchanges can become more effective. It also shows that a strategy can have a varied effect on the resilience capacities depending on the perspective taken.

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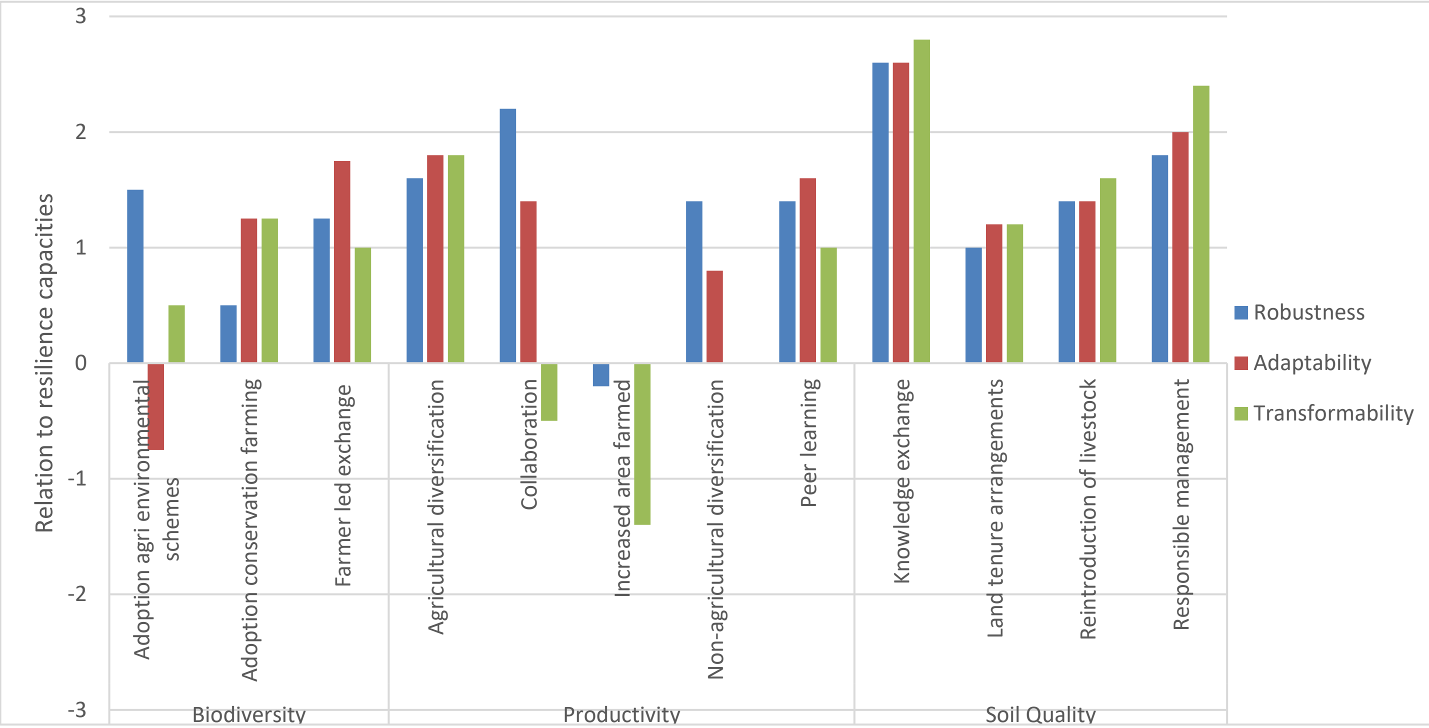

Figure 11. Bar graph showing average scoring of effect of the identified strategies on robustness, adaptability and transformability of the farming system. A 0 implies no relationship, a 1 or -1 a weak positive or negative relationship, a 2 or -2 an intermediate positive or negative relationship, and a 3 or -3 is a strong positive or negative relationship.

Figure 11 also shows trade-offs between the three resilience capacities or possibly between the strategies listed by each group. The biodiversity group indicated no consistent trade-off or synergy between the different resilience capacities, only one trade-off was identified for the "adoption of agri-environmental schemes". This strategy seems to mainly contribute to robustness, poorly to transformability and negatively to adaptability. This is surprising as these schemes have a tendency to promote and incentivise adaptability and transformability. The other two strategies resulted in a general synergy between the three resilience capacities.

The productivity group identified a trade-off between transformability and the other two resilience capacities for two strategies. The mean relationship with transformability is negative, non-existent or at least lower than the positive relationship of the strategies with robustness and adaptability. Here as well the results found are surprising as "collaboration" is expected to contribute to transformability and much less to robustness, which is a typical resilience capacity for the actors of the system that work on their own. Furthermore, "increased area farmed" by a single farmer is a strategy that would be expected to contribute to robustness and not have a negative relationship with it. As mentioned before, the group did not show this trend with "agricultural diversity" and "peer learning" as it was equally positively related to all three resilience capacities. As a total these strategies seem to mainly represent a robustness response to challenges of productivity, followed by an adaptability response.

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Lastly the soil quality group only showed a synergy between all resilience capacities for all strategies. This would mean that these strategies have quite a lot of potential to increase the resilience of the soil quality of the farming system to challenges. Also, that the adopted strategies to improve soil quality contribute in a similar way to the three resilience capacities.

6.2 General resilience attributes

In the last part of the workshop, the participants were asked to score the current performance and the relation to robustness, adaptability and transformability of the 13 resilience attributes identified by the SURE-Farm consortium. During this exercise discussion occurred around attribute number 5 (exposed to disturbance) as many stakeholders were confused by how to interpret it. For this reason, it will be considered separately. During the preparation phase the explanation statement was changed from "*The amount of year to year economic, environmental, social or institutional disturbance is small (well dosaged) in order to timely adapt to a changing environment*" to "*The amount of year to year economic, environmental, social, or institutional disturbance is minimal.*". This change was made in an attempt to obtain more clarity during the workshop. This has the issue that the meaning changes, instead of being exposed to an acceptable level of disturbance allowing the actor to learn to cope with those disturbances they are in the new meaning avoiding the disturbances a much as possible, and not learn from them anymore. As this explanation was leading to varied interpretation the statement was also changed during the workshop to "*The amount of year to year economic, environmental, social, or institutional disturbance.*". However, this did not solve all confusion, as the meaning of the attribute changed, resulting in quite different scoring compared to the rest of the attributes. The performance and relation to the resilience capacities of this attribute were scored with the most disagreement, which can be observed with the high standard deviations of the means in Table A7 and Table A8 in Appendix D. Figure A7 in Appendix D also shows that the standard deviations of the relation of this attribute to the three capacities is mostly a result of a disagreement between positive and negative contribution, and not only a disagreement of the intensity of that contribution. This results in a very low mean contribution to the resilience capacities (Figure 13). In Figure 12 this attribute was also scored much higher than the others as the stakeholders agreed that the farming system is exposed to many disturbances. Their opinion varied when judging if this was good or bad for resilience (Figure A7 – Appendix D).

The stakeholders scored the other 12 resilience factors on average lower than the strategies (section 6.1). The highest scoring attributes (Figure 13) had low to moderate performances (Figure 12), namely:

- Reasonably profitable (2.4)
- Coupled with local and natural capital (production) (2.4)
- Spatial and temporal heterogeneity farm types (2.5)

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- Socially self-organised (2.4)
- Appropriately connected with actors outside the farming system (2.6)
- Infrastructure for innovation (2.4)

The lowest scoring attributes, with a mean score lower than 2 (somewhat applied) were:

- Optimally redundant (farms) (1.9)
- Supports rural life (1.7)
- Coupled with local and natural capital (legislation) (1.8)

The attributes for which there was the most disagreement on their performance in the farming system, based on the standard deviations (Table A7 – Appendix D), are also attributes that were among the highest or lowest scores. These included: "optimally redundant farms", "socially self-organised" and "appropriately connected with actors outside the farming system".

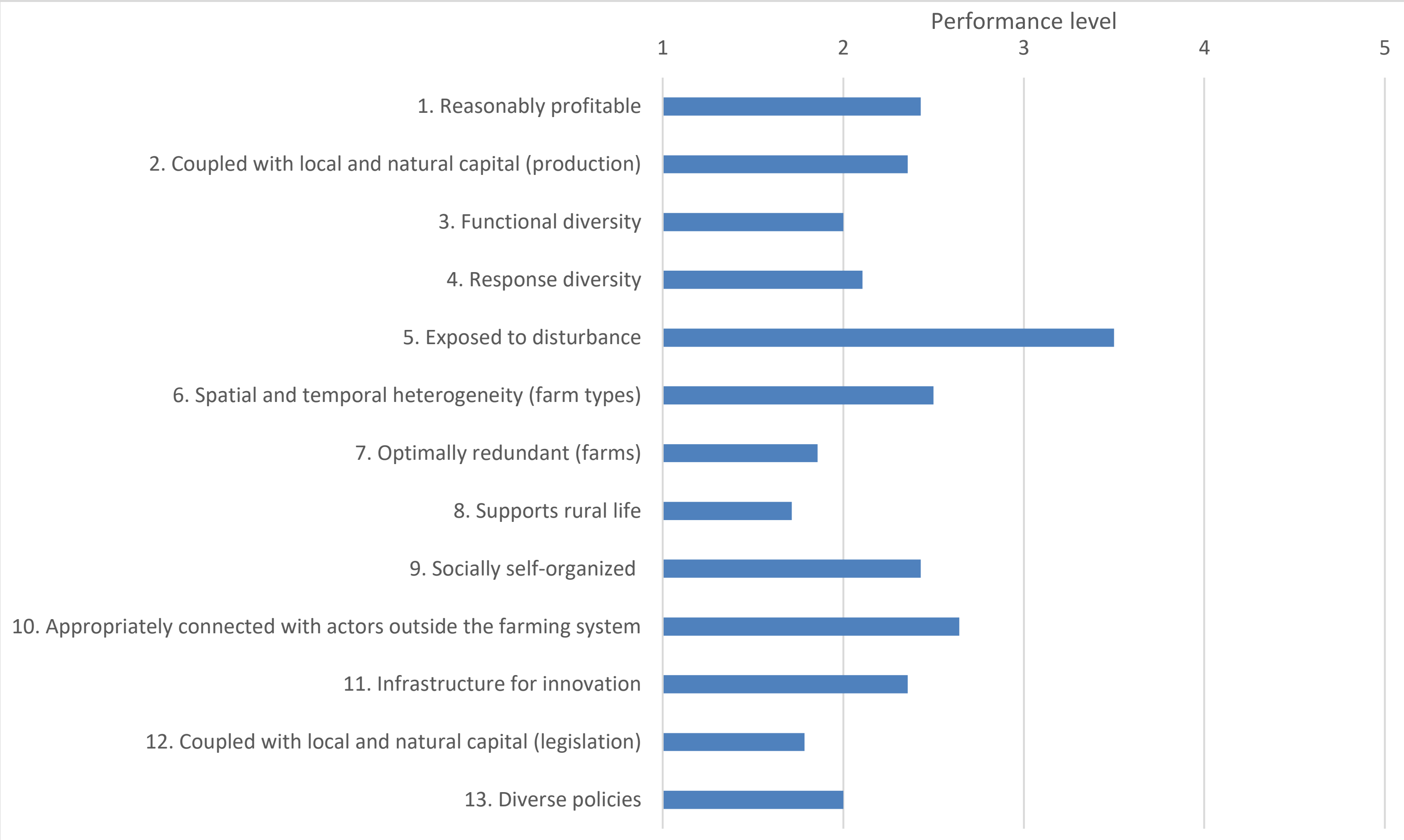

Figure 12. Bar graph showing current performance level of resilience attributes. Performance is scored as 1 = not at all applied, 2 = somewhat applied, 3 = moderately applied, 4 = much applied, 5 = very much applied.

Comments and remarks were also shared by the stakeholders to complement the scores that were given. The most noticeable general remark given was that this whole exercise was difficult or confusing; which, together with the fact that it was the end of a long workshop might have

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resulted in the low scores given to the performance of the attributes. One participant also pointed out that a farmer's good understanding of his finances and business, together with advice from grain merchants about end markets helps to create good business planning and business sustainability. Other comments were specific to the different attributes:

1. Reasonably profitable: stakeholders commented that there are too many 'subsidy junkies' out there, who don't try to depend less on subsidies. Others pointed out that profitability is an important attribute as it allows business to change.
2. Coupled with local and natural capital (production): it was mentioned that farmers will have to adapt their method and deliver on the maintenance of resources and biodiversity.
3. Functional diversity: stakeholders brought forward that the opportunities are getting narrower; and that reducing the availability of chemical inputs impacts the ability to respond to challenges.
4. Response diversity: it was pointed out that flexible payments are indeed possible with merchants, however, the reducing availability of chemicals is the problem.
5. Exposed to disturbance: besides issues mentioned earlier, stakeholders also shared that social media opposition to farmers is a big problem.
6. Spatial and temporal heterogeneity (farm types): stakeholders noted here that the East of England does not have much heterogeneity as it is heavily arable.
7. Optimally redundant (farms): several stakeholders brought forward the issue of succession in relation to this attribute. Succession is a big problem, which is very emotional and brings high risk. Key issues now are housing planning and succession planning.
8. Supports rural life: for this attribute it was highlighted that rural facilities, housing opportunities and job opportunities do not support a healthy rural population.
9. Socially self-organised: the issue of farmer networks and other similar activities tend to 'preach to the converted'. This implies that farmers that should be participating in such networks to benefit from them tend not to join them.
10. Appropriately connected with actors outside the farming system: stakeholders mentioned here that farmers can reach out, however, the effect can be quite variable as for example with losing crop protection chemicals such as metaldehyde and neonicotinoids.
11. Infrastructure for innovation: in this case stakeholders underlined that the knowledge is available, but farmers do not follow advice.
12. Coupled with local and natural capital (legislation): no comments given
13. Diverse policies: stakeholders mentioned that policies are not supporting farming without the use of payments, which brings serious challenges to financing. This relates also to earlier comments saying that policies tend to tie farmers into fixed approaches.

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The attributes chosen for SURE-Farm were, in previous work of the consortium, related to the four main processes of SURE-Farm. This leads to the possibility to score the performance of the main processes for the East of England using the average performance of the attributes linked to the main process.

a) Agricultural practices: as a result of being linked to attributes 1, 2, 11 and 12 the "agricultural practices" process would score a performance of about 2.3 (between somewhat applied to moderately applied).
b) Farm demographics: as a result of being linked to attributes 6, 7 and 8 the "farm demographics" process would score a performance of about 2.0 (somewhat applied).
c) Governance: as a result of being linked to attributes 9, 10, 11, 12 and 13 the "governance" process would score a performance of about 2.2 (between somewhat applied to moderately applied).
d) Risk management: as a result of being linked to attributes 3, 4, 5, 6 and 7 the "risk management" process would score a performance of about 2.4 (between somewhat applied to moderately applied). However, as this includes the earlier mentioned "exposed to disturbance" attribute, the score might be wrongly estimated. For this reason, the score can also be estimated at 2.1 (somewhat applied) when the attribute is not considered.

When considering those scores, the processes can be divided into "agricultural practices" and "governance" as the better performing processes of the farming system; and "farm demographics" and "risk management" as the processes with a lower performance. This shows that the farming system has more opportunities to develop the latter two processes to improve its resilience. However, as they all four have a relatively low performance it can be argued that further development of the processes is desired. Priorities can could be set at later stages in case the development of the processes does not happen equally, resulting in a potential unbalanced performance of the processes.

Similarly to the four main SURE-Farm processes, the attributes have also been linked to five general resilience principles by the consortium. This also leads to the possibility to score the performance of the general resilience principles for the East of England using the performance of the attributes.

a) Diversity: as a result of being linked to attributes 3, 4, 6 and 12 the "diversity" resilience principle would score a performance of about 2.2 (between somewhat applied to moderately applied).
b) Modularity: as a result of being linked to attributes 6 and 7 the "modularity" resilience principle would score a performance of about 2.2 (between somewhat applied to moderately applied).

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c) Openness: as a result of being linked to attributes 5 and 11 the "openness" resilience principle would score a performance of about 3.0 (moderately applied). However, as this includes the earlier mentioned "exposed to disturbance" attribute, the score might be wrongly estimated. For this reason, the score can also be estimated at 2.4 (between somewhat applied to moderately applied) when the attribute is not considered
d) System reserves: as a result of being linked to attributes 1, 2, 8, 11 and 12 the "system reserves" resilience principle would score a performance of about 2.1 (somewhat applied).
e) Tightness of feedback: as a result of being linked to attributes 6 and 7 the "tightness of feedback" resilience principle would score a performance of about 2.5 (between somewhat applied to moderately applied).

The scores indicate that the resilience of the system would mainly come from the openness of the system and the tightness of feedback within the system. However, as with the SURE-Farm processes, all the resilience principles score relatively low. This means that there is room for improvement and development for all five principles with most development potential on the three with the lowest score, namely: "diversity", "modularity" and "system reserves".

When looking at Figure 13 with the mean contribution of the resilience attributes to the three resilience capacities, it can be noticed that there is not much variety in the relative contribution from one capacity to the other. Besides contributing to robustness, adaptability and transformability in a relatively uniform way, it can also be noticed that the mean contribution of all the attributes is positive. The largest difference in contribution comes from the "being socially self-organised" attribute. This attribute has the lowest standard deviations together with the "spatial and temporal heterogeneity" attribute.

When adding the information of Figure A7 (Appendix D), it can also be concluded that the attributes that contribute the least to the resilience capacities, are already the lowest scoring attributes without the reducing effect of negative scoring. Additionally, there is a very low frequency of negative scoring in general, which indicates that the largest contribution to the standard deviations a result is of the variability of the positive scoring. This means that most of the disagreement on the contribution of the attributes to the capacities revolves around the intensity of a positive relationship and less around positive versus negative relationship. The "supports rural life" and "coupled with local and natural capital (legislation)" attributes contribute the least to the resilience capacities. These are also the lowest scored in performance as discussed earlier. Furthermore, the scoring of the attributes' contribution to the resilience capacities seems to mirror the scores of their performance. This possibly indicates that, while scoring, stakeholders assuming that the attributes always contribute positively; then, based on the performance, judged what the level of the positive contribution is.

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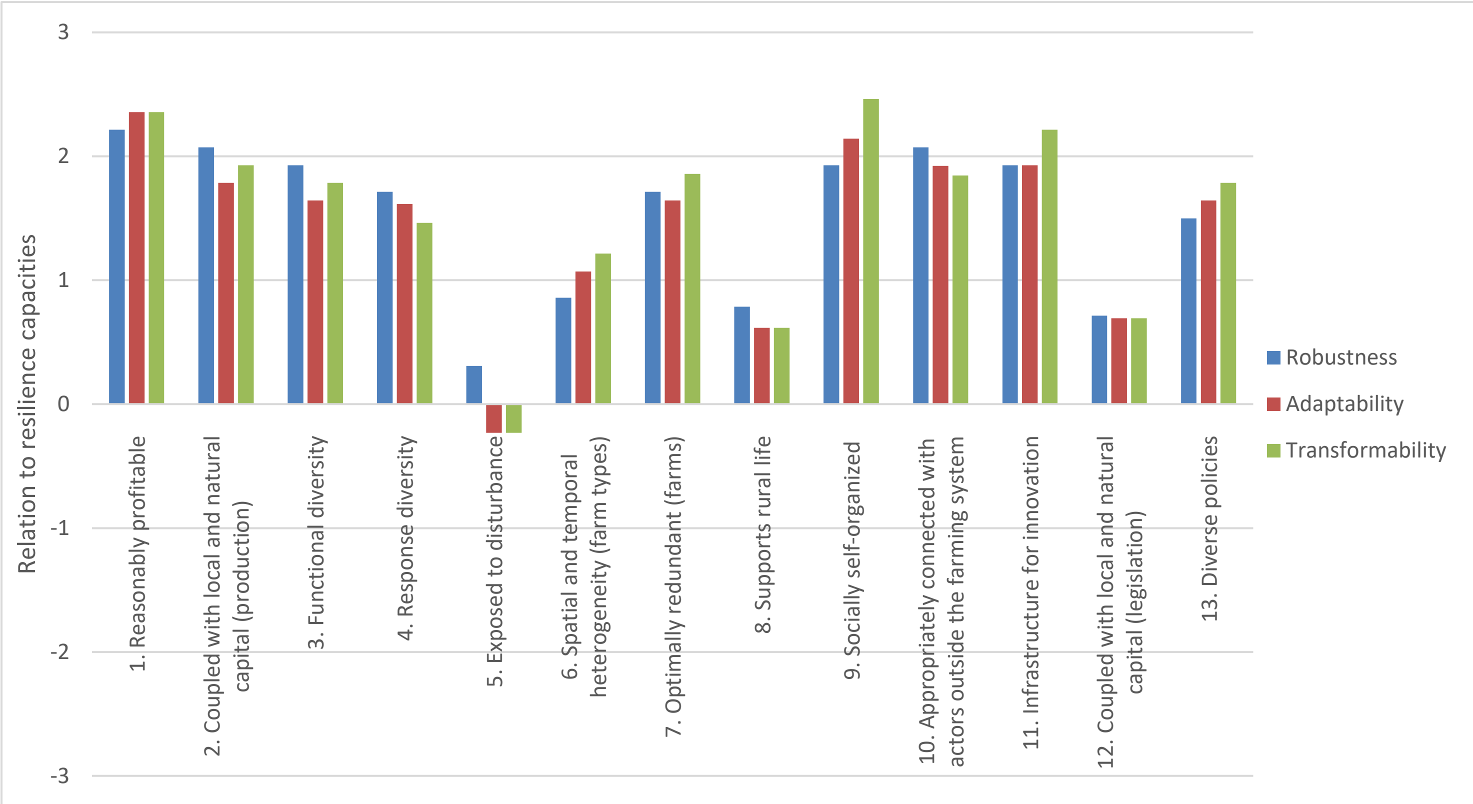

Figure 13. Bar graph showing average scoring of perceived effect of attribute on robustness, adaptability and transformability. A 0 implies no relationship, a 1 or -1 a weak positive or negative relationship, a 2 or -2 an intermediate positive or negative relationship, and a 3 or -3 is a strong positive or negative relationship.

As a result of the uniform distribution of the scores between the three resilience capacities, there can only be concluded that there is a general synergy and no trade-offs between robustness, adaptability and transformability. The only trade-off happens when choosing for attributes to develop, e.g. if one had to choose between “reasonably profitable” and “supports rural life” there is a trade-off between the amount of contribution to resilience.

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The combined interpretation of the performance and the contribution to the resilience capacities of the attributes provides information on the current general resilience of the farming system. In this case, the low average performance of the attributes benefits from the overall positive contribution to the capacities. In other words, although there is much room for improvement for the performance, according to the stakeholders they all improve the robustness, adaptability and the transformability of the system. Additionally, any improvement of the performance of the attributes is perceived to considerably improve the general resilience of the system as it becomes more robust, adaptable and transformable at the same time. The main exception to this would be the "exposed to disturbance" attribute as it already is at high performance and when it changes, stakeholders perceive little (positive for robustness, negative for the other capacities) to no effect on the robustness, adaptability and the transformability of the system. For the other attributes there are three arguments that indicate that the higher the performance of the attribute the higher the potential for increase of the system's resilience:

1. All have a relatively low performance and could increase,
2. All have a positive contribution to the three resilience capacities,
3. Higher performing attributes have higher contribution to resilience which means that the same amount of increased performance has more effect.

Lastly, the current resilience of the East of England arable farming system seems to be quite poor based on the performance of the resilience attributes. The general positive effect on the resilience capacities of the attributes provides the system with a high resilience potential, which would be balanced equally over the three capacities, consolidating that potential. However, as the performance is low, there is a clear need to increase it to be able to be resilient to coming challenges. It would be advised to invest in the performance enhancement of the resilience attributes, starting with those most cost effective or those most suited to recover from challenges expected to cause disruption.

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7 Discussion and conclusion

7.1 Functions of the farming system

From section 3, System functions, and section 4, Indicators of functions, it seems that "food production", "economic viability", and "natural resources" are the three functions through which the participants perceive the identity of the farming system. Both performance and importance are relevant. In other words, the participants identify their large scale arable as the result of farmers aiming to increase their production of food, to improve their economic viability, and to manage their natural resources well. The system's focus on increasing "food production" is expected as these intensive large-scale arable systems were the result of the Green Revolution, for which this function was central, interlinked with economic enhancement (Tilman et al., 2002). It then seems that "maintaining natural resources in good condition" gained in importance at a later stage, possibly due to policies, which promoted overuse of resource inputs (Pingali, 2012). Additionally, "economic viability" is not surprising to be considered as most important, as the system revolves around many businesses, and once they are not economically viable anymore, they stop. Once enough businesses stop their activity the whole system could be at risk.

The indicators that were put forward by the participants as key to the identity of the farming system are "Productivity", "Food quality", "Net farm income", "Water quality" "Soil quality", and "Diversity and abundance of key farmland species". These indicators were also selected as a result of their perceived importance and performance by the participants. All these indicators, except for "Diversity and abundance of key farmland species", belong to the three abovementioned system functions. Interestingly, the "Diversity and abundance of key farmland species" indicator was also considered as part of the identity of the farming system, albeit its system function was not key to the identity of the system. Stakeholders did have a tendency to consider it as closely related to "natural resources" making it somehow still linked to the one of the three key functions.

The performance of the system functions can serve to estimate the sustainability of the farming system's performance (Meuwissen et al., 2018; Meuwissen et al., under review). The general medium performance of the system functions would indicate a general medium sustainability of the system's performance. The function with the lowest performance, "biodiversity & habitat", could then also be considered a weak element of the system's sustainability. Loss of biodiversity and habitat has been observed in intensive agricultural systems (Uchida & Ushimaru, 2014), linked to the agricultural practices and land uses by the intensive agricultural systems. This would confirm the participants perception of function's relatively low performance and determining the system's sustainability. However, as can be seen in Figure 7 the lower performance score of the "biodiversity & habitat" function is very close to most of the other system functions. This implies that the medium sustainability of the farming system would also be caused by the medium performance of other system functions. Lower performances of other functions, such as

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"maintaining natural resources in good condition", in intensive arable systems has also been observed and lowering the long-term sustainability of a farming system (Matson et al., 1997).

7.2 Robustness, adaptability and transformability of the farming system

As mentioned in section 6 on the resilience attributes, it seems that the farming system has a high potential to increase resilience based on the general positive contribution of the attributes to robustness, adaptability and transformability, and the low performance scores. The resilience of the system also seems to be well balanced across the three resilience capacities as none was brought forward as being better supported by the attributes. The system would currently be as robust as it is adaptable and transformable. In some other case studies of the SURE-Farm project the contribution of the attributes has been observed to be close to equal, albeit not as well distributed as the UK case study. However, with the low performance of the attributes the actual resilience is quite poor, leaving the system quite vulnerable to challenges. During the discussion, there were indeed some challenges that seemed to worry some stakeholders. E.g. the fragile situation of glyphosate, a key tool in the intensive system (Brookes & Barfoot, 2013). On the one hand they fear the disruption caused by the banning of glyphosate. On the other hand, they realise that they must try and switch to different methods, as the use of glyphosate will not be permitted forever. The main efforts of the actors in the system to improve the resilience of the farming system should be to invest in the performance of the attributes (except for "Exposed to disturbance"). For the fastest results, the first investments should be focussed towards the attributes with the highest contribution to the resilience capacities, before investing in a broader spectrum of attributes, to consolidate the increased resilience. Also, investing in the performance of attributes that would help increase the resilience to challenges that are expected to come. For example, to be able to cope with the challenge of the banning of glyphosate investments can be made in the "infrastructure for innovation", "functional diversity" and "response diversity" attributes. This would allow the system to prepare to create diversity in inputs, management strategies and other tools; together with the drive of innovation to improve knowledge and invest in new (replacement) technology (Cabell &Oelefse, 2012).

The strategies identified during the group sessions give an overview of the farming system resilience in the past years. Most identified strategies show a similar effect as the attributes in the sense that most seem to generate a positive and synergetic effect on the three resilience capacities. Although, the contribution of the strategies to the resilience capacities seems to be less uniform and they appear to contribute more to robustness and adaptability than to transformability. These strategies can be analysed in terms of their relation to resilience capacities and to resilience attributes. These relations, summarised in Table 4, can be seen as follows:

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For the “Biodiversity” indicator:

- Adoption of agri-environmental schemes: this strategy is linked to the “Coupled with local and natural capital (legislation)” attribute as both aim to make use of schemes and legislation as a tool for resilience. The performance of the attribute (1.79) was scored lower than the performance of the strategy (3). This could be explained by the strategy being the execution of the attribute by the actor, meaning that legislation and schemes are well adopted by actors in the system while these might not be developed to the specific needs of the system. However, there is more disparity on their perceived contribution to the resilience capacities. While the attribute shows a low positive synergetic effect on all three capacities, the strategy shows a trade-off between adaptability and the other two. Additionally, the positive effect of the strategy on robustness is much higher than on transformability and the effect of the attribute on the three resilience capacities. While these are linked with each other, the difference in scoring might be caused by the difference in their angle on the matter. While the attribute is more specified on the suitability of the legislation (Deliverable 5.2.1 – Reidsma et al., 2018), the strategy focuses more on the application of the legislation. The application can be seen as more important or efficient because of its active nature.
- Adoption of conservation farming: this strategy is linked to the “Coupled with local and natural capital (production)” attribute as both aim to maintain and preserve natural resources such as water, soil and biodiversity. The two also score similarly on performance levels. The main difference is in their effect on the resilience capacities, where the attribute is perceived to have a stronger positive synergetic effect on all three capacities, than the strategy. For robustness there is a bigger difference as strategy has a much lower positive effect. The difference in their contribution to the resilience capacities could lie in that the strategy is only one of the possible methods to improve the attribute. Being only part of the solution, the stakeholders might also perceive it as less contributing to the resilience capacities.
- Farmer led exchange: this strategy is linked to the “Socially self-organised” attribute as both have collaboration and knowledge exchange as central elements, usually through structured organisations and groups. The two also have an equal perceived performance in the farming system and have a comparable positive synergetic effect on the three resilience capacities, albeit that the strategy seems to have a lower effect on robustness and transformability. The very comparable scoring could be explained by “farmer led exchange” being a clear result of self-organisation. The lower effect on robustness could be issued from the strategy due to its potential to exchange associated innovation which tends to have more influence on adaptability and on transformability. Whereas the self-organisation can also include concepts as cooperative which could have a relatively higher positive effect on robustness.

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For the "Productivity" indicator:

- Agricultural diversification: this strategy is linked to the "Spatial and temporal heterogeneity (farm types)" attribute as both bring the increased number of farm types, specialisations, intensity, etc. forward as contributors to resilience; and to the "Functional diversity" attribute for the focus on increased variety of inputs, outputs and markets. It seems that the attributes do perform slightly better than the strategy; however, their contribution to the resilience capacities shows a similar positive synergetic effect on all three capacities. In this case the strategy seems to be more general than the two attributes linked to it, this could lead to the perception of a lower performance by the stakeholder and explain the difference in performance.
- Collaboration: this strategy is linked to the "Socially self-organised" attribute in the same way as the abovementioned "Farmer led exchange". Participants did score the performance of both relatively low, with the strategy as the lowest performer of both. The scoring of their effect on the resilience capacities does show more differences; the attribute has a relatively high positive synergetic effect on the three capacities, whereas the strategy shows a trade-off between transformability (negative effect) and the other two capacities (positive synergy). As the attribute has a broader definition it can explain the differences. The work executed in collaboration can also vary a lot; from two or more actors working managing their business together and splitting the daily workload, to two or more actors working together on a plan to transform their business. The trade-off identified could issue from stakeholders associating "collaboration" more with the first notion could see this as a positive influence on robustness and an inhibitor for transformability. This effect could be even strengthened by the fact that this strategy is linked to productivity, driving the focus even more on that first notion.
- Increased area farmed (by a single farmer): this strategy is linked to the "optimally redundant (farms)" attribute as they work in opposite directions. When increasing the area farmed by a single farmer and thus lowering the number of farmer(s) there are less opportunities duplicates of relationships and critical components in case of failure. The strategy is a reaction to farmers stopping their practices, often by a lack of succession or economic struggle, leading to the farming practices being maintained by the remaining farmers who are looking for expansion to remain economically viable. This phenomenon has been documented in the UK, where over the period of 2005-2016 the number of farms were reduced by 35,5%, while the area of agricultural land stayed stable (European Commission – Eurostat, 2019). This effect was even stronger in the East of England, where the number of farms reduced by 46,2% over the same period (European Commission – Eurostat, 2019). This being labelled as a strategy results from actors that are part of the system, logically famers today are the ones who are part of the remaining farms and would consider it a strategy. Farmers who had to exit the business over that period of time might disagree. The definitions of this strategy and

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attribute are clearly linked, as the more the strategy is applied, the less redundancy there is in the system. The participants seemed to estimate the strategy as more applied in the case study area with its much higher performance than the attribute. This tendency is indeed noticeable from the data mentioned above. Their effect on the resilience capacities received opposite estimation, fitting their link. The attribute shows a medium positive synergetic effect on the three capacities while the strategy medium-low negative synergetic effect on robustness and transformability, and no effect on adaptability. The stakeholders seemed to judge that the strategy of increasing farm size seems to decrease the ability of a farm to transform: this results from the larger investments needed to transform a larger farm. The overall negative effect on resilience can be the result of strategies applied by farmers, which can reduce the system's resilience. Also, certain strategies applied for short-term increase in resilience can influence the system's resilience negatively on the long-term (Ashkenazy et al., 2018). That the attribute positively contributes to the three capacities could be related to the effect of having duplicates of critical relationships, it allows the farm to adapt or transform more safely as the relationships can be changed gradually. In the case of robustness, it serves more as a buffer when undergoing a challenge.

- Non-agricultural diversification: this strategy is linked to the "functional diversity" attribute as both revolve around services to the system coming from outside. The participants rated the strategy as more performant than the broader attribute it is linked to and judged that it has less positive effect on robustness and adaptability and no effect on transformability. This scoring could indicate that the participants do not consider all non-agricultural diversification as a transformation, but more as an adaptation or even as increasing robustness by creating some sort of economic buffer. That the diversification is not considered as transformative might also be explained by the predictability of the diversification. Farms tend to diversify based on certain characteristics such as: e.g. size, specialisation, structure (Weltin et al., 2017). This might make it look more as an adaptation rather than a transformation.
- Peer learning: this strategy is linked to the "socially self-organised" attribute in the same way as the abovementioned "farmer led exchange". Participants gave, in this case, a higher performance to the strategy than the attribute and identified a positive synergetic effect on the three resilience capacities which appears to be lower for the strategy. The effect on the resilience of "peer learning" was scored almost the same as of "farmer led exchange". This shows that the groups were likely working around similar concepts and ideas, which were then named differently. The slightly lower performance of "peer learning" could be attributed to the different context it is used in, "productivity" instead of "biodiversity". "Productivity" of a farm mainly depends on inputs and resources on the farm giving a less collaborative nature than "biodiversity" which is something that happens on landscape scale, involving more actors (McKenzie et al., 2013).

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For the “Soil quality” indicator:

- Knowledge exchange: this strategy is linked to the “socially self-organised” attribute in the same way as the abovementioned “farmer led exchange”. The group gave a slightly higher performance to the strategy than the attributes received. The effect on the capacities however is scored very similarly with a positive synergetic effect of the same range on the three capacities. When comparing it with the previously mentioned “peer learning” and “farmer led exchange” a noticeably higher positive synergetic effect on the three resilience capacities can be seen. The difference could be explained by the graph provided by the members of the group, which emphasised that soil awareness plays a key role in the improvement of spoil quality. A tool with a high potential to spread awareness would be “knowledge exchange”. Additionally, as soil quality appears to be, together with economic viability, among the main concerns of farmers (Mandryk et al., 2014), it would be expected that this strategy is considered to improve the resilience for this aspect. Also, this strategy seems to contribute more to transformability in the context of “soil quality” than in context of “productivity” and “biodiversity”. This could be caused by the knowledge being exchanged calls for transformative measures such as land use change to improve soil organic carbon content (Beniston et al., 2014).
- Land tenure arrangements: this strategy is linked to the “optimally redundant (farms)” attribute similarly as “increased area farmed (by a single farmer)” is linked to “optimally redundant (farms)”. The strategy was scored to perform better than the attribute; in contrast, the positive synergy of the effect on the three resilience capacities seems to be higher for the attributes. The difference of the effect on the resilience capacities between “land tenure arrangements” and “increased area farmed (by a single farmer)” could come from an additional link between the “land tenure arrangements” and the “optimally redundant (farms)” attribute. These arrangements can, aside from increasing the area farmer by one farmer, also promote exchange of land between several farmers. This can in its turn create relationships that could be considered optimally redundant, explaining the scoring of this strategy being closer to the attribute.
- Reintroduction of livestock: this strategy is linked to the “spatial and temporal heterogeneity (farm types)” attribute because it results in a higher number of farm types and specialisations; and to the “functional diversity” attribute for the focus on increased variety of inputs, outputs and markets. The performance of the strategy is scored lower than the two attributes it is linked to. The strategy and the two attributes show positive effect on all three resilience capacities, with the strategy scoring in same (lower) range as the “spatial and temporal heterogeneity (farm types)” attribute. This similarity could be explained by the “reintroduction of livestock” being the discussed example during the workshop of the “spatial and temporal heterogeneity (farm types)” attribute. The link with “functional diversity” being

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less direct, could also explain its higher effect on the resilience capacities. "Functional diversity" could be considered as less specific and thus containing more potential, resulting in the higher score given. Research does agree on the positive effect of the reintroduction of livestock on the resilience of the farming system, however the effect of this strategy could be considered greater than what stakeholders estimated in relation to soil quality (Schiere et al., 2002). Literature also shows that this strategy is also good for the sustainability of the farming system (Schiere et al., (2002); Gil et al., (2017)) or to cope with other challenges such as climate change (Gil et al., 2017).

- Responsible management: this strategy is linked to the "coupled with local and natural capital (production)" attribute for the same reasons as "adoption of conservation farming" links to the same attribute. The performance of both was scored the same. For their effect on the capacities, the main difference in their intermediate effect across the three resilience capacities is that the "responsible management" strategy has a slightly higher effect on transformability than on robustness. The higher effect on the three resilience capacities and especially transformability could be caused by the wider potential of responsible management. The "adoption of conservation farming" is a very specific example with its consequences, while "responsible management" could entail many concrete examples. Furthermore, the name of this strategy implies that the actor applying it would be responsible, allowing for everyone to interpret the strategy as effective.

Table 4. Overview of the identified strategies and the resilience attributes they are linked with.

Identified strategies	Attributes linked to strategies
Biodiversity indicator	
Adoption agri-environmental schemes	Coupled with local and natural capital (legislation)
Adoption conservation farming	Coupled with local and natural capital (production)
Farmer led exchange	Socially self-organised
Productivity indicator	
Agricultural diversification	Spatial and temporal heterogeneity (farm types) Functional diversity
Collaboration	Socially self-organised
Increased area farmed	Optimally redundant (farms)
Non-agricultural diversification	Functional diversity
Peer learning	Socially self-organised
Soil quality indicator	
Knowledge exchange	Socially self-organised
Land tenure arrangements	Optimally redundant (farms)
Reintroduction of livestock	Spatial and temporal heterogeneity (farm types) Functional diversity
Responsible management	Coupled with local and natural capital (production)

As the more varied contribution of the strategies to the resilience capacities compared to the attributes' contribution can be explained, there is no incentive from it to consider the scores given to the attributes differently.

When considering the link between the resilience attributes with the four SURE-Farm processes and the five general resilience principles, the performance scores of the attributes can be used as basis to score the processes and principles. This would indicate that there is not much difference

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in the performance of the different SURE-Farm processes and the general resilience principles. They all have room for further development to strengthen the resilience of the farming system. When looking at the highest scores, the "Agricultural practices" and the "Governance" SURE-Farm processes are the most developed. This means that the farms of the system are working on a set of productive and multifunctional activities leading to the provision of private and public goods (Deliverable 1.1 – Meuwissen et al. (2018). The actors of the system also obtained a certain level of organisation from their own structure or imposed by policy enabling the realisation of collective goals (Deliverable 1.1 – Meuwissen et al. (2018)). When adding this to the general resilience principles in can be concluded from the highest scoring that an improvement of the resilience of the system would mainly come from the openness of the system and the tightness of feedback within the system.

7.3 Options to improve the resilience of the farming system

The low scores given by the participants on the performance of the attributes would indicate that the resilience of the system is not very well established, putting it at risk for challenges to come. However, the contribution of the attributes to the resilience capacities were judged by the participants as positive and higher than the strategies identified in the past. This would imply that although the performance is low the attributes represent a potential to increase the resilience of the system. As mentioned earlier the way to bring about a balanced improvement of the farming system resilience would be through investment in the increase of the performance of as many resilience attributes as possible. The fastest way would be to invest in the performance of attributes with the highest positive effect on the resilience capacities. "Socially self-organised" for example is an attribute with relatively high contribution scores to the capacities and was repeatedly brought forward in the form of strategies linked to it. This would make this a key attribute to further develop, which could in its turn also help developing other strategies through various forms of collaboration. Actors in the system could then improve the performance of other attributes, which have a higher contribution to resilience, such as "reasonably profitable", "infrastructure for innovation", "appropriately connected with actors outside the farming system", "coupled with local and natural capital (production)" and "functional diversity". To then consolidate and further diversify the resilience, actors could then continue on the performance enhancement of the attributes with a lower contribution, however these will have less effect on the overall resilience of the system. Some attributes can be more complicated to increase in performance, e.g. "coupled with local and natural capital (legislation)" and "exposed to disturbance", as these are partly dependent on processes outside the farming system.

It is also important to note that Brexit was not discussed extensively during the workshop, while one would expect it to be at the centre of most participants' attention during a workshop on resilience. However, as this workshop mainly focussed on past and current resilience based on past challenges it follows logically that the topic was not at the centre of the discussion. Organisers

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should expect Brexit to gain in importance during the next FoPIA-SURE-Farm workshop on the assessment of the future resilience of the farming system, as the exit itself has not happened yet.

7.4 Methodological challenges

The workshop benefited from an excellent group of engaged participants from a range of backgrounds including five farmers. Overall the experience was positive, but I would recommend that the workshop is adaptable to the needs of the group of participants, while still collecting the required data. Key to the success of the UK workshop was allowing plenty of time for group and plenary discussion, particularly in the historical dynamics exercises. In turn this exchange was felt to have improved the quality of data collected during the latter exercises on resilience attributes and capacities. More detailed information on technical improvements and suggestions for specific aspects of the workshop can be found in Appendix E.

With the data obtained during the workshop from the participants one can also look for the reliability of the stakeholders' perceptions. When comparing their perception with historical data as was done for example with the skylark population it can be said that the information passed on by the stakeholders is reliable. Also, when looking at sections 4.1, 5.1 and 7.2 most observations and comments made by the participants could be backed up by literature, implying again that passed on information is reliable. This is to be expected as most participants are actors that are highly invested in the farming system and are well informed. Even though their specialisation might not be the same, to function well in the system they all seemed to have acquired a complete picture of the farming system they operate in. As a result of their different function in the system, they might perceive certain elements or events as having more or less impact which can be observed in the scoring differences of the stakeholder groups. However, when looking at the standard deviations of the scores given by the stakeholders within the "Farmer" and "NGO" stakeholders classes there tends to be more agreement than when considering all stakeholders. This shows that, on the one hand, indeed perception between classes differ and on the other hand within a class they are more consistent. This strengthens the argument that comparing their perception as was done in this report has added value. The "Others" class does have higher standard deviations; this can be explained by the fact that this class was the smallest, leading to higher effect of differences on the standard deviations. Adding to this it is also a more varied class of stakeholders with a higher likelihood of having different perception on the discussed matters, which also would result in more varied standard deviations.

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7.5 Conclusion

For the assessment of the system functions it can be concluded that the central functions of the system are “deliver healthy and affordable food products”, “ensure economic viability” and “maintain natural resources in good condition”. The indicators perceived as most important are “net farm income”, “productivity”, “food quality”, “soil quality” and “water quality” do belong to the central functions of the system. A sixth indicator not belonging to these functions, “diversity and abundance of key farmland species”, was also considered as important especially through comments and discussion. Indicators were, on average, judged to have a medium performance implying that there is room for improvement before reaching the system’s potential performance.

Through the analysis of three of the main indicators (“productivity”, “soil quality” and “biodiversity”) an assessment of the resilience capacities was made. “Productivity” was estimated to increase since the 1960s, slowing down in the past ten years. “Soil quality” seems to have declined over the past 18 years, with a stop of the decline in the last few years. “Biodiversity” was estimated to decline over the past 18 years. During the establishment of those trends, strategies were identified to deal with challenges the system faced with regard to those indicators. The implementation level of the strategies was relatively low leading to the conclusion that there was a low resilience in the past of the system. The strategies’ contribution to the resilience capacities was mostly scored as positive. The strategies were also scored to have more effect on robustness and adaptability compared to transformability. The most prominent strategy used in the system was the collaboration between farmers in the form of “peer learning”, “knowledge exchange” and “farmer led exchange”. The effect and performance of this strategy depends on the indicator: in the context of “soil quality” it seems to be the most effective with a medium to high positive effect on all three resilience capacities. This strategy was best implemented in the context of “productivity” with a moderate implementation. Most noticeable is the best implemented strategy by the farmers of the system to cope with challenges was “increased area farmed”, which was estimated to mostly negative effect on the resilience by the participants. This implies that this strategy is now considered as having worsened the resilience of the system.

The analysis of the strategies applied in the past can give an insight in the past resilience of the farming system and suggest that the farming system was mainly robust. The level of robustness was closely followed by the level of adaptability meaning that the system’s resilience was also due to its ability to adapt to new situations created by challenges. The lowest resilience capacity was transformability, meaning that the system lacked in flexibility allowing stakeholders to transform. While the system showed a higher robustness and adaptability compared to transformability, this study showed that the arable farming system had a low resilience.

Lastly, the current resilience of the system was further investigated through the general resilience attributes and estimating their implementation and contribution to the resilience capacities. The identified strategies linked mostly with the following attributes: “socially self-organised”, “functional diversity”, “coupled with local and natural capital (production and legislation)” and “spatial and temporal heterogeneity (farm types)”. The scoring of the attributes themselves can

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give an insight in the present resilience of the system. It showed that most general resilience attributes have a relatively high positive synergetic effect on the three resilience capacities for this farming system. The effect also seems to be evenly distributed across all three resilience capacities. Leading to the conclusion that there is a relatively high potential for the increase of resilience, combined with the low performance of the attributes. The low performance, however, indicates that the system's current resilience is low. The most important attributes for the system can be identified by considering the product of their performance combined with their effect on the resilience capacities, to create a weighted importance. The most important general resilience attributes of the system are the following: "reasonably profitable", "coupled with local and natural capital (production)", "socially self-organised", "appropriately connected with actors outside the farming system" and "infrastructure for innovation".

The low scores of the resilience attributes mean that the current resilience of the system is quite low. However current resilience seems to be well balanced across robustness, adaptability and transformability. It is mostly a consequence of the actors in the system being able to make a livelihood and save money, while functioning as much as possible on available natural recourses. These actors are also able create and reconfigure social interactions based on their needs, while also trying to for ties with actors outside of the farming system, with a system's infrastructure that facilitates diffusion of knowledge and technologies.

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Appendix A. Workshop memo

1. Short summary of mood and location aspect of the workshop

The workshop was held in a highly suitable room in terms of size, temperature and acoustics. Tea and coffee were freely available throughout the day and an appropriate and simple buffet style lunch was served on time. The layout of the room enabled division into three groups, which proved useful for the exercises, and assisted in generating both peer and plenary discussions. As reported in section 7.4, the event was attended by an interested and motivated group of participants who came with a positive attitude and who were amenable to engaging with the quantitative exercises, and to contributing meaningfully to the discussions.

2. Detailed schedule of the workshop

Time	Main activity	Secondary activity	Tertiary activity
09:30	Welcoming guests	Making sure refreshments are available to guests	
09:35			
09:40			
09:45			
09:50			
09:55			
10:00	Start + intro to FoPIA-SURE Farm		
10:05			
10:10			
10:15	Presentation Farming system		
10:20	Plenary discussion on farming system	Take notes of comments	
10:25			
10:30	Presentation Essential functions		
10:35			
10:40	Ranking Essential Functions	Handing out & collecting scoring sheets	
10:45	Presentation Indicators		Recording data + edit ppt
10:50	Ranking Indicators	Handing out & collecting scoring sheets	
10:55			
11:00	Scoring Indicator Performance		
11:05			
11:10	Coffee **b**reak	Making sure refreshments are available to guests	
11:15			
11:20			
11:25	Presentation results essential functions		
11:30			
11:35			
11:40			
11:45			
11:50	Indicator Dynamic	create & supervise groups (mixed) around single selected indicator	
11:55			

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12:00			Recording data + edit ppt
12:05	Relating challenges to dynamics	Supervise groups around same indicator	
12:10			
12:15	Relating strategies to dynamics	Supervise groups around same indicator	
12:20			
12:25			
12:30	Lunch break		
12:35			
12:40			
12:45			
12:50			
12:55			
13:00			
13:05			
13:10			
13:15			
13:20			
13:25			
13:30			
13:35			
13:40	Plenary discussion and comparison	Supervise groups around same indicator	
13:45			
13:50			
13:55			
14:00	Presentation resilience capacities		
14:05			
14:10	Strategies scoring	Supervise groups around same indicator	
14:15			
14:20	Coffee break	Making sure refreshments are available to guests	
14:25			
14:30			
14:35	Presentation Attributes		
14:40			
14:45	Scoring of attributes	Handing out & collecting scoring sheets	
14:50			
14:55			
15:00			
15:05	Examples of attributes	Handing out & collecting scoring sheets	
15:10			
15:15			
15:20			
15:25	Summary results Strategies		
15:30	Summary results Attributes		
15:35	Plenary decision on conclusions of the day		
15:40			
15:45			

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15:50			
15:55	Send Stakeholders home		
16:00			

3. Overview of participating stakeholders

Table A1. Stakeholder overview

Function	Organisation	Stakeholder group
Sector Manager	AIC	Other (Industry)
Former President	Landscape Institute	NGO
Agricultural Business Development Manager	EEAS	NGO
Consultant and Adviser National secretariat	ALA	NGO
Member of Rural Business Research Management Group	RBR-FBS	Other (RI)
Farmer		Farmer
Knowledge Exchange Manager - cereals and oilseeds	AHDB	Other (Industry)
County Adviser Norfolk	NFU - East Anglia	NGO
Farm Environment Adviser & Farmer	FWAG - East	NGO
Farmer	South Elmham Hall Farms	Farmer
Farmer	Knights Farm	Farmer
Crop specialist - Farming Systems Team	NIAB	NGO
Director East	CLA	NGO
Farmer	On the Fens	Farmer
Farmer	A.G. Young & Sons	Farmer

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Appendix B. details on ranking and rating the 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 functions.

	Farmer		NGO		Other		Grand Total	
Function	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Food production	17	6	20	6	28	13	21	8
Bio-based resources	5	4	8	5	7	7	7	5
Economic viability	25	21	15	6	26	5	20	13
Quality of life	9	5	9	3	6	4	8	4
Natural resources	16	4	19	8	15	5	17	6
Biodiversity & habitat	13	7	11	3	10	0	12	4
Attractiveness of the area	5	4	8	4	6	4	7	4
Animal health & welfare	10	7	10	3	2	2	8	6

Table A3(a). Importance of indicators per stakeholder group, original values. Per function, 100 points were divided over the indicators.

	Original values							
	Farmer		NGO		Other		Grand Total	
Indicator	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Productivity (e.g. ton/ha)	32	22	49	21	70	23	47	24
Food quality (e.g. % under certification schemes)	68	22	51	14	30	26	53	23
% land used for biofuels	100	40	100	41	100	46	100	39
Net farm income	64	30	59	22	80	20	65	25
% farms that are owned/tenanted	10	10	11	7	0	0	8	8
Debt/asset ratio	26	22	30	18	20	20	26	19
Income level for agricultural workers	34	26	42	13	50	10	41	18
Number of on-farm & agribusiness jobs (e.g. working units/ha)	36	29	31	13	30	10	32	18
Capacity development (trainings and opportunities for workers)	30	7	27	8	20	10	27	8
Water quality (e.g. pesticides and nitrates in rivers)	45	11	45	11	55	15	47	12
Soil Quality (e.g. erosion, stability, …)	55	9	55	5	45	15	53	9
Diversity and abundance of key farmland animal, plant and insect species (e.g. birds, butterflies, meadow plants)	45	16	48	18	41	9	46	15
Diversity of production	27	12	26	15	33	8	28	12
% agricultural land under environmental conservation	28	11	25	11	26	7	26	10
Happiness index (OECD) of rural populations	61	5	45	19	23	21	46	19
Regional agri-tourism offered	25	16	31	14	40	10	31	14
Extent of public access (e.g. footpaths, bridleways etc.)	15	11	24	15	37	12	24	15
Market share of products with certified higher levels of animal welfare	100	26	100	42	100	42	100	35

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*Table A3(b). Importance of indicators per stakeholder group, transformed values (indicator importance score * number of indicators for specific function * importance given to corresponding function by stakeholder category / 100) to include importance of the function and number of indicators per function. Transformed values allow for direct comparison between all indicators across all functions.*

	Transformed values							
	Farmer		NGO		Other		Grand Total	
Indicator	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Productivity (e.g. ton/ha)	11	7	20	8	39	15	21	13
Food quality (e.g. % under certification schemes)	23	7	21	8	17	15	21	9
% land used for biofuels	5	0	8	0	7	0	7	1
Net farm income	47	23	23	14	62	16	39	23
% farms that are owned/tenanted	7	7	4	3	0	0	4	5
Debt/asset ratio	19	16	12	9	16	16	15	13
Income level for agricultural workers	9	7	12	4	9	2	10	5
Number of on-farm & agribusiness jobs (e.g. working units/ha)	10	8	8	4	5	2	8	5
Capacity development (trainings and opportunities for workers)	8	2	7	2	4	2	7	2
Water quality (e.g. pesticides and nitrates in rivers)	14	3	17	4	17	5	16	4
Soil Quality (e.g. erosion, stability, …)	18	3	21	4	14	5	18	5
Diversity and abundance of key farmland animal, plant and insect species (e.g. birds, butterflies, meadow plants)	18	7	16	6	12	3	16	6
Diversity of production	11	4	9	5	10	2	10	4
% agricultural land under environmental conservation	11	4	8	4	8	2	9	4
Happiness index (OECD) of rural populations	10	2	10	4	4	4	9	4
Regional agri-tourism offered	4	2	7	3	7	2	6	3
Extent of public access (e.g. footpaths, bridleways etc.)	2	2	6	4	6	2	5	3
Market share of products with certified higher levels of animal welfare	10	0	10	0	2	0	8	3

Table A4. Mean and standard deviation of scoring on performance of indicators per stakeholder group and for all participants. Indicators were scored from 1-5 where 1 = very low, 2 = low, 3 = medium, 4 = good, and 5 = perfect; with coloured ranges: 1-2 = red, 2-3 = orange, 3-4 = light green and 4-5 = dark green.

	Corrected values							
	Farmer		NGO		Other		Grand Total	
Indicator	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Productivity (e.g. ton/ha)	3.600	0.548	3.429	0.535	4.333	0.577	3.667	0.617
Food quality (e.g. % under certification schemes)	3.400	0.548	3.714	0.756	4.000	0.000	3.643	0.633
% land used for biofuels	3.600	1.673	2.571	0.787	3.667	1.528	3.133	1.302
Net farm income	3.400	0.894	2.714	0.488	3.333	1.528	3.067	0.884
% farms that are owned/tenanted	3.000	0.816	2.000	0.894	2.500	0.707	2.417	0.900
Debt/asset ratio	3.250	1.708	2.667	0.816	3.500	0.707	3.000	1.128
Income level for agricultural workers	3.100	0.742	2.571	0.535	3.667	0.577	2.967	0.719
Number of on-farm & agribusiness jobs (e.g. working units/ha)	2.600	1.140	2.571	0.535	3.667	1.155	2.800	0.941
Capacity development (trainings and opportunities for workers)	2.200	1.304	2.429	1.134	3.333	0.577	2.533	1.125
Water quality (e.g. pesticides and nitrates in rivers)	2.900	0.894	3.286	1.113	4.000	1.000	3.300	1.032
Soil Quality (e.g. erosion, stability, …)	2.600	0.894	2.571	0.976	3.000	0.000	2.667	0.816
Diversity and abundance of key farmland animal, plant and insect species (e.g. birds, butterflies, meadow plants)	2.600	0.548	2.857	1.069	3.667	1.528	2.933	1.033
Diversity of production	2.000	0.707	2.286	0.951	3.000	1.000	2.333	0.900
% agricultural land under environmental conservation	2.800	0.447	2.857	0.690	3.667	0.577	3.000	0.655
Happiness index (OECD) of rural populations	2.800	0.837	3.143	0.378	2.333	1.155	2.867	0.743
Regional agri-tourism offered	3.100	0.742	3.000	0.816	3.000	1.000	3.033	0.767
Extent of public access (e.g. footpaths, bridleways etc.)	4.000	0.707	3.857	0.690	3.000	1.000	3.733	0.799
Market share of products with certified higher levels of animal welfare	3.700	0.447	3.857	0.690	3.333	1.155	3.700	0.702

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Table A5. Mean and standard deviation of scoring on performance of functions per stakeholder group and for all participants. Derived from scoring of importance and performance of indicators. Indicators were scored from 1-5 where 1 = very low, 2 = low, 3 = medium, 4 = good, and 5 = perfect; with coloured ranges: 1-2 = red, 2-3 = orange, 3-4 = light green and 4-5 = dark green.

	Corrected values							
	Farmer		NGO		Other		Grand Total	
Function	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Food production	3.5	0.4	3.6	0.5	4.0	0.0	3.6	0.4
Bio-based resources	3.6	1.7	2.6	0.8	3.7	1.5	3.1	1.3
Economic viability	3.2	1.0	2.6	0.4	3.7	0.7	3.0	0.8
Quality of life	2.7	0.7	2.5	0.3	3.6	0.5	2.8	0.6
Natural resources	2.7	0.8	2.9	1.0	3.5	0.5	3.0	0.8
Biodiversity & habitat	2.5	0.3	2.7	0.6	3.5	1.1	2.8	0.7
Attractiveness of the area	3.2	0.5	3.3	0.4	2.7	0.5	3.1	0.5
Animal health & welfare	3.7	0.4	3.9	0.7	3.3	1.2	3.7	0.7

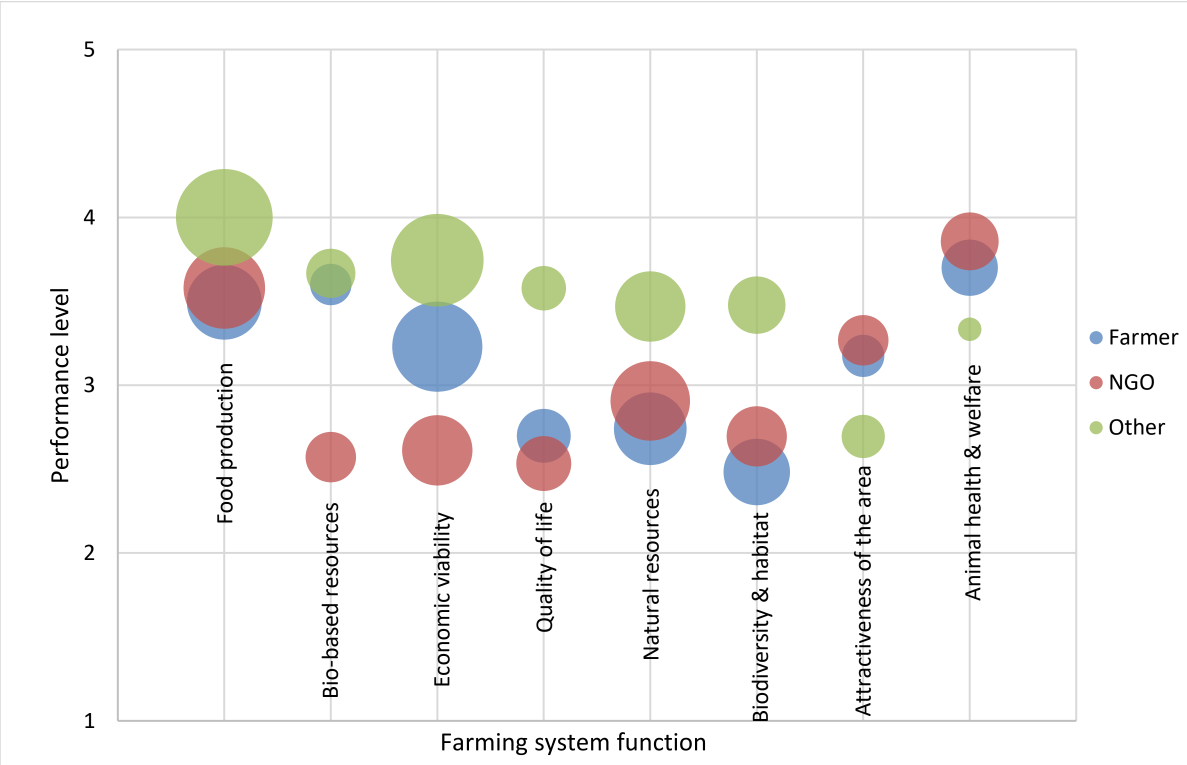

Figure A1. Bubble graph presenting averaged scores on performance of ***functions*** *(from 1 to 5), per stakeholder group, while also indicating their importance (size of the bubbles), relative to each other.*

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Appendix C. Dynamics of main indicators

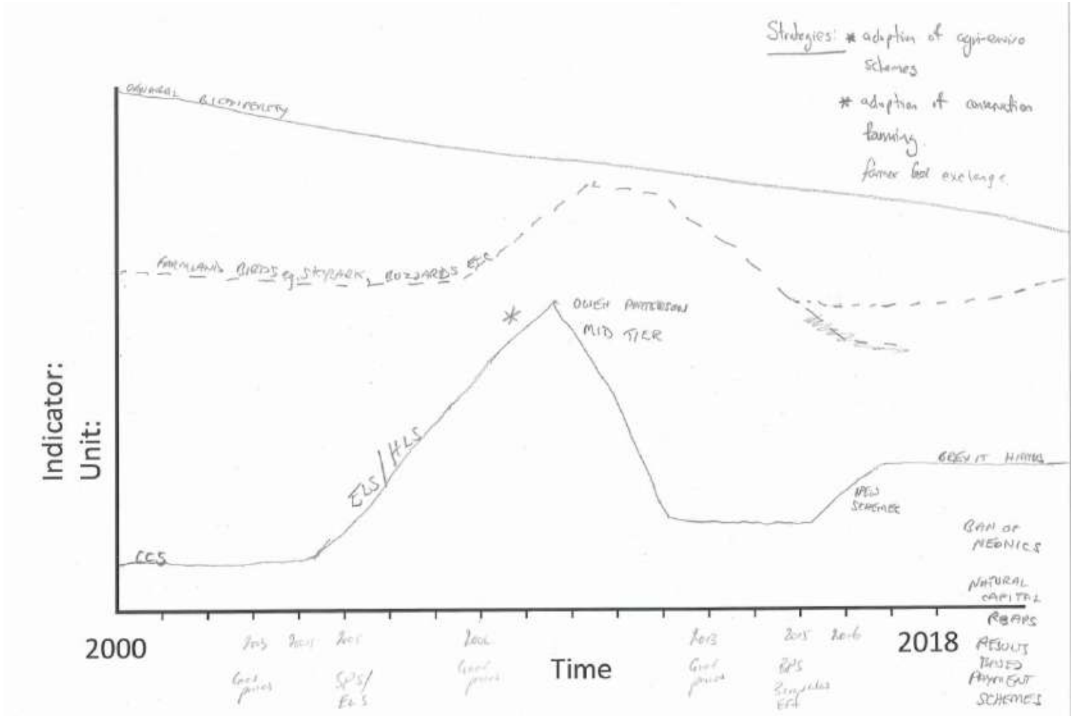

Figure A2. Drawing of the "Biodiversity" indicator made during the group session of the workshop. The top line represents the performance of general biodiversity, the middle line represents the performance of farmland birds e.g. skylarks & buzzards, and the bottom line represents the performance of legislation. Abbreviations used are: CCS – carbon capture and storage, ELS – entry level stewardship, HLS – high level stewardship, SPS – single payment scheme, BPS – basic payment scheme, EFA – ecological focus area.

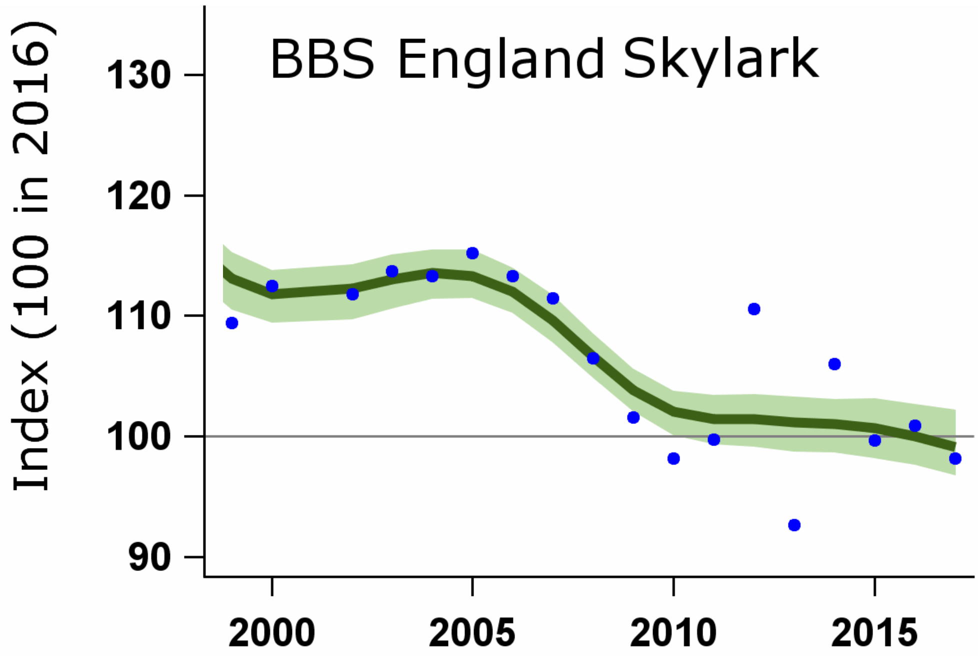

Figure A3. Graph of the performance of skylarks in England over the period of 2000-2017 – BTO/JNCC BirdTrends Report from the British Trust for Ornithology (Woodward, I.D.; et al. (2018))

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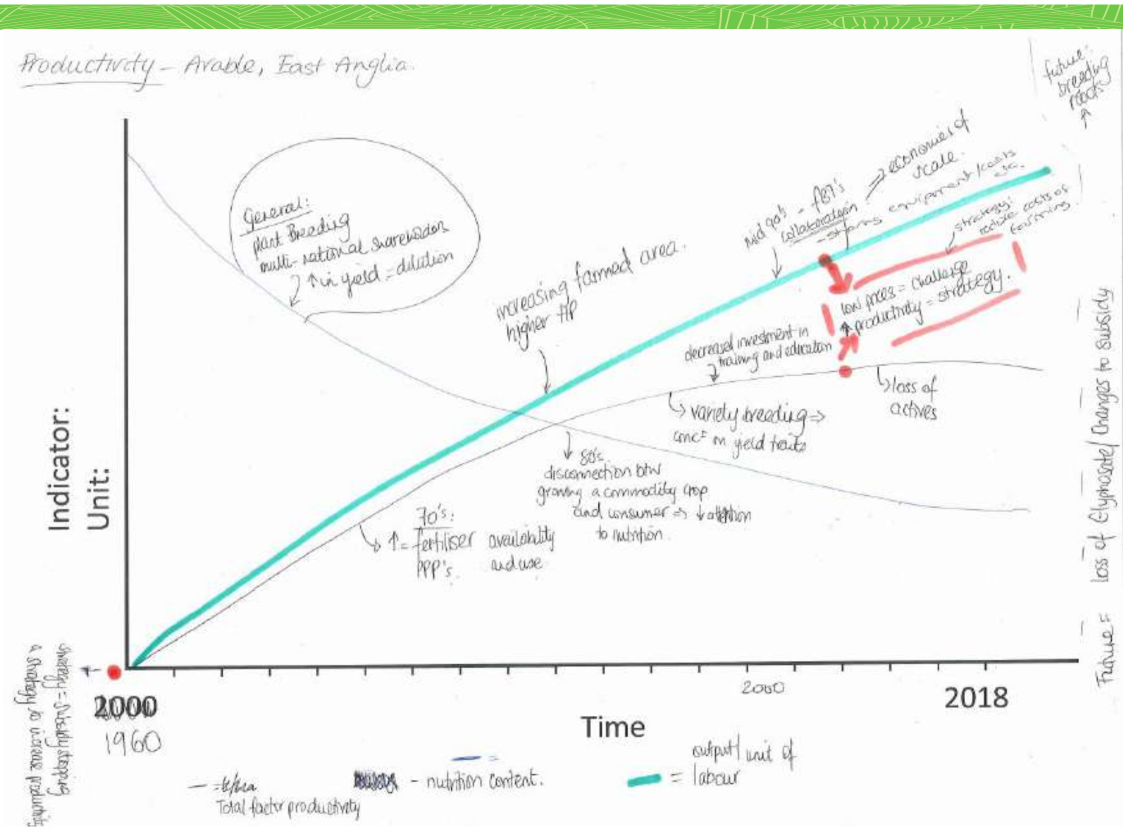

Figure A4. Drawing of the "Productivity" indicator made during the group session of the workshop: output per unit of labour (turquoise line), nutrition content (blue line) and total factor of productivity (black line). Abbreviations: PPP – plant protection products, FBT – farm business tenancy

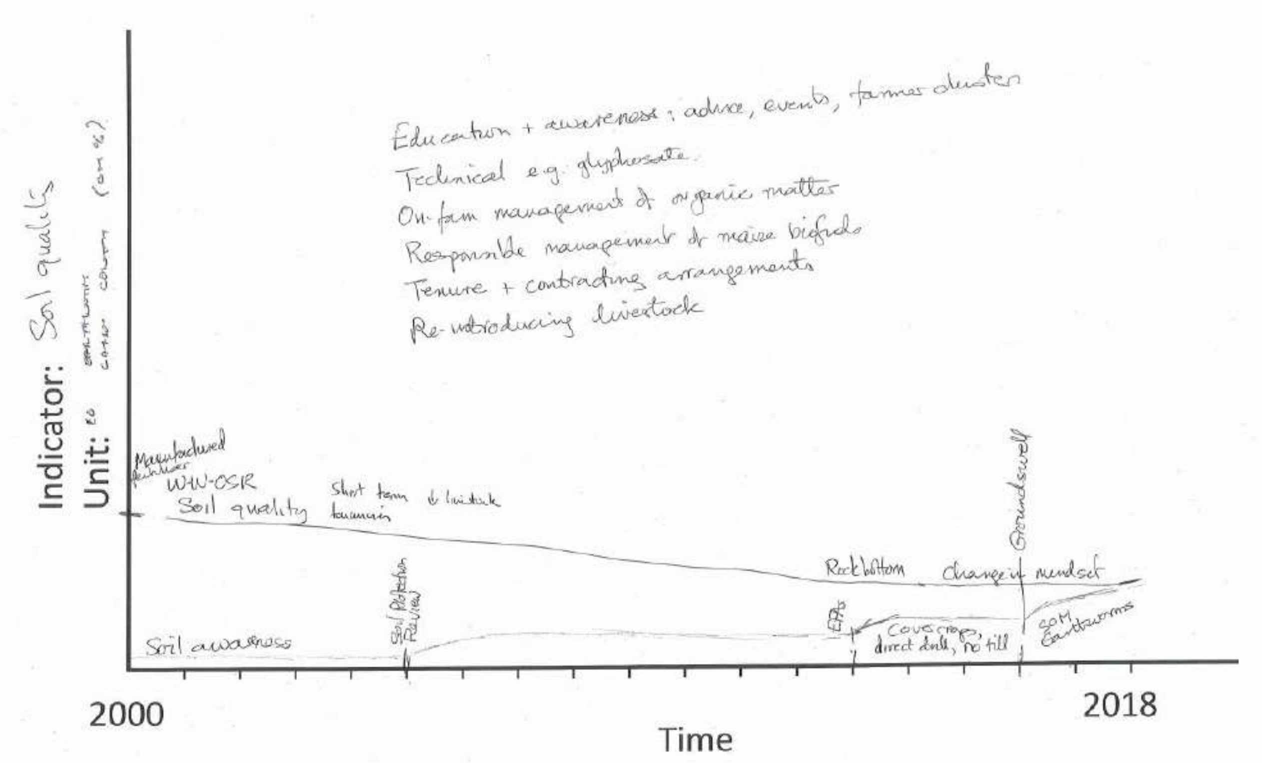

Figure A5. Digitalised graph of the "Soil quality" indicator depicted by a soil quality line and a soil awareness line. Abbreviations: W-W-OSR – winter wheat-oilseed rape, EFAS – ecological focus areas (S)OM – (soil) organic matter.

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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.

				Potential contribution to resilience capacities					
		Implementation score		Robustness		Adaptability		Transformability	
Selected indicator	Strategy	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Biodiversity	Adoption agri environmental schemes	2.8	0.5	1.5	0.6	-0.8	1.3	0.5	1.7
	Adoption conservation farming	2.3	0.5	0.5	0.6	1.3	1.0	1.3	1.5
	Farmer led exchange	2.8	1.2	1.3	1.5	1.8	0.5	1.0	1.4
Productivity	Agricultural diversification	1.4	0.5	1.6	1.5	1.8	1.1	1.8	1.6
	Collaboration	1.8	0.4	2.2	0.8	1.4	0.5	-0.5	1.0
	Increased area farmed	4.0	0.0	-0.2	1.3	0.0	1.9	-1.4	2.1
	Non-agricultural diversification	3.6	1.1	1.4	1.5	0.8	1.6	0.0	2.3
	Peer learning	3.0	0.7	1.4	0.5	1.6	0.5	1.0	1.2
Soil Quality	Knowledge exchange	2.6	0.9	2.6	0.9	2.6	0.5	2.8	0.4
	Land tenure arrangements	2.6	1.1	1.0	0.0	1.2	0.4	1.2	0.4
	Reintroduction of livestock	1.6	0.9	1.4	0.5	1.4	0.9	1.6	1.1
	Responsible management	2.2	0.8	1.8	1.1	2.0	1.2	2.4	0.9

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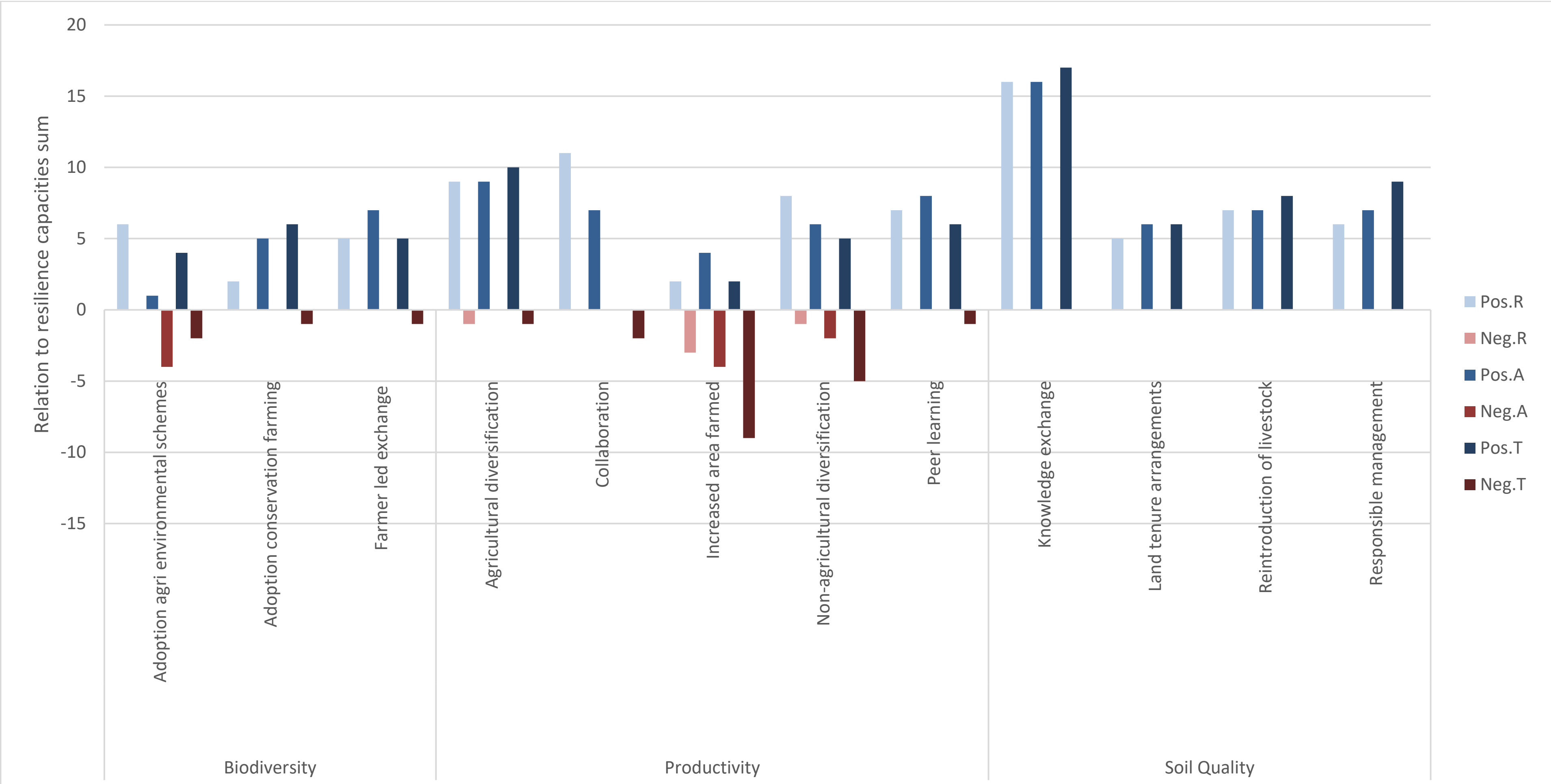

Figure A6. Bar graph presenting total positive and negative points allocated to a strategy's contribution to robustness, adaptability and transformability.

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Table A7. Mean and standard deviation of performance scores of resilience attributes. Per stakeholder group and for all participants.

	Extent into which attribute applies in FS							
	Farmer		NGO		Other		Grand Total	
Resilience attribute	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
1. Reasonably profitable	2.2	0.8	2.3	0.5	3.5	2.1	2.4	0.9
2. Coupled with local and natural capital (production)	2.3	0.5	2.3	0.8	2.5	0.7	2.4	0.6
3. Functional diversity	1.8	0.4	2.0	0.9	2.5	0.7	2.0	0.7
4. Response diversity	2.3	0.4	2.0	0.0	2.0	0.0	2.1	0.3
5. Exposed to disturbance	4.0	1.1	3.5	1.4	2.0	0.0	3.5	1.3
6. Spatial and temporal heterogeneity (farm types)	2.2	0.4	2.7	0.8	3.0	1.4	2.5	0.8
7. Optimally redundant (farms)	1.5	0.8	1.8	1.2	3.0	1.4	1.9	1.1
8. Supports rural life	1.7	0.8	1.5	0.5	2.5	2.1	1.7	0.9
9. Socially self-organised	2.3	1.0	2.3	0.8	3.0	2.8	2.4	1.2
10. Appropriately connected with actors outside the farming system	2.7	1.2	2.7	1.0	2.5	2.1	2.6	1.2
11. Infrastructure for innovation	2.3	0.8	2.2	0.4	3.0	0.0	2.4	0.6
12. Coupled with local and natural capital (legislation)	1.8	0.8	1.5	0.5	2.5	0.7	1.8	0.7
13. Diverse policies	2.2	1.2	2.0	0.0	1.5	0.7	2.0	0.8

Table A8. Mean and standard deviation of resilience attribute's contribution to robustness, adaptability and transformability. Per stakeholder group and for all participants.

	Extent into which resilience attribute potentially can contribute to resilience capacities in FS																							
	Farmer						NGO						Other						Total Robustness		Total Adaptability		Total Transformability	
	Robustness		Adaptability		Transformability		Robustness		Adaptability		Transformability		Robustness		Adaptability		Transformability							
Resilience attribute	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
1. Reasonably profitable	3.0	0.0	2.7	0.8	2.7	0.8	1.8	2.0	2.2	1.3	2.0	2.0	1.0	2.8	2.0	0.0	2.5	0.7	2.2	1.7	2.4	1.0	2.4	1.4
2. Coupled with local and natural capital (production)	2.5	0.8	2.3	0.8	2.2	1.2	1.8	1.5	1.5	2.3	1.8	1.9	1.5	0.7	1.0	0.0	1.5	0.7	2.1	1.1	1.8	1.6	1.9	1.4
3. Functional diversity	1.8	0.8	2.0	0.6	2.0	0.9	2.0	1.1	1.7	1.9	1.8	1.2	2.0	1.4	0.5	2.1	1.0	2.8	1.9	0.9	1.6	1.4	1.8	1.3
4. Response diversity	1.5	0.8	1.8	1.1	1.8	1.1	1.7	1.2	1.5	1.5	1.5	1.0	2.5	0.7	1.5	0.7	0.5	2.1	1.7	1.0	1.6	1.2	1.5	1.2
5. Exposed to disturbance	-0.5	1.9	-0.8	2.1	-1.0	2.3	0.6	2.5	0.4	2.1	0.2	1.9	2.0	1.4	0.0	1.4	1.0	2.8	0.3	2.1	-0.2	2.0	-0.2	2.2
6. Spatial and temporal heterogeneity (farm types)	1.0	0.9	1.2	0.8	1.0	0.6	0.7	0.5	1.0	0.6	1.3	0.8	1.0	0.0	1.0	0.0	1.5	0.7	0.9	0.7	1.1	0.6	1.2	0.7
7. Optimally redundant (farms)	1.8	1.2	1.7	1.2	2.3	1.2	2.0	0.6	2.2	0.8	2.2	0.8	0.5	0.7	0.0	0.0	-0.5	0.7	1.7	1.0	1.6	1.2	1.9	1.4
8. Supports rural life	0.2	0.8	0.4	1.1	0.4	1.1	0.8	1.2	0.7	1.4	0.5	1.6	2.5	0.7	1.0	0.0	1.5	0.7	0.8	1.2	0.6	1.1	0.6	1.3
9. Socially self-organised	2.0	0.6	2.5	0.5	2.2	1.1	1.8	1.2	2.0	0.9	2.7	0.5	2.0	1.4	1.5	2.1	2.5	0.7	1.9	0.9	2.1	0.9	2.5	0.8
10. Appropriately connected with actors outside the farming system	1.7	0.8	1.8	0.8	1.6	1.5	2.2	1.2	2.0	1.3	2.0	1.5	3.0	0.0	2.0	0.0	2.0	0.0	2.1	1.0	1.9	1.0	1.8	1.3
11. Infrastructure for innovation	1.7	1.0	1.7	0.8	1.7	1.2	2.0	1.3	2.2	1.6	2.7	0.5	2.5	0.7	2.0	0.0	2.5	0.7	1.9	1.1	1.9	1.1	2.2	1.0
12. Coupled with local and natural capital (legislation)	0.8	0.8	1.0	1.0	0.8	0.8	1.0	1.4	0.8	1.9	1.0	2.1	-0.5	0.7	-0.5	0.7	-0.5	0.7	0.7	1.1	0.7	1.5	0.7	1.5
13. Diverse policies	1.5	0.8	1.5	0.8	1.3	1.0	1.7	1.2	2.0	1.1	2.5	0.8	1.0	2.8	1.0	2.8	1.0	2.8	1.5	1.2	1.6	1.2	1.8	1.3

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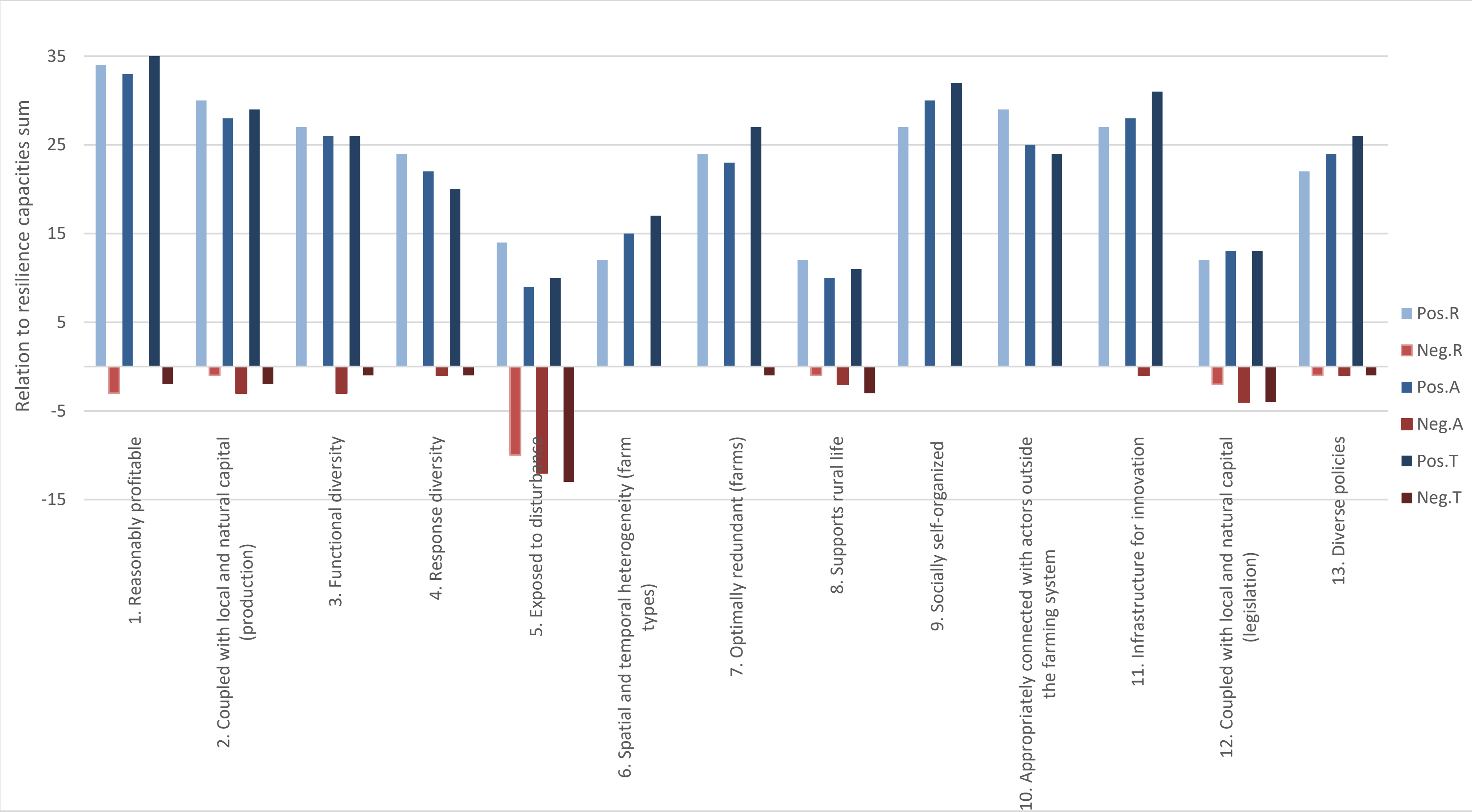

Figure A7. Bar graph presenting total positive and negative points allocated to a resilience attributes' contribution to robustness, adaptability and transformability.

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Appendix E. Workshop challenges and improvements

Information and suggestions on the workshop method were sourced from communication on the workshop proceedings to the consortium shortly after conclusion of the workshop. Discussion points 1-14 were circulated by the CCRI team; discussion points 15-22 were circulated by William de Grunne, support to the CCRI team for the first FoPIA-SURE-Farm workshop.

1. We had a total of 15 participants, which was a good number. We feel that any more than that would have been unmanageable, particularly in terms of inputting the data for feedback of the results during the workshop. As it was, there were some issues with the Excel sheets when inputting the data (which William will be able to provide more detail on), so we had to be fairly flexible with the workshop scheduling to avoid participants waiting while we prepared the graphs to show them.

2. We had 4 members of staff at the event, which was just about enough. We had 3 break out groups and it is important to have one person per table to help them to fill in the forms correctly. We also had one person (William) inputting the data. It may have been useful to have an extra person to read out the data while William input it, which would have speeded up this process.

3. Ranking essential functions exercise: generally, this worked ok, although there were some discussions around whether 'Deliver health and affordable food products' is actually two functions (i.e. 1. Healthy food and 2. Affordable food), and also whether this could be considered a public good.

4. Performance of indicators exercise: There was some confusion over the meaning of some of the indicators. For instance, '% of land used for biofuels' – the assumption here is that a higher % of land used for biofuels is a positive thing. This may not necessarily be the case – respondents felt that this was not a good indicator for this essential function. Similarly, they did not feel that '% of farms that are owned/tenanted' is a good indicator as it presumes that owning farms is better. This is not always the case. For the soil quality indicator, they suggested soil structure and earthworms may be better than erosion and stability.

5. The group exercise on sketching the dynamics of an indicator and identifying challenges and strategies worked well. We found we had to prompt them to be clear about the strategies, given that this was important for the next activity. The most interesting part was the plenary discussion, where each group shared their graph. This session went over time, but the participants were very engaged with the discussion, so we let it run and made up the time elsewhere. We felt that it would be quite frustrating for participants to curtail the discussion which was, for them, the most interesting part of the workshop.

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6. The scoring of strategies exercise worked best by using a combination of group discussion and individual scoring. Otherwise it is a tedious exercise. We therefore encouraged the groups to discuss each strategy in terms of level of implementation and whether it appeared to be robust, adaptable or transformable. We then asked them to score independently. This helped to keep them interested in the activity.

7. The scoring of attributes exercise was the most difficult and participants did not particularly enjoy doing this activity. They were also getting tired by this stage of the workshop. We therefore decided not to ask them to complete the final activity of identifying examples, as we wanted them to leave with a positive impression of the workshop, plus we already had concrete examples via the previous plenary discussion re. indicators and related strategies. The explanation of attribute 5 was difficult to understand. We therefore reworded it to 'The amount of year to year economic, environmental, social or institutional disturbance'.

8. We actually finished the workshop about 40 minutes early. We would suggest that other partners are sensitive to the mood of the group and don't drag out the final plenary if the participants seem like they have had enough!

9. Participants wanted to know what the outcomes from the workshop would be and how it would be used. They were particularly keen that it would feed in to the UK government post-Brexit policy making. Other partners may want to consider how the outcomes of the workshop will be used in their own country and how it might feed in to national policy.

10. Ensuring participants are well fed can help get them through the long day.

11. Our experience of doing the workshop is that participants are really keen to engage in discussion with other participants, so allowing sufficient time for this is important. Individual exercises can be quite frustrating and tedious, so trying to combine these with group and plenary discussion can help to maintain interest.

12. We would suggest that it helps to set out from the beginning the nature of the workshop so that participants know what to expect (i.e. a number of quite complicated individual activities, as well as group and plenary discussion). It's also important to outline how the workshop relates to them and why they have been invited. We also related the concepts discussed in the workshop to those being discussed currently around the UK agricultural bill.

13. We did include some examples on each of the forms to illustrate what information was needed. This helped, as well as table facilitators answering questions about how to fill in the forms as we went through each one.

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14. We had a really good group of engaged participants from a range of backgrounds including 5 farmers. Overall the experience was positive, but we would recommend that partners are sensitive to the needs of their particular group and adapt the session as needed, while still collecting the required data. For our case study, it was allowing plenty of time for group and plenary discussion.

15. To make sure you have not too many surprises regarding no-shows at the event send out an email to your participants a week before the event this triggered our participants that could not come anymore to warn us of their absence which made running the workshop easier.

16. At the beginning of the presentation when talking about the farming system we took a slightly different approach in two slides explaining that the system has two boundaries: a geographical one and a social one with stakeholders and their interactions (with a focus on the definitions and not the examples). This allowed the stakeholders to understand what we were on about without entering endless discussion with who goes in which circle.

17. We changed the schedule of the day slightly by moving some bits of the workshop around to make it slightly easier for the participants to understand what we are talking about and what they are supposed to do. This was mainly done for the group exercise when they are making the graphs depicting the historical dynamics of the indicators of essential function. We executed the exercise in one go before lunch and explained the participants to draw the graph and to place challenges on it from the start as they shape the graph anyway. Only the strategies were done separately to make sure they focus on them for a bit as they are what you need for the next exercise. Make sure each group has a clear list of the strategies at the end of this exercise, as when they note down the list for the next bit it is in the same order for everyone in the group making the data processing easier.

18. During our workshop the plenary discussion of the graphs lasted longer than foreseen. However, the topics discussed were also fitting for the general discussion at the end which can then be shortened.

19. We also suggest that the presentation of robustness, adaptability & transformability comes after the plenary discussion of the graphs and before the scoring of attributes as the participants do not need that information before then, this makes it easier for the participants to understand the exercises.

20. For a smooth execution also suggest making a detailed schedule for the organising team to keep track of the days progress, we added ours as example which also shows how the previous discussion points have been reorganised.

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21. Having at least one person from the organising team present per group of 5 participants helped us a lot to handle various questions during exercises, to help with the creation of the graph and to make sure that after they finished the graphs there is a clear list of strategies to be used in the following exercise.

22. And finally, when working with the MS Excel file to process the data during the workshop to reproduce the graphs for the presentation a few things helped us out:

    a. Working with MS Excel file beforehand helped to avoid too many problems

    b. Make sure your number of classes (farmer, NGO, ...) does not exceed 3 or else certain graphs and tables will not work in the excel

    c. Filling in on every recording sheet in the excel things such as names, stakeholder groups, ... gave us a big time advantage

    d. Working directly on the cloud made it also very easy to edit the presentation with the new graphs as everything synchronises. This permitted us to not have to run around with usb sticks and ending up with many files that contain partial information.

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