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FoPIA-Surefarm Case-study Report Belgium

Work Performed by P3, ILVO

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1 Introduction

1.1 General introduction:

Flanders is located in the northern half of Belgium. It is a semi-autonomous region governed by the Flemish parliament. The region has a population of about 6.5 million, which accounts for 68% of the Belgian population and covers an area of about 13,500 km^2. Geographically, the region is mainly flat. The soils are predominantly clayey and loamy/sandy. Agricultural activities in the region vary widely; the total agricultural sector has a production value of 5.5 billion euros (Departement landbouw en visserij, 2015). Livestock farming accounts for 3.25 billion euros, of which dairy farming accounts for 639 million euros. About 12% of the total amount of farms are dairy farms (Departement Landbouw en Visserij, 2015).

Historically, dairy farming has been very important in Belgium and Flanders. The dairy sector in Flanders is characterised by scale enlargement and high technological development over the last decades. Traditionally, dairy farming used to be combined with other agricultural production; typically arable farming or beef production. However, after the second world war, agriculture gradually became more specialized. The European market was highly protected for the last decades and milk prices were relatively stable. However, since 2007, the dairy sector has been subjected to price volatility. This is mainly due to the gradual decrease of protection measures by the CAP. In 2015, dairy quota in Europe have been abolished which resulted in an increased production of milk, quickly followed by a fall in prices (BCZ, 2017). However, after a few years of low profits and instability in the market, the milk price has become more profitable again in recent years.

The average stocking rate between 2012 and 2016 in Flanders was 2.5 livestock units per hectare (FADN, 2019). The average number of dairy cows per farm is 55. Around 36% of the dairy farms have less than 30 cows, while 37% of the farms have more than 60 cows and 73% of all dairy cows in Flanders are milked on farms with more than 60 cows (Departement Landbouw en Visserij, 2019).

Within the dairy sector, farm types in which milk production has a substantial contribution to farm income, can be subdivided as follows:

- specialised dairy farms with around 80 cows or more (50% of all dairy farms)
- mixed dairy farms with cattle (25% of farms)
- mixed dairy farms with arable agriculture (25% of farms)
- organic dairy farms (small group)

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Total milk production in Flanders exceeds national self-sufficiency. The market in dairy products is therefore strongly reliant on export. Fluctuations on the international market are therefore reflected in the milk price on Flemish dairy farms. Belgian farm-gate milk price evolution mirrors very well world milk prices.

The main strategy of dairy farms in Flanders to react upon decreasing margins has been scale enlargement and intensification. The number of dairy farms has almost halved over the last 20 years. The area in use for dairy production in Flanders, however, did not decrease (Departement Landbouw en Visserij, 2019). The number of cows decreased, while the amount of produced milk increased (VLAM, 2018). This strategy of intensification comes with certain disadvantages. Whereas intensification has, on the one hand, been beneficial for some environmental aspects, it had a negative impact on several environmental aspects. This results in a more negative societal opinion and a decreasing image of the sector. These growing environmental concerns have resulted in stricter regulation, posing a threat to further intensification. The most important challenges for the resilience of dairy farming system in Flanders are summarized in table 1. Challenges are highly interconnected (fig 1.).

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Table 1. Resilience challenges for intensifying dairy farms in Flanders, Belgium

	Challenges			
	Economic	**Environmental**	**Social**	**Institutional**
Shocks	Fluctuating milk and feed prices [3] Russian ban on dairy products [1]	Extreme drought events [1] Rising feed prices due to climatic events elsewhere [3] Diseases like FMD, Bluetongue [3] Flood risks (certain regions) [4]	Wellbeing of farmers and household members; casualty; personal health [2, 7]* Disagreements; contrasting visions on farm business strategy *	Decoupling of CAP payments [2, 7] Frequently changing policies [2]*
Long-term pressures	Low capital productivity [3] Over-production [3] Export reliability [3] low profit margins [2]	Increasing pest and disease pressure due to climate change [1] Soil degradation (biological, chemical, physical) [6] Poor water quality [2]	Ageing of the countryside [3] Competition with other careers [3] Low succession rate [1] Changing societal opinion [2,3] labour shortage [3] High pressure/ stress on farmers * Gender gap [5] Lack of independent advice *	Bilateral trade agreements [3] Low availability and high prices of land[7]* Poor bargaining position of farmers in the food chain [2]* Strict environmental regulations for fertilizer use [3] Increasingly strict manure regulations [3]

1: Bijttebier et al., 2018.
2: Debruyne et al., 2011
3: IRWiR PAN, 2017
4: Kellens et al., 2013
5: Meuwissen et al., 2018
6: Verstraeten et al., 2003
7: Wauters et al., 2014
8: Lawless & Morgenroth, 2016
*****: information from interviews conducted with farmers.

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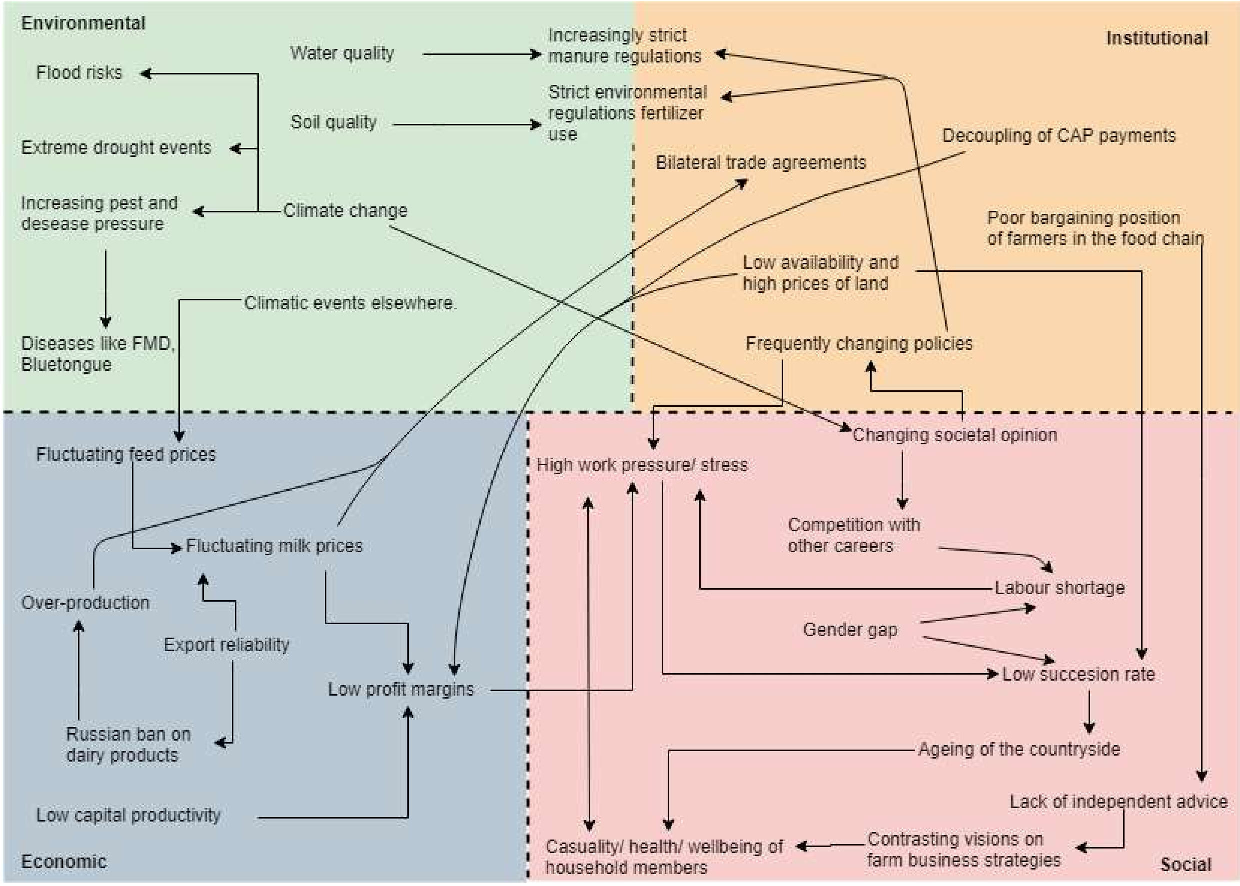

Figure 1. Interconnectedness of challenges for the intensifying dairy farming system in Flanders across the environmental, institutional, economic and social domains, Belgium.

Very recently, the dairy sector in Flanders has shown considerable dynamics. Total milk production increased by more than 20% in the last 4 years. Further, recent statistics show an increase in the number of dairy cows in that same period by 7%, which suggests that the increase in milk production is not solely obtained through higher milk production per cow, but that it also results from an increase in the total number of cows, after a decade long decrease.

1.2 Workshop details

On the 27th of November 2018, a participatory impact assessment workshop was organised (FoPIA-SureFarm), in the Social Sciences Unit of ILVO, to assess the sustainability and resilience of the farming system. The workshop started at 10:00 am and ended around 16:00. Besides the SureFarm team at ILVO, some members from the Italian and Dutch partner attended the workshop, both for assisting and for learning.

It was rather challenging to find enough participating farmers. Other stakeholders were easier to find. Many invitations were sent, ending with a total of 16 participants, of which 1 left before the end. Because the number of participants from governments and NGO's was small, these two groups were combined into one group ´others´. This resulted in 3 homogeneous groups of stakeholders, 5 farmers, 5 industry representatives and 6 ´others´. The category 'others' includes a participant from a consultancy organisation, two policy officers, a veterinarian and a representative from an NGO for agriculture and food.

2 Farming system

As part of preparing the workshop, the FoPIA team delineated the social boundaries of the farming system whereby important stakeholders are mapped into a figure (Fig 2). The way the stakeholders influence each other determines their position in the figure. Actors placed in the inner ring exert mutual influence on each other, placement in the second ring indicates one-way interaction towards the middle ring, placement in the outer ring indicates indirect influence. Positioning stakeholders was based on interview data, expert knowledge and literature. (Appendix B).

The workshop started with introducing and discussing the constructed farming system. That the farming system approach is a difficult concept complex to grasp (Giller, 2013), became clear from the extensive feedback on the proposed farming system (Fig. 2). This was partly because the reasoning behind positioning stakeholders was not completely clear, as participants believed that the position mainly was linked to importance of influence. When the reasoning behind positioning was explained later on in discussion, the discussion became more constructive. Finally, it was decided that the position of consumers is depending on the marketing strategies of farmers (e.g. direct selling at farms) and were therefore moved to the middle ring (Fig. 2). The farmers did not agree with the influence of the contract workers. They find that the contract workers have little influence on them as they can disagree over prices and just contract another company. The most extensive discussion was about the cooperatives, as there was some disagreement on positioning them. Some farmers claimed that they had little to no influence on the course of the cooperative, other farmers claimed the opposite. It was interesting to see that the farmers that proclaimed to have a strong influence on the cooperatives were those that were to some extent involved in the advisory or steering committees of the cooperative. The discussion was mostly focussing on the influence of the cooperative on the milk price paid to the farmers. Some farmers hold the cooperatives responsible for this. The other farmers however believed that the pricing of milk was something mainly established by the world market over which the cooperatives had little influence.

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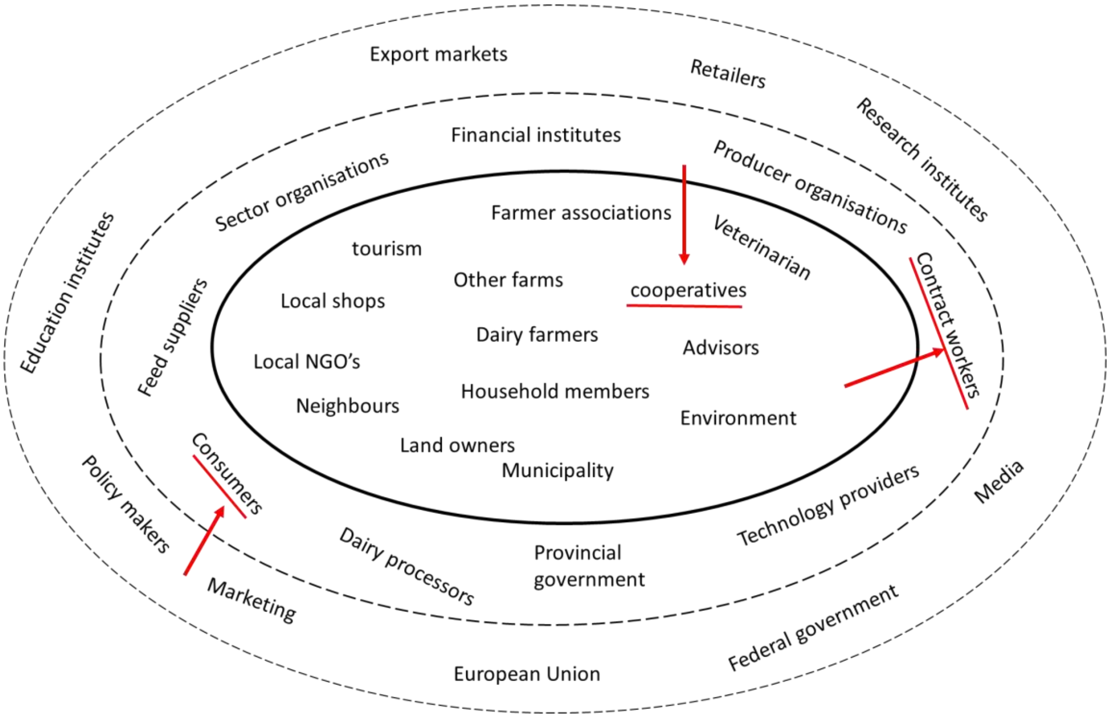

Figure 2. Updated farming system after feedback from participants. Actors placed in the inner ring exert mutual influence on each other, placement in the second ring indicates one-way interaction towards the middle ring, placement in the outer ring indicates indirect influence.

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3 Functions

3.1 Scoring of functions

After the participants agreed on the adapted farming system, they were asked to rank the functions of the farming system according to their importance. Each participant had to divide 100 points over 8 different functions, which were described by the FOPIA team. The more points a function received, the more important it was for the system according to the participants.

Farmers ranked the economic viability as the most important function (Table A2). Food production and quality of life are also scored high by the farmers. They scored attractiveness of the landscape as least important, followed by biodiversity & habitat. For the industry and the other stakeholders, the most important function was the production of food. For the industry group the second highest was maintaining natural resources while for the 'others' group the second highest score was for the economic viability of the farming system. The industry scored the attractiveness of the landscape and the deliverance of other bio-based resources as the least important; while the 'others' group scored bio-based resources as lowest followed by quality of life. Overall, the economic viability scored highest and secondly the production of food. Deliverance of other bio-based resources was ranked as the least important function. In general, standard deviations were high for high averages (Table A2).

Most interesting differences are the scores for maintaining natural resources. Here farmers gave a relatively low score, while industry and others gave a high score. Another point on which stakeholders strongly differ is at the economic viability. Farmers score this very high (38) while industry scores it (15), less than half. The 'others' group is in between (22). It should be noted that participants from industry still evaluated economic viability as the third most important function. Their scores were more evenly distributed across the functions than the scores by farmers (Figure 3).

3.2 Discussion outcomes

After the scoring exercise, results were shown to the participants in a clear graph (Figure 3). They were invited to comment on what they found surprising. One of the farmers, was shocked by the fact that industry and others rated the economic viability of the system not as the most important function. Another farmer countered his argument by pointing out that the provision of high quality and affordable food, was more important than income, as food production forms the base of their "*right to exist*". A third farmer agreed but added that people often think that the farmers income increases because the prices of dairy products for consumers rise. The rural attractiveness

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scored low as a function, and the participants explained that this function is strongly connected with maintaining natural resources in good condition and protecting biodiversity. As the rural attractiveness will be high when these functions are well deployed, they ranked the importance of this function low. It was also stated, that the low attendance of representatives of NGO's at the workshop has an impact on the low scores for biodiversity and attractiveness of the countryside. The rising pressure from public opinion on the performance of these functions makes it harder for farmers to keep farming, as they say that rules become increasingly strict. Moreover, their efforts towards these functions are not sufficiently appreciated, as people do not want to pay for these public goods.

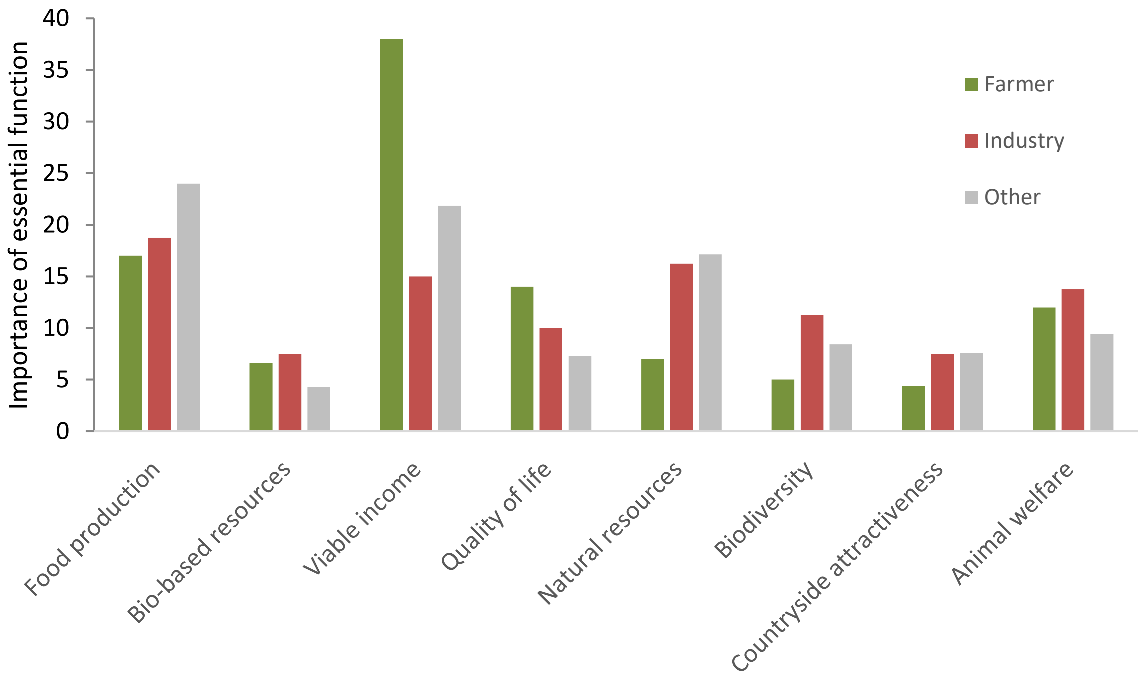

Figure 3. Average scores for each function, for different stakeholder groups (farmers, industry, others). 100 points needed to be divided over 8 functions. (n = 16)

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4 Indicators of functions

4.1 Indicator importance

As part of preparing the workshop, a list of indicators for each of the functions was established by the FoPIA team (Table A3). These indicators were selected based on literature and interviews. The participants were asked to score these indicators based on their ability to represent the corresponding function. Per function, 100 points had to be divided over the corresponding indicators.

At first there was a short discussion about the selected indicators. Some participants did not fully agree with the presented list and suggested other formulations or indicators. One indicator, 'income from farm tourism' was replaced by 'income from tourism at the countryside', as the share of income from 'farm tourism' on total income from tourism is limited. Other suggestions for indicators were water footprint, number of requirements a farmer has to comply with, and societal appreciation. However, no consensus was reached over these suggestions, so it was chosen not to include them. On the scoring forms some other suggestions were made; Nutritional value as an indicator for food quality, veterinary costs per cow and death rate of calves for animal welfare. At last, a farmer wrote that within the chosen indicators there is too much focus on the effects on the sector and too little focus on internal processes.

For the function food production, stakeholders strongly disagreed on the most important indicator (Figure 4). Farmers find the total amount of produced milk in Flanders the strongest indicator while the industry and the 'others' group find the price per litre of milk for consumers (real price of milk) more important. For the industry group, standard deviation of scores regarding this indicator was low, for the other two groups much higher (Table A3).

For the production of other bio-based resources, there were no big disagreements between stakeholders (Figure 4). The three indicators representing this function were, the production of crops, the production of meat and the number of farms with biogas installations. It was decided to place crop and meat production under the function bio-based resources because the focus of this case study is the production of dairy products. The number of crops produced is seen as the most important indicator for bio-based resources.

More disagreement was present regarding the economic viability of the farming system (Figure 4). The indicators for this function were: Share of total farm income from milk, labour income, gross margin per litre of milk. All stakeholders see the share of total farm income as much less important than the other two indicators. For the farmers and the industry there was no large difference between the gross margin per litre and the total farm income. The 'other' group saw

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the farm income as a more important indicator. However, this was accompanied by a high standard deviation (Table A3).

For the quality of life, there were no large disagreements between stakeholders (Figure 4). The indicator with the highest average score was "the average amount of working hours per farmer per day".

Maintenance of natural resources was best represented by the soil and water quality according to the farmers (Figure 4). The industry, however, disagreed and thought that the carbon footprint was better suited. The 'other' group scored the soil quality as most important. From the high standard deviation, it can however be seen that the 'other' group had some internal disagreements regarding this point.

The industry and the 'other' stakeholders scored the share of ecologically valuable grassland as most important for the biodiversity, while the farmers had a very strong preference for the indicator 'responsible use of crop protection chemicals' (Figure 4). There was a high standard deviation, meaning that not all farmers agreed (Table A3). But it is evident that farmers have a different view on the best indicator for biodiversity. All stakeholder groups scored the genetic variability of the herd as the least important indicator.

When scoring the indicators for the attractiveness of the landscape, stakeholders seemed to not strongly prefer one indicator above the other (Figure 4). Only within the industry group the share of farms with outside grazing was ranked somewhat higher than the other indicators.

For animal welfare the same applied (Figure 4). There was no large difference in the scoring by all stakeholder groups for the indicators.

Concluding on indicator importance:

For the farmers, the most important indicator clearly was the amount of milk produced in Flanders (Figure 3). Secondly, the responsible use of crop protection. Thirdly, the number of crops produced.
For the industry, the most important indicator was the price per litre of milk that consumers have to pay. Secondly, the average amount of working hours per day per farmer. Other indicators that scored high were tons of crops produced and the longevity of cows.

The 'other' group also scored the consumer price per litre as the highest. Total farm income was second. Furthermore, cow longevity and responsible use of antibiotics scored high.

Overall, the most important indicators were; milk price for consumers, cow longevity, total farm income, average amount of working hours per day per farmer and responsible use of antibiotics and crop protection chemicals.

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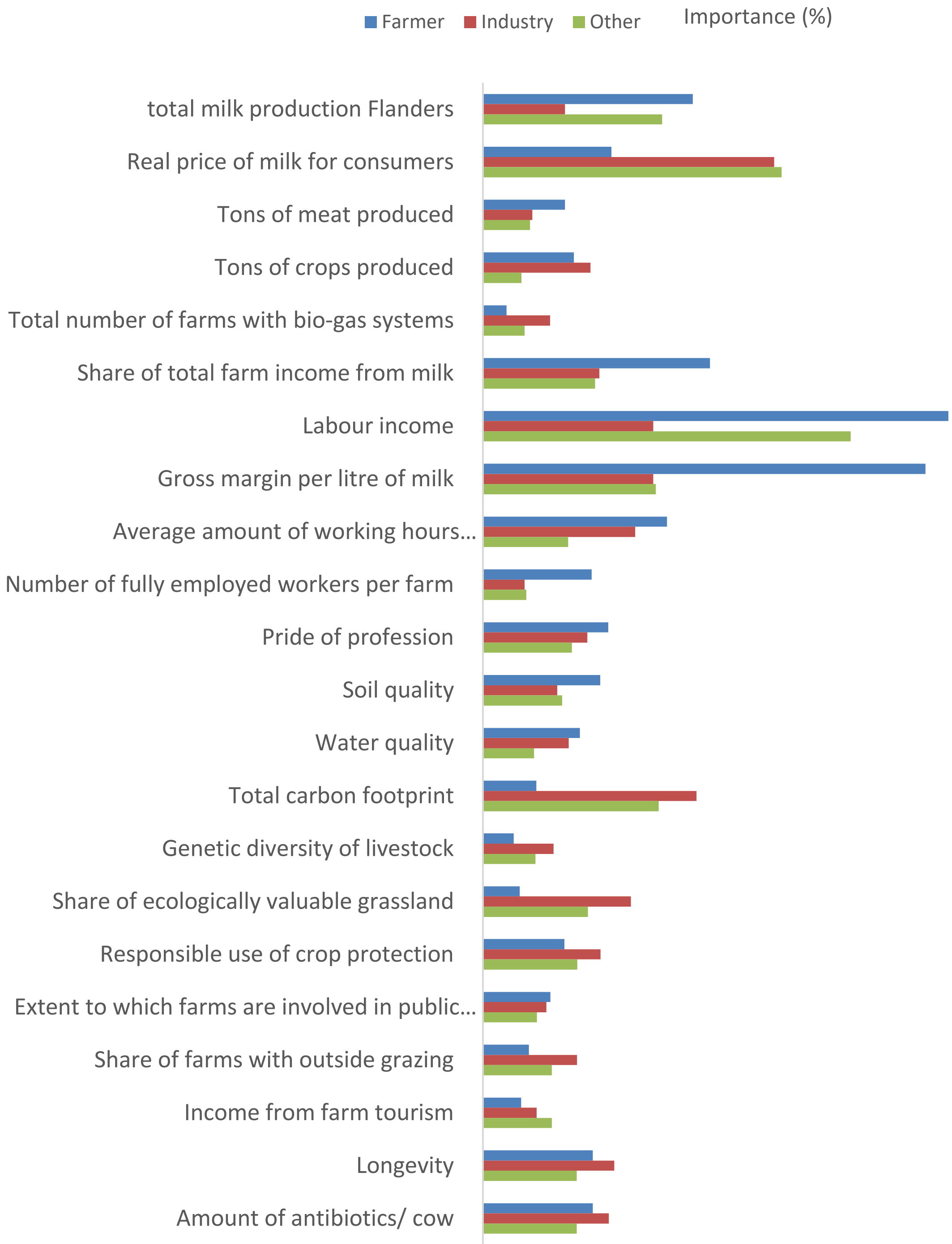

Figure 4. Bar graph with scoring of importance per indicator, aggregated by stakeholder group. Per function, 100 points were divided over the indicators. Values are transformed to include the importance and number of indicators of the function that the indicators represent. (n = 16)

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4.2 Indicator performance

After assessing the importance of indicators, the participants were asked to score the indicators regarding to their current performance within the system. These results were then combined in several graphs. The average performance of each indicator grouped by stakeholder group (Figure 6), the average performance of each indicator (Figure 7), the performance of the functions (Figure 8) and the importance of the functions combined with the current performance of the indicators grouped per stakeholder group (Figure A1).

The farmers scored the indicator ‘average working hours per day’ very low. They seem to be unhappy about the current workload. The other indicators for assessing economic viability have low scores, especially for the farmers. Strikingly high scores of farmers are found under the indicators concerning the maintenance of natural resources.

The industry has a more moderate scoring of the indicators. The industry agrees with farmers on the performance of the indicators corresponding to the function ‘maintaining natural resources’. Compared to the farmers, they are more positive on the ‘share of farm income from milk’ and ‘the real milk price for consumers’. The industry scored the indicators of economic viability as the lowest. An interesting high score can be found for the responsible use of antibiotics.

Just as the farmers and the industry, scores for indicators assessing ‘economic viability’ are lowest. However, they are less optimistic on the conservation of soil quality, total carbon footprint and indicators related to animal welfare. The highest score was given to the total milk production in Flanders. The lowest score they gave to the total income for farmer.

At last, it should be noted that we succeeded in bringing together a quite heterogeneous group of participants, with different interests and opinions. However, even though many different stakeholders were represented, the results will always be reflected and dependent on the individuals themselves, especially as the overall group is not very large. This was also noted by the participants themselves. If the workshop was held with another group, the results could be different. This is already illustrated by high standard devations.

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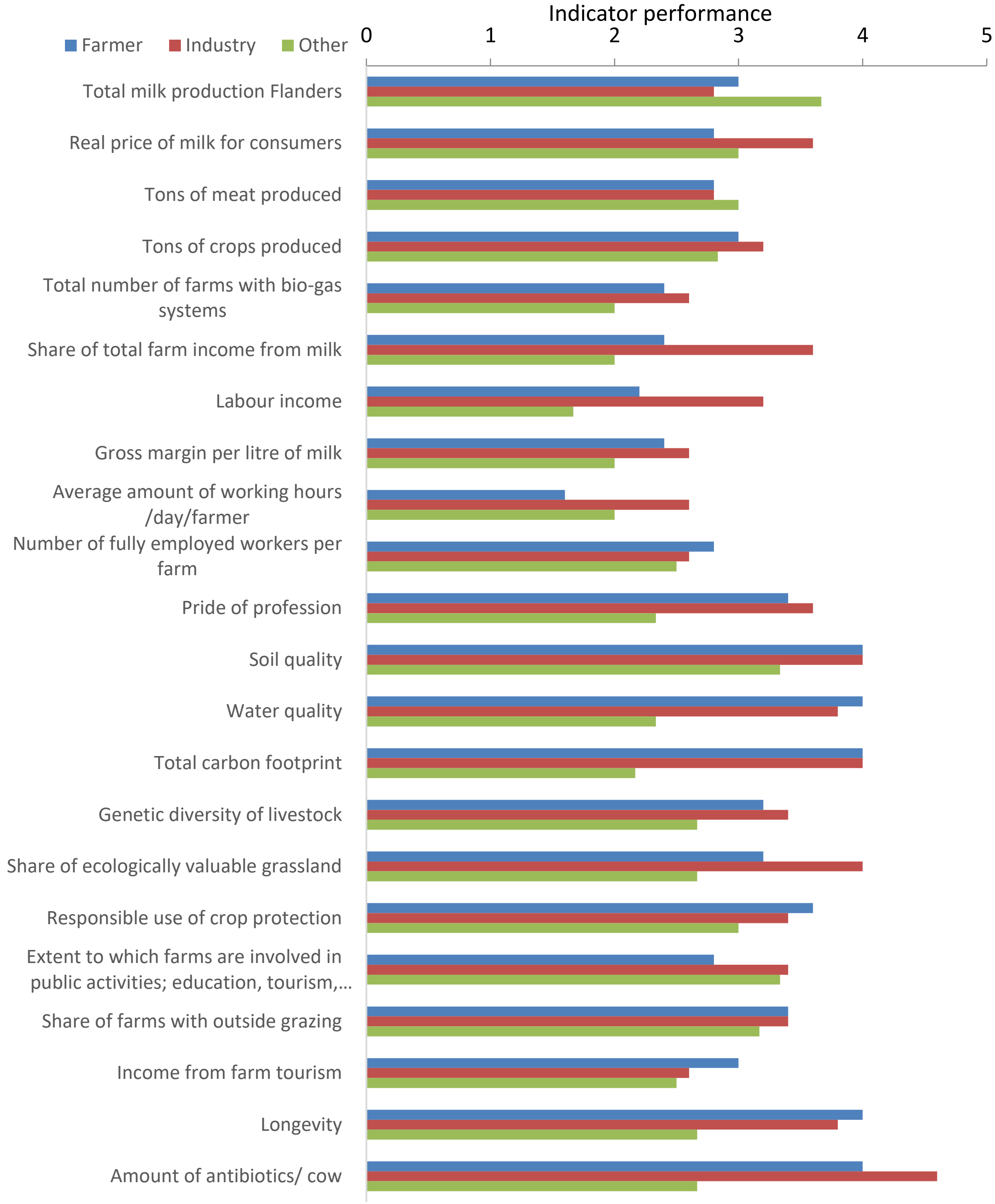

Figure 6. Performance of all indicators (from 1 to 5), aggregated by stakeholder group.

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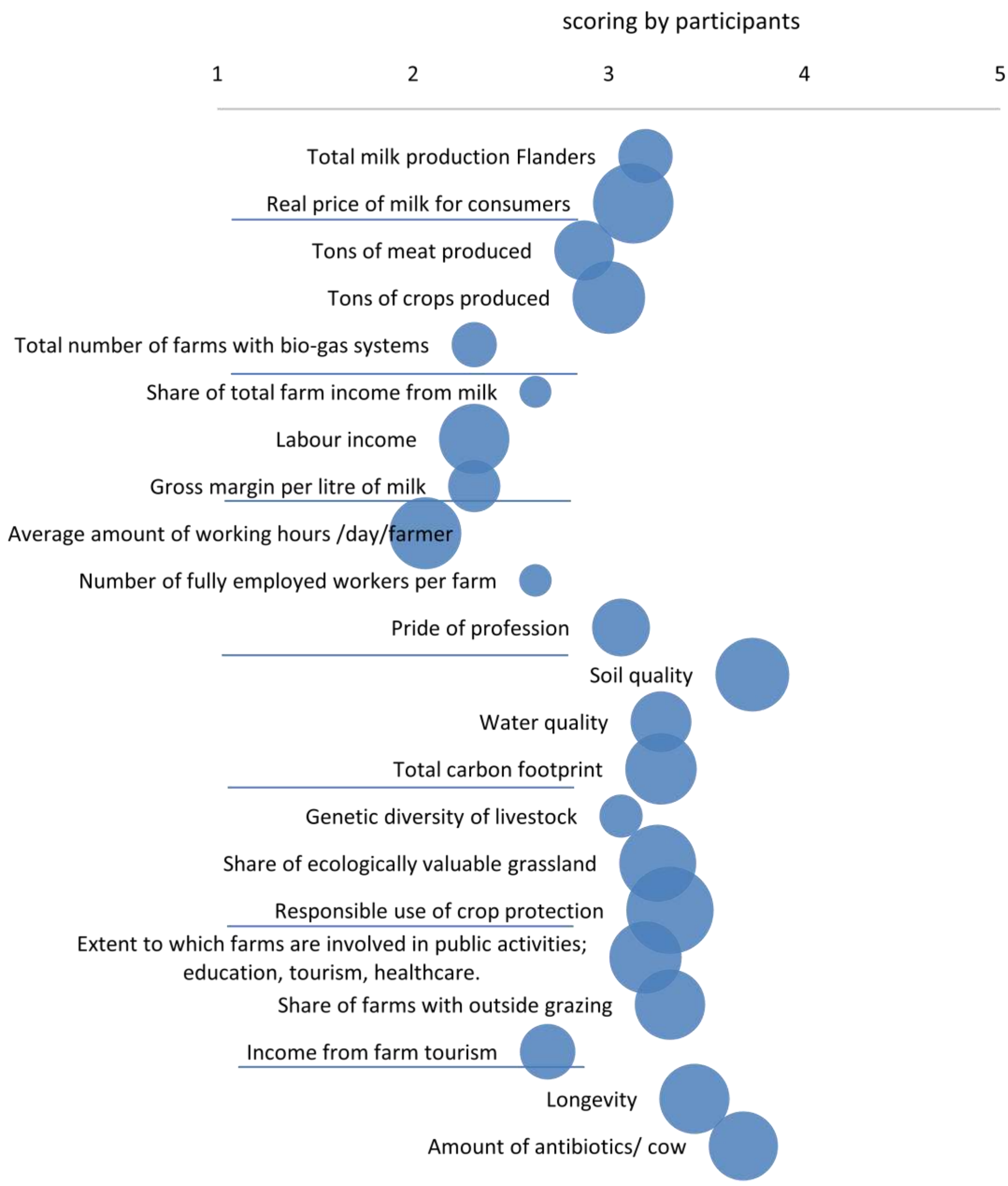

Figure 7. Bubble graph presenting averaged scores on performance of ***indicators*** *(from 1 to 5), while also indicating their importance (size of the bubbles) for assessing the corresponding function. (n = 16)*

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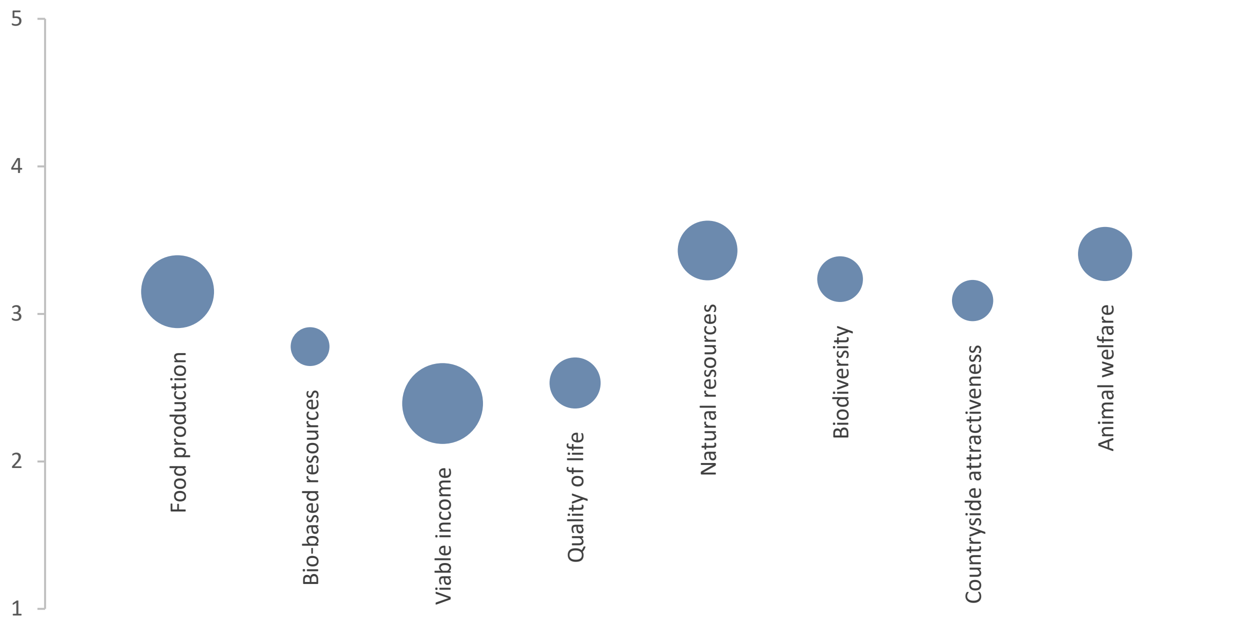

Figure 8. Bubble graph presenting averaged scores on performance of ***functions*** *(from 1 to 5), while also indicating their importance (size of the bubbles), relative to each other.* (n = 16)

4.3 Indicator selection

After the scoring of the current performance of the indicators, the group was shown a combination of the previous results (importance of functions and indicator performance) in the bubble diagram (Figure 6 and Figure 7). Then they were invited to discuss which indicators they would like to continue the workshop with. Finally, it was decided to select the following indicators:

-Real price of milk for consumers
-Labour income
-Total carbon footprint
-Total milk production in Flanders

There was some discussion about the indicators 'total milk production' and the 'real price for consumers' as some participants found them overlapping. The farmers however, were convinced that both were different and important. It was decided then, to keep them both.

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5 Resilience of indicators

To further elaborate on the selected indicators the participants were asked to draw a graph representing the development of the indicators over the last 20 years. Then they were asked to determine the challenges, that influenced dynamics of the indicator. The last part of this exercise was to find the strategies that were used within the farming system to cope with the challenges. During the workshop, some groups had more difficulties than others to define the development of the indicators, while others had more difficulties to define the challenges and the strategies. For total milk production and real milk price for consumers, the participants were able to clearly define the dynamics, but were struggling with the challenges and the strategies. For the groups that worked on labour income and total carbon footprint the opposite was the case. They were struggling with the dynamics but were able to define clear challenges and strategies.

5.1 Total milk production

Historical dynamics

The participants within this indicator group quickly agreed that the milk production over the last 20 years has increased (Figure 8A). The first years until roughly 2007 they agreed that the milk production was completely stable. Then from 2007 to 2014 there was a slight increase in production. Around this time there was scarcity on the market and milk prices were rising. According to the participants there was a discussion about the abolition of the so-called ´superheffing´ (quota penalty). This is a penalty that has to be paid for the milk that farmers produce above their quota limit. When milk prices were high, many farmers were tempted to produce more, which finally led to large penalties (BCZ, 2014). When in 2015 the milk quota was relieved the production quickly increased and according to the participants it is currently still rising.

In literature it was found that the total production of milk in Flanders has been rising by 30% over the last 18 years (Figure 8B). From 2000 to 2006 the milk production stayed relatively stable. From 2014 to 2017 the milk production increased most. We can conclude that the participants had adequate knowledge about total milk production trends over the years.

Challenges that caused the dynamics of the indicator

Milk production in Flanders used to be highly limited by the quota regulation. Until 2007 the participants agreed on the fact that there were little challenges for the dairy sector. A first challenge was the gradual disappearance of the quota regime, from 2006 to 2015. During that time period, a higher production was allowed each year. When the quota was relieved completely in 2015, farmers produced more milk, which caused an over-production and consequently a

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decrease in the milk price. Furthermore, in the latter years, the gradual decrease of protection measures caused more volatility in prices. This decreased the certainty of returns on investments. The low availability of land was mentioned as a challenge. Changing weather conditions have also proven to be a challenge, as drought has affected profits in more recent years. Another challenge for the sector is the negatively changing public opinion towards intensive production systems. The farmers said that it was becoming increasingly difficult to involve consumers with their farming practices. Lastly the availability of labour was described by the participants as too low. As a conclusion it was noted that the challenges were not actually challenges contributing to increasing milk production. Instead, the challenges were a result of the rising milk production.

Strategies to deal with or benefit from the challenges

An important strategy to respond to the challenges and the opportunities is to increase milk production by intensification and scale enlargement. However, land availability has become very low which made it more difficult to increase the scale of production. This is the main reason that dairy farming mainly has an intensified character in Flanders, there is little extensive dairy farming. In order to further increase production when the quota was relieved, farmers could follow two strategies to increase the number of cows. They could do this by rearing their own cattle and by buying from other farmers. At farm level, the first strategy would result in a more gradual increase and the latter in an instant increase of production. Another strategy farmers applied was broadening their business activities (on-farm processing or selling; agri-tourism). By doing so they respond to increasing price volatility and low milk prices as a result from increasing milk production. Lastly, farmers and cooperatives started to implement new risk management strategies by for example entering the futures exchange. The futures exchange is a system whereby price insurances are giving for future deliveries of milk (Maynard et al., 2005). This means that when the milk price decreases, the buyer will still pay the promised price. Of course, the opposite is also possible.

The strategies that were found could be summarized into 4 categories: Intensification: increase efficiency. Scale enlargement: expansion of business (own rearing), expansion of business (buying cattle). Diversification: broaden business. Risk management: futures exchange (Wolf, 2012).

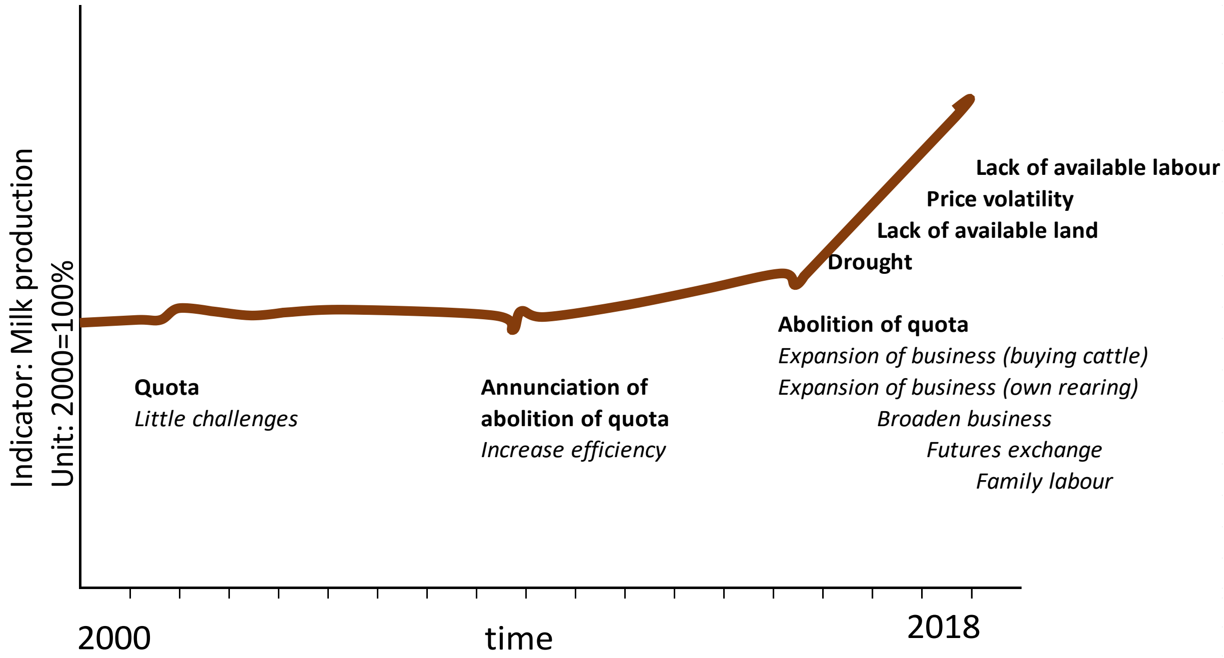

Figure 8A. Digitalized graph for milk production.

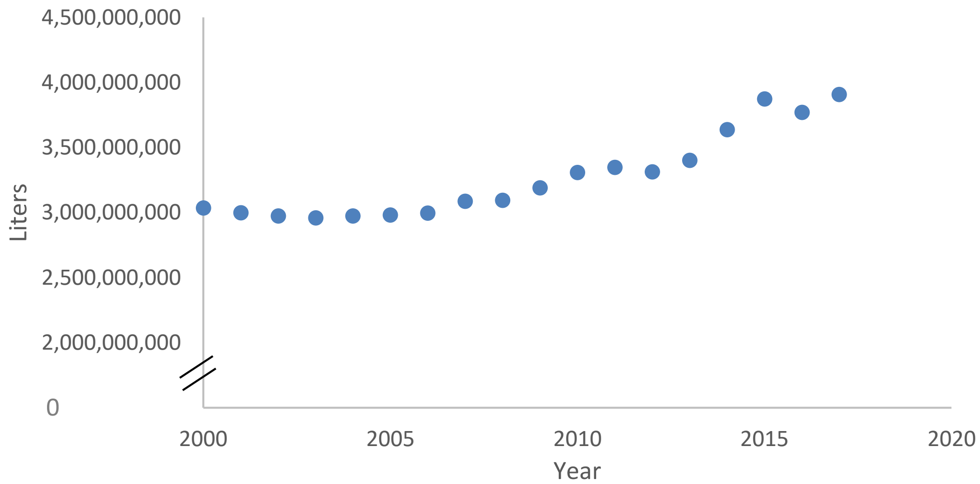

Figure 8B. Total milk production Belgium (Source: Statistics Belgium, 2019*).*

5.2 Real milk price for consumers

Historical dynamics

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One of the participants within this group shares as a first thought that there is an increased availability of more expensive "*luxury*" milk on the market but that the overall milk price slightly decreased over the last 20 years. The others agree on the decrease of the real price of milk. The group moderator points out that recently, the real price of milk increased. This created a discussion between the participants. A farmer recalled that some years he received more for his milk and some years less. This information was used for constructing the graph. Finally, it was concluded that the long trend of the decreasing real price of milk stopped in 2010 (Figure 9A). The participants decided that from 2010 onwards the price trend has been more erratic and is gradually increasing. Furthermore, the participants drew the average income of consumers over the last 20 years (Figure 9). According to them, the average income increased faster than the milk prices, which created a bigger distance between the two lines. They also reached consensus about the fact that there are now, in the recent decade, bigger differences in milk prices for consumers, depending on brand and supermarkets, then previously. Another conclusion they found was that there was also a bigger differentiation in milk products. Some luxury products entered the market, which they argued, were out of reach for the lower class incomes.

Challenges that caused the dynamics of the indicator

The real price of milk has been decreasing for decades after the second world war. During a final discussion, these decreasing milk prices and commodity prices in general were attributed to technological development, in a process whereby technological innovation leads to a fast increase in production in a market with already sufficient supply and inelastic demand. However, in more recent years, prices have been rising. The participants attributed this to market distortions caused by the bank crisis in 2008, the Arabic spring events and the Russian ban on milk.

Strategies to deal with or benefit from the challenges

The rising milk price partly is a result of liberalization of the European market for dairy production. This, however, was a strategy of the European Union to make the dairy sector more market-proof. This would reduce the costs of production for the European Union and realise a more apt relation between supplies and demands. When milk prices were very low, farmers had difficulties to remain operative. The then called FEDIS (now Comeos) federation of trade and services, supported the farmers when the prices were very low (VILT, 2009). Because of the low prices that farmers received for their milk, they occupied several supermarkets and distribution centres to force the retail organisation (Fedis) to meet their demand of a higher compensation for the milk. To appease the situation, Fedis provided the farmers with a supplementary compensation. When milk prices reached another low, they repeated this compensation. It is however not likely that they will provide this support again in the future (VILT, 2009). Another strategy to help the dairy farmers survive the milk price crises in 2015 was the organised buying of milk powder by the

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members of the European union (VILT, 2018). Member states could buy up to until 109.000 tonnes of milk powder stocks per year, to be gradually sold in a later stadium when prices improved. This has become a challenge lately as the milk powder stocks are not as easily sold as expected and milk prices are again decreasing.

Strategies that were found could be summarized into 2 categories: **Diversification:** open for international markets (Meuwissen et al., 2018), **Financial support:** Fedis support, buying of milk powder stocks.

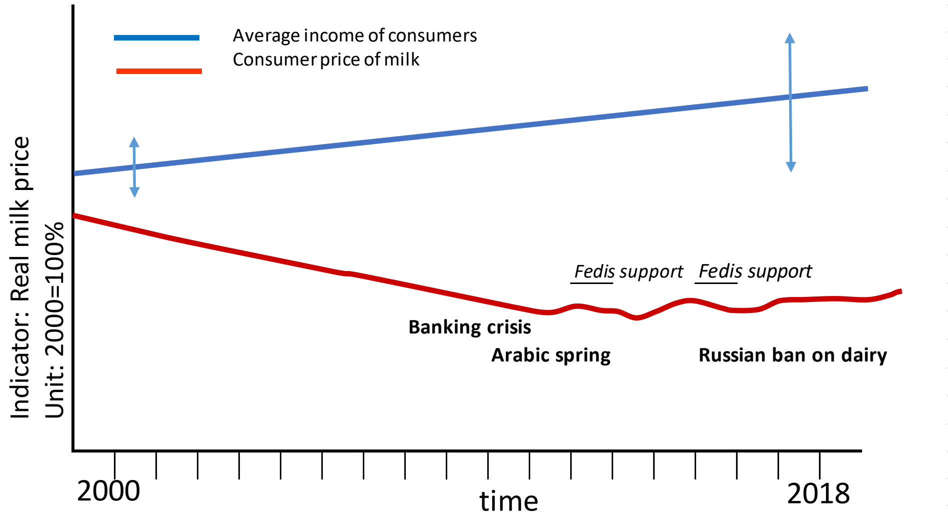

Figure 9A. Digitalized graph for real milk price.

5.3 Labour income

Historical dynamics

For the farm income, participants found it difficult to recognize a trend (Figure 10A). However, after a slow start a discussion about the milk price started. The participants used the (farm-gate) milk price to draw dynamics for the indicator 'total farm income'. They argue that the milk price is strongly correlated with the income of farmers. The net profit of the farms follows an irregular path and values highly differ between the years. A participant said: ¨There have been some good years and some bad years¨. This also follows from the data from literature (FADN, 2018). There are large differences in labour income through the years. If a trendline is plotted within the available data, a slight increment can be seen (Figure 10B).

Challenges influencing the dynamics of labour income

Since the liberalization of the European dairy market, the participants agreed that the income of farmers has been very different from year to year. A big challenge for realizing a stable income is the increasing volatility of milk prices. The increasing milk production resulted in a decreasing milk price, which as a result had a negative influence on the income of farmers. Other factors that according to the participants influence income are the high costs of investments on farms, which might vary from farm to farm. Specific challenges that were mentioned were the banking crisis, globalisation, the decreasing Chinese demand and the Russian ban. Also, it was mentioned that when the prices were low, the European union helped farmers by buying up milk, but later dumped the milk stocks on the market which resulted in lower prices, according to them this is still affecting farmers today.

Strategies to deal with or benefit from the challenges

In order to cope with the volatility of the labour income of farmers again an important strategy was to increase production by scale enlargement and intensification. Another strategy was farm diversification. By focussing on niches and on other agricultural products, a farm can realise a more stable income. As stated earlier, technological development has a major influence on farm income. Technological development allowed higher efficiency of milk production which resulted in more milk production and lower prices. Decreasing prices and lower margins stimulate farmers to scale enlargement. To increase labour efficiency, investments in other technology is again required. Thus, the investment in technology by either farmers and the cooperatives can also be seen as a strategy. This occurred frequently in the years before the quota ended. Participants mentioned that farmers or farms that invested heavily still have trouble returning those investments with the current milk prices. Furthermore, it was argued that changes in farm structures occurred. In the years before the abolition of the milk quota many of the small farms were bought up by larger farms which often were of a co-partnership structure (´vennootschap´). At last, it was mentioned by the participants of the workshop that cyclic investment is a strategy. Which means that investments follow the economic growth rate. In times of recession, investments will be postponed to times of economic prosperity.

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Strategies that were found could be summarized into 4 categories: **Intensification:** increase efficiency of milk production. **Scale enlargement**: increase total milk production on the farm. **Innovation:** cyclic investing, investments of cooperatives. **Diversification**: Maintain diversity of dairy farms.

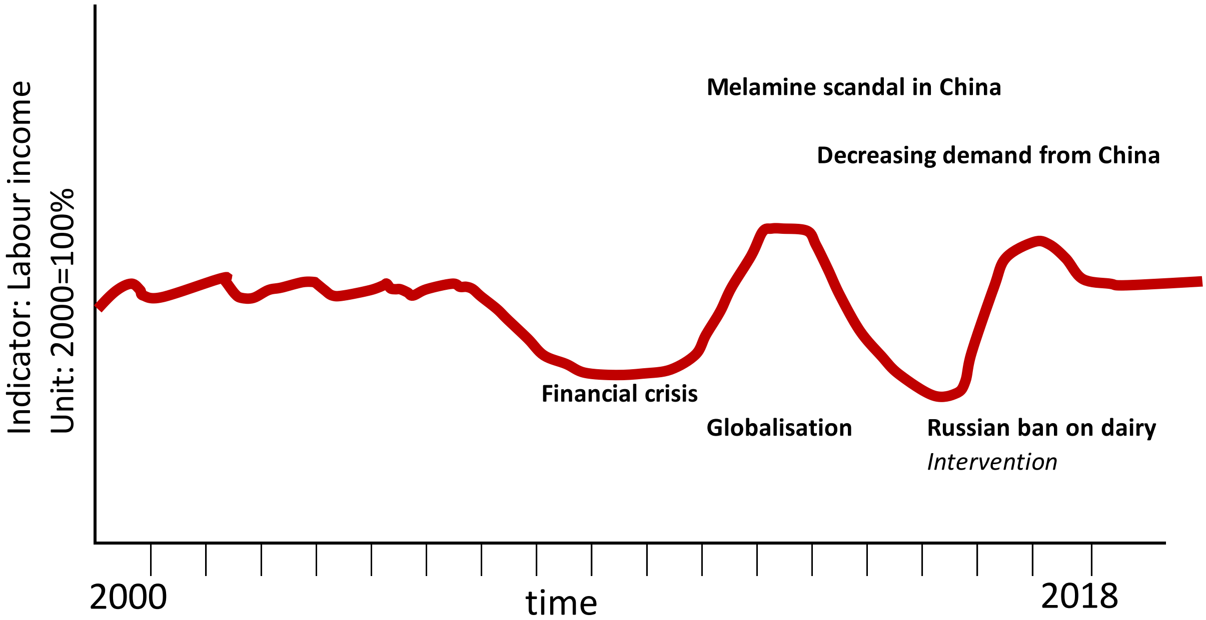

Figure 10A. Digitalized graph for labour income.

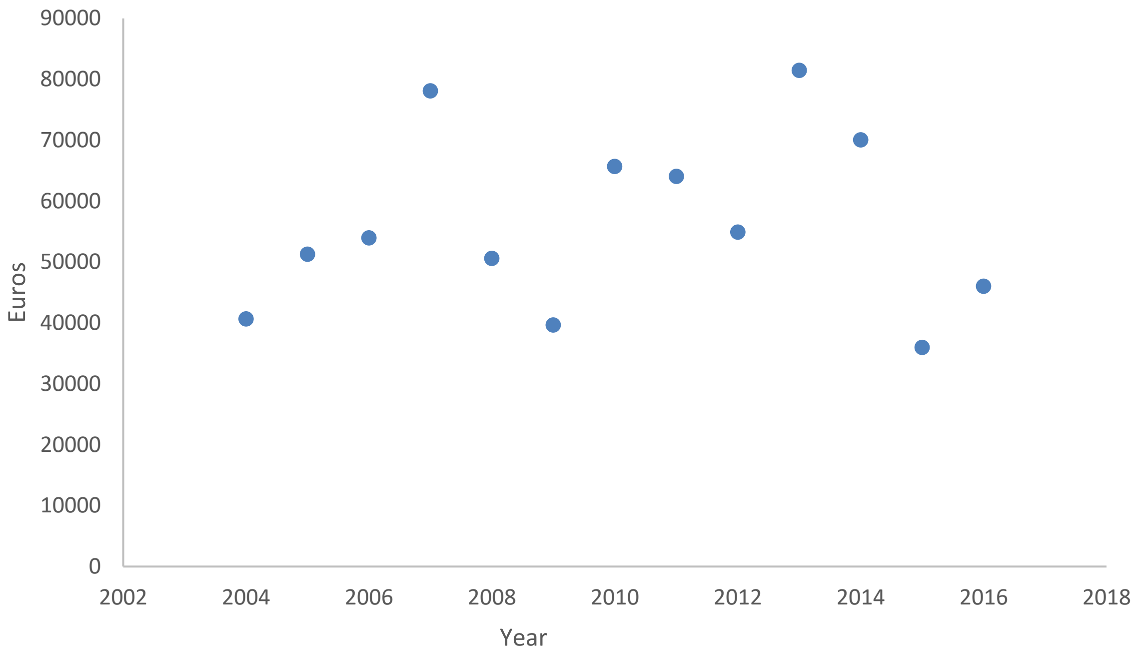

Figure 10B. Farm Net Income of Specialised dairy farms Flanders. (source: Farm accountancy data network, 2018)

5.4 Total carbon footprint

Historical dynamics

For the carbon footprint the participants quickly decided that it must have decreased over the last 20 years. However, as it is a difficult indicator to grasp, they had trouble to draw the curve (Figure 11A). When discussing how they should address the problem it was mentioned to plot the number of cows in Flanders. They decided that the number of cows decreased until the abolition of the quota in 2015 and then rose again. Then they drew the line for carbon footprint with a gradual decrease towards 2018. Interestingly, according to the participants the carbon footprint did not increase when the number of cows increased. They argued that due to the increased efficiency the emissions became lower.

Data for total carbon footprint specifically could not be found. However, trends of carbon footprints are largely comprised by the data for greenhouse gas emissions (Figure 11B).

Challenges that influenced the dynamics of the indicator

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The carbon footprint decreased over the last 20 years. This decrease was according to the participants probably more a side effect of other trends in the dairy sector. There has only lately been a stronger focus on the carbon footprint, and actual measures to decrease carbon footprint were scarce on dairy farms. The only clear challenge the participants mutually agreed on was the abolition of the milk quota. As the number of cows was no longer controlled the sector could increase their emissions. However, all participants agreed that the sector overcame this challenge and emissions did not increase (which is not the case: Figure 11B). Although this Figure should be read carefully as it is based on data for both dairy and beef producing cattle. Furthermore, according to the participants the decrease in carbon footprint is for example partly a result of rising energy prices and rising costs of production. There has been a need to produce in a more efficient way to be able to keep up with economic challenges. Another driving force to decrease carbon footprint might have been the increasingly strict regulations on the use of chemicals and emissions. Although no regulations exist concerning a carbon footprint, its decrease may well have been an indirect effect of legislation related to other environmental issues. Public opinion around greenhouse gas emissions is becoming stronger too. In more recent years there has been a stronger climate lobby that was raising awareness.

Strategies to deal with or benefit from the challenges

As described earlier, the decrease in carbon footprint was rather a positive side effect of increased resource use efficiency in response to mainly economic and other environmental challenges. As a reaction on higher prices and the availability of improved technology, farmers are now able to feed their cattle much more efficiently. Efficient feeding reduces the waste and the spill streams and therefore contributes to a lower carbon footprint. Also, by genetically improving cow breeds, the efficiency of the cows improved. Less feed is needed now for the same amount of produce 20 years ago. This also decreases the carbon footprint per litre of milk. Another strategy was improving the management of waste streams by making the farming system more circular; by recycling manure for example. Other strategies were to increase longevity of cows and to generate green energy on farms. These all benefit the carbon footprint.

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Strategies that were found could be summarized into 3 categories: **Intensification:** mainly by higher milk production per dairy cow through more efficient feeding, genetical improvement, increase longevity. **Innovation:** manure recycling/ circular agriculture. **Diversification:** production of green energy

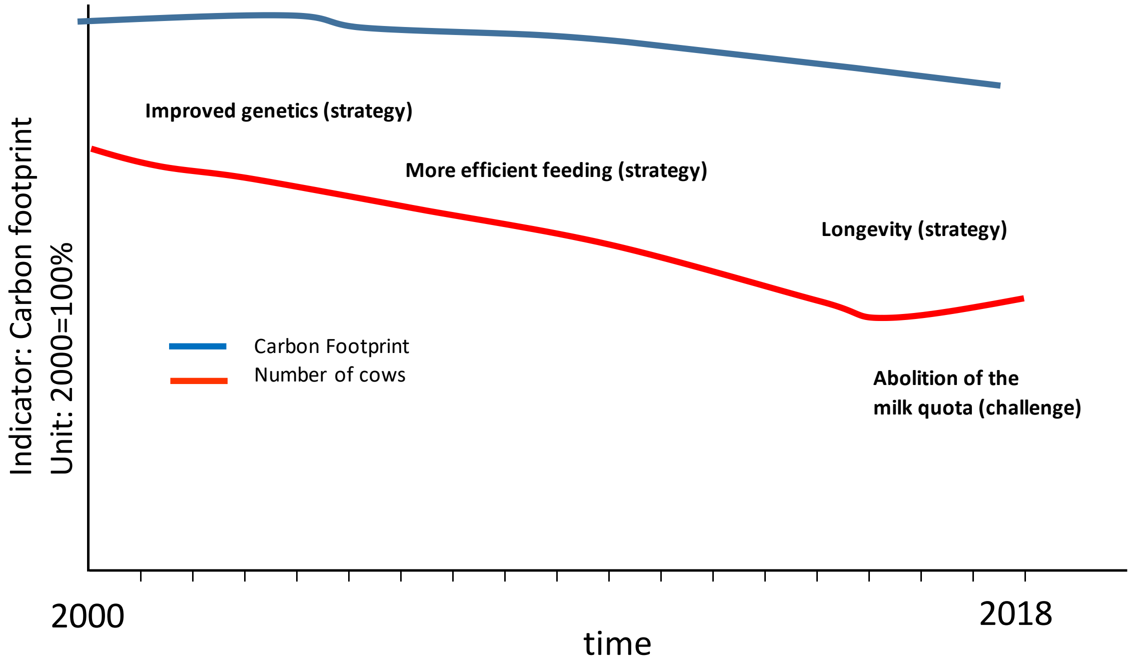
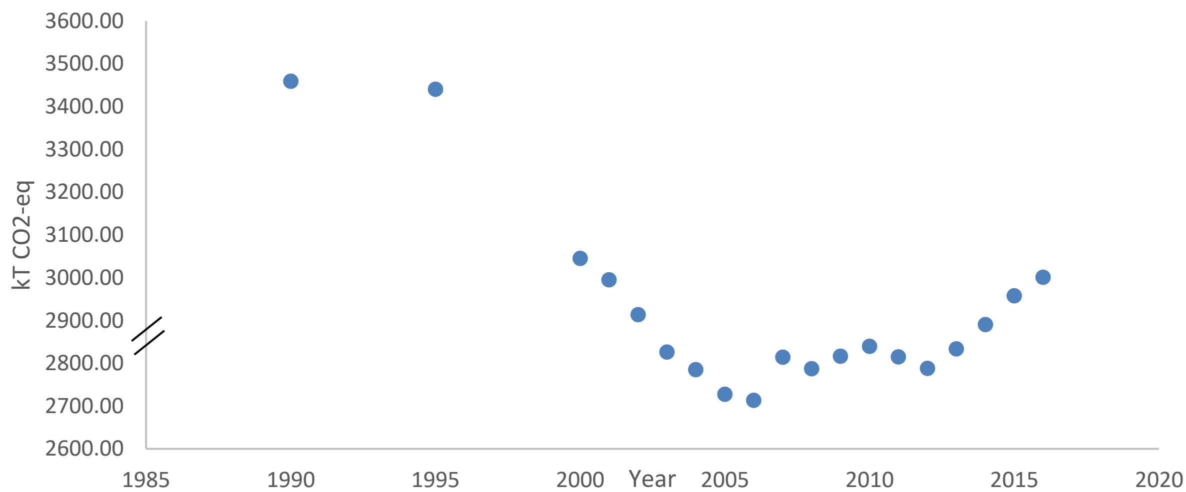


Figure 11A. Digitalized graph for carbon footprint.

Figure 11B. Greenhouse gas emission for all farming systems involving cattle in Flanders.



Greenhouse gasses include: CO2, CH4, N2O, HFK's, PFK's, NF3 and SF6 (source: Vlaamse Millieu maatschappij, 2017).).

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6 Resilience attributes

6.1 Case-study specific strategies

6.1.1 Level of implementation of strategies

After the drawing exercise (chapter 5) the participants from each indicator group were asked to evaluate the strategies that they identified for each indicator individually. The strategies were assessed by their level of implementation (Figure 12) and their contribution to the resilience capacities (Figure 13).

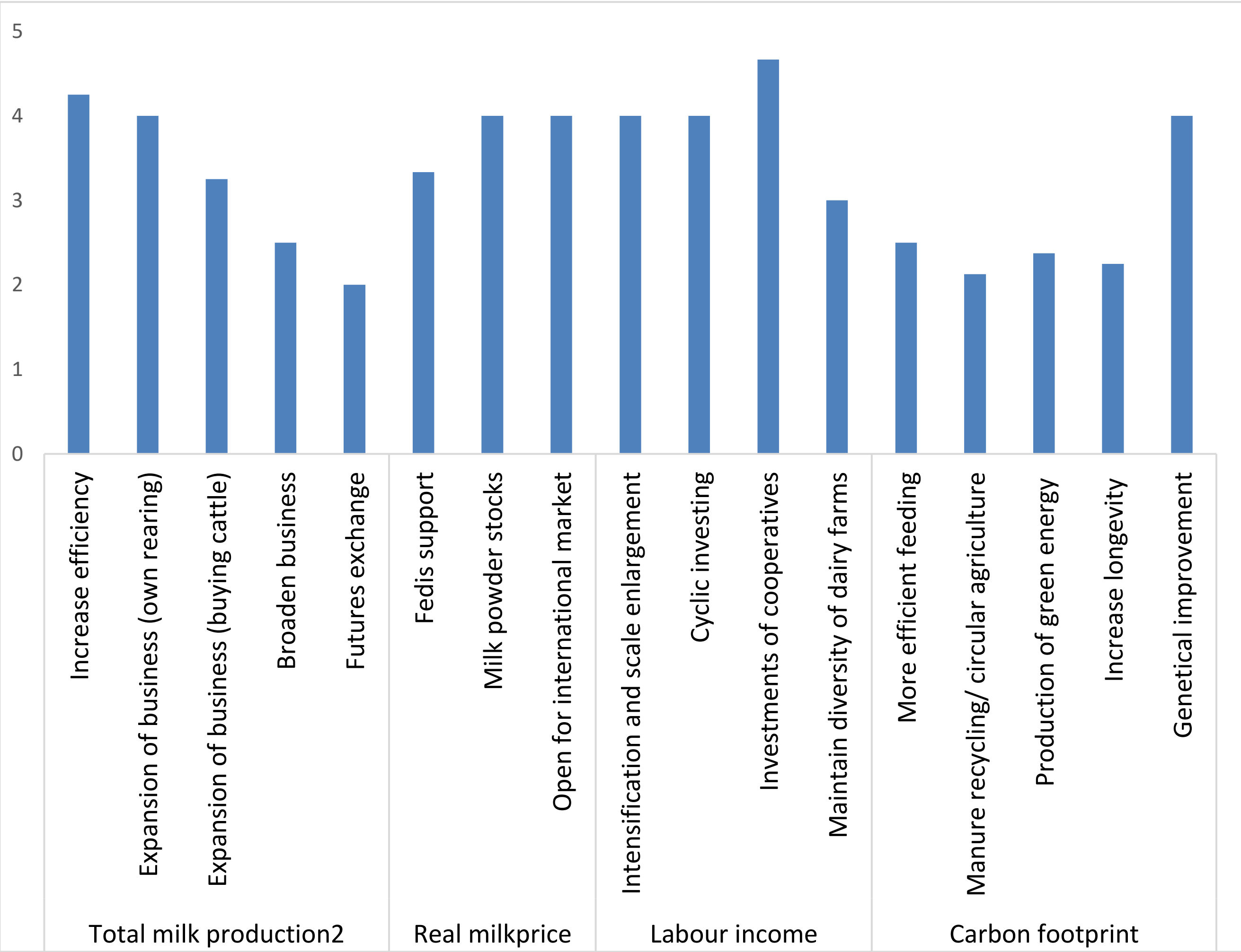

Figure 12. Bar graph showing level of implementation of strategies. 1 = not applied, 2 = slightly applied, 3 = moderately applied, 4 = adequately applied, 5 = perfectly applied. (n = 15)

For total milk production, increasing the efficiency of the production process was the strategy with the highest implementation strength (Figure 12). Scale enlargement was the second most implemented strategy. Most farms applied scale enlargement through own rearing rather than

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by buying new cattle. Lesser implemented strategies were broadening the business and accessing the futures exchange.

For the real milk price strongest implemented strategies were the opening to the international market and the buying up of milk powder (milk powder stocks). Thirdly, the participants scored the support of Fedis (Comeos) as moderately implemented. Overall the implementation of strategies for the real milk price scored high.

For labour income the highest implemented strategy was the investment from cooperatives. After that, intensification & scale enlargement and cyclic investment scored highest. Lastly the participants scored the implementation of diversification of businesses (maintain diversity of farms).

The participants of the carbon footprint group were less positive about the implementation of the strategies. They scored the implementation of genetic improvement as the highest. After that came from high to low implementation, more efficient feeding, production of green energy, increased longevity and circular agriculture respectively.

6.1.2 Contribution of strategies to resilience capacities.

After scoring the level of implementation, the participants of the workshop scored the contribution of each strategy within the indicator group to the resilience capacities (Fig 13).

For total milk production the participants scored most of the strategies to contribute mainly to robustness and adaptability. The strongest contributor to robustness was increased efficiency. The strongest contributor to adaptability was to broaden the business. Which was also the strongest contributor for transformability. However, transformability was, according to the participants, mainly negatively influenced by the strategies. Especially increasing efficiency and scale enlargement (own rearing & buying of cattle) was perceived as contributing negatively towards transformability.

The strategies for the real milk price were also mainly contributing to robustness and secondly to adaptability. There were no strategies with a positive contribution towards transformability according to the participants. The strongest contributor to robustness was the opening of the Flemish (European) dairy sector to the world market. For adaptability the strongest contributor was the buying up of milk powder by the EU (milk powder stocks). The strongest negative contributor to transformability was the financial support to farmers from the retail organisation Fedis (Comeos).

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Labour income was the indicator that was, according to the participants, represented by strategies that had the strongest contribution to transformability compared to the other indicators. All strategies contributed somewhat equally to robustness. The strongest contributor to robustness was the investments of the cooperatives in the dairy sector. Which was also the strongest contributor to adaptability together with maintaining diversity within the dairy sector. The diversity was according to the participants also the strongest contributor towards transformability. This strategy has the highest total resilience, as all three resilience capacities are equally supported by it. The strongest strategy with a negative contribution towards transformability was scale enlargement and intensification.

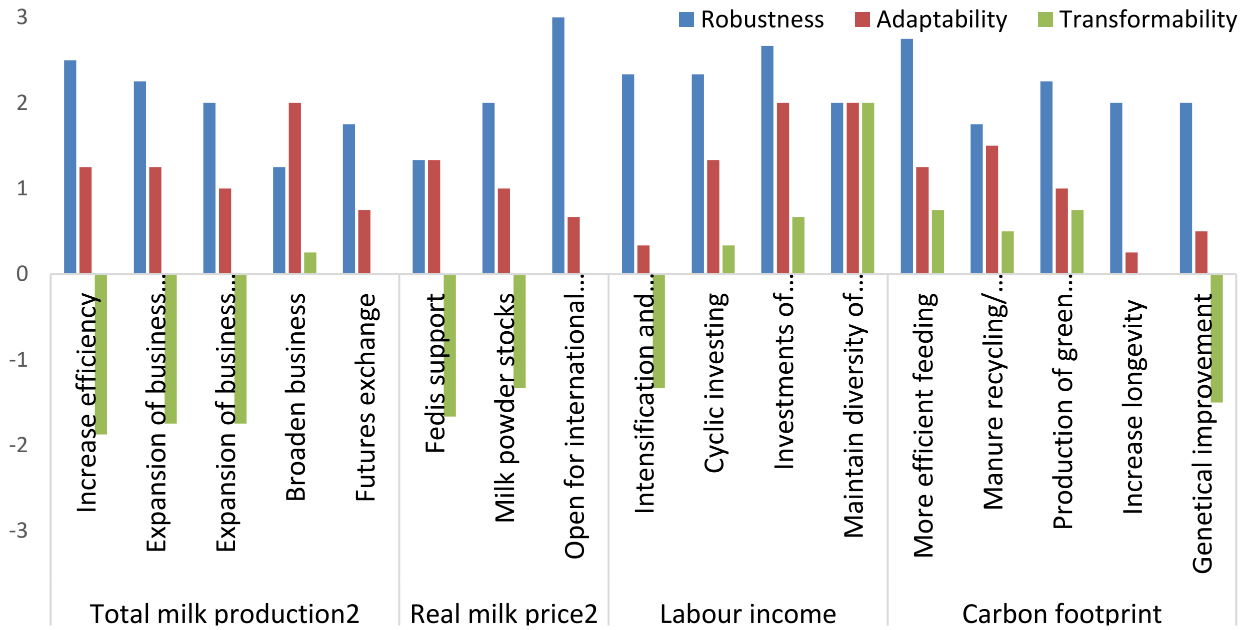

Figure 13. Bar graph showing average scoring of effect of strategy on robustness, adaptability and transformability of the farming system. A 0 implies no relationship, a 1 or -1 a weak positive or negative relationship, a 2 or -2 an intermediate positive or negative relationship, and a 3 or -3 is a strong positive or negative relationship. (n = 15)

For the Carbon footprint again, most strategies are contributing to robustness. More efficient feeding was scored as the highest robustness contributor. Followed by the production of green energy, increased longevity, genetic improvement and circular agriculture respectively. Circular agriculture was scored as the highest contributor to adaptability. Increased longevity scored lowest as contributor to adaptability. For transformability, more efficient feeding, green energy and circular agriculture scored comparable positive results for contributing towards transformability. Genetic improvement was as a strategy scored to have a strong negative impact on the transformability of the system.

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6.1.3 Trade-offs and synergies.

In general, the strategies strongly contribute to robustness. There was not one strategy that had a stronger contribution towards transformability compared to robustness. Only one strategy had a stronger contribution to adaptability than robustness (broaden business). Several strategies were mentioned as response to multiple challenges. Most strategies can be roughly grouped into six general strategies: intensification, scale enlargement, diversification, innovation, risk management and financial support.

For intensification and scale enlargement the participants strongly agree on their positive contribution to robustness and negative contribution towards transformability. The participants thought that strategies aligned with diversification contributed positively to all resilience capacities. Relying on external aid, from both (governmental) organisations inside and outside the farming system, was not seen as a very strong contributor towards resilience. However, this strategy contributed towards robustness and adaptability in comparable ways. For some strategies, participants have difficulties in assessing their contribution to transformability, including liberalisation of the European dairy production, participation in the futures exchange, and increased longevity. Liberalisation of European dairy production, was even seen as the strongest contributor towards robustness of all strategies. This is also described in literature, as the resilience attribute 'exposedness to disturbances' (Cabell & Oelofse, 2012).

The strategies that have an influence on total milk production were intensification, scale enlargement, diversification and risk management (futures exchange). Intensification and scale enlargement seem to have similar effects on the resilience of the system. They all contribute strongly towards robustness, less to adaptability and negatively towards transformability. Diversification (broadening of the business activities) contributes strong towards adaptability. Risk management (futures exchange) is also mostly contributing towards robustness. The strategies that the participants implemented for the last 20 years had thus a negative or no impact at all towards the transformability of the system. All strategies have a strong focus towards robustness.

For the real milk price, all strategies mentioned are implemented by stakeholders outside the farming system. The financial support (buying of milk powder) and the commercial financial support (Fedis) show similar effects on the resilience of the system (they both influence transformability negatively). The strategy of liberalization of the European dairy market makes the system more robust according to the participants. But within this indicator, there were no strategies identified that stimulated transformability. Also, contribution of strategies contributing to adaptability is rather low.

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More synergies were found within the strategies for the indicator 'labour income'. Intensification and scale enlargement showed a similar contribution towards the resilience capacities as for the other indicators. For innovation (cyclic investing), there seems to be a trade-off between robustness and transformability. Interestingly, the investments of the cooperatives (innovation) were seen as strongly contributing towards robustness and adaptability rather than to transformability. This is contrasting with the outcomes of the real milk price group, were the participants thought that financial support negatively impacted transformability. However, it is not completely equal in this case as the cooperatives investments are a support from within the system, and the money is invested in improving the system rather than for mere damage control. At last, within the strategy; diversification, the strongest synergy is found. The participants thought that this strategy contributes equally strong towards all capacities.

For carbon footprint, the strategies are mainly linked to improving the efficiency of the production process (more efficient feeding, increased longevity and genetic improvement), which fits in with the other intensification strategies. They argue that increasing the efficiency increases the robustness and decreases the transformability. The other two innovation (circular agriculture) and diversification (the production of green energy) had similar scores to the other strategies within these groups. Both strategies contribute towards all three capacities according to the participants.

6.2 General resilience attributes

During the workshop the participants were asked to assess the general resilience of the farming system. A list of 13 specific resilience attributes was created within FoPIA in order to give a representation of the contribution of specific system indicators to resilience. However, later it was decided to apply these attributes to the whole system with the aim to receive a more general overview of the systems resilience according to the participants.

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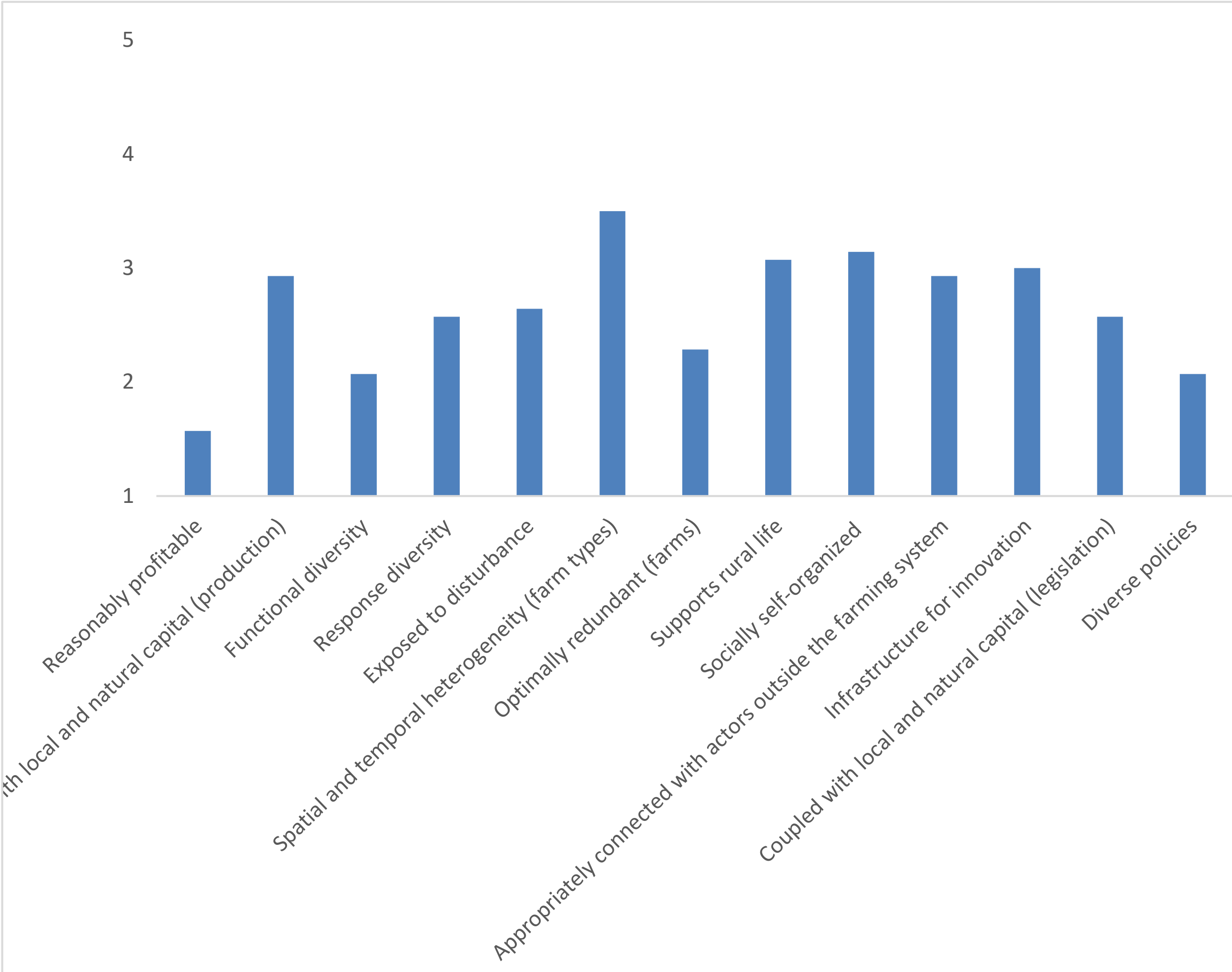

Figure 14. Bar graph showing current performance level of resilience attributes. Performance is scored as 1 = not at all, 2 = small extent, 3 = moderate extent, 4 = big extent, 5 = very big extent. (n = 15)

6.2.1 General resilience attributes

Next to assessing specified resilience that is represented by the resilience attributes, the ultimate goal of this research is to evaluating, the general resilience (Resilience Alliance, 2010); which resembles the resilience of the whole system. Unlike specified resilience, it does not relate to any particular challenges or aspects of a system, but to how the system as a whole responds to various outer noise and disturbances. By improving the general resilience of a system, the system is also able to react to unexpected shocks and pressures. The five general resilience principles defined by the Resilience Alliance (2010) are: : diversity, openness, reserves, tightness of feedbacks and modularity. Furthermore, it is attempted to link the resilience attributes with the four main processes (agricultural production, farm demographics, governance and risk management) (Meuwissen et al., 2018).

6.2.1.1 Diversity

Through the specific resilience attributes - functional diversity, response diversity and diverse policies - the overall diversity of the farming system is scored low. According to the participants their farming system is especially lacking functional diversity and diverse policies. This indicates that the array of eco-system services is small and unvaried and that the current policies do not support strengthening of all resilience capacities. A lack in functional diversity leads to vulnerability to both shocks and long-term pressures and an unsustainable extraction of natural resources. The resilience challenges (Table 1) that were encountered represent a similar image. Challenges the system was sensible to because of a lack of functional diversity are for example the Russian ban on dairy, over-production and sensitivity to drought. The frequent changing policies and regulations (Table 1) were important challenges for this farming system. During the workshop it became clear that there is a lack of a stable and safe environment that enables adaptations and/or transformations of the farming systems. Although the level of implementation of response diversity was higher (Figure 14), the strategies corresponding to the challenges that were found during the workshop were strongly focussing on robustness (Figure 13). It has been argued in literature that this is a pitfall for general resilience (Folke et al., 2010). A system that is efficiently adapted to frequent perturbations is likely to be more vulnerable to unexpected challenges.

6.2.1.2 Openness

The openness of the farming system is represented by the exposure to perturbations and the infrastructure for innovation. Both resilience attributes scored relatively good (Figure 14), indicating that the system possesses a moderate openness. This means that the system scored a preferably score on this general resilience attribute. In literature it is argued that either a very low and a very high degree of openness is negatively contributing towards resilience (Resilience Alliance, 2010). Frequently exposing a farming system to small perturbations without causing it to move to another state, enhances natural selection and helps it to re-organise internal structures (Cabell & Oloefse, 2012). Since the abolishment of the milk quota, the fluctuation of milk and feed prices have frequently affected the farming system (Table 1). According to Cabell and Oloefse (2012) this process can be seen as a positive influence towards the adaptability of the system because only the stronger actors of the system can survive, and it creates incentive to adopt new strategies. The current performance of the infrastructure for innovation was scored slightly higher. This indicates that the participants were of opinion that the existing infrastructure enabled the farming system to adopt new technologies and new ways of production to cope with a changing environment (Meuwissen, 2018). Challenges for an enabling infrastructure for innovation that were found (Table 1) include lack of independent advice (social), changing societal opinion (social) and a low capital productivity (economic).

6.2.1.3 System Reserves

The specific resilience attributes 'reasonably profitable', 'coupled with local and natural capital (production & legislation)', 'supports rural life' and 'infrastructure for innovation' are contributing to the general resilience principle 'system reserves'. The scoring (Fig 14.) shows that the systems lacks the attribute 'reasonably profitability'. In fact, this was the lowest scoring attribute from this exercise. This means that respondents feel like farmers do not earn a sufficient salary and that the farming system is likely to rely heavily on subsidies. Profitability of a system is an important contributor to resilience (Cabell &Oelofse, 2012). Wealth that has been built up during better years can serve as a buffer in later years. It is thus alarming that the participants rated this attribute so low. Also, many important challenges were found regarding the profitability of the system (Table 1). Especially the long-term pressures, such as the low profit margins and the low capital productivity, seem to relate to the attribute (Table 1).. From the discussions during the historical dynamics exercise, it was noticed that most of the challenges regarding the profitability of the system arose in the second half of the 20 years that were assessed. It seems that the abolishment of the milk quota put a heavy pressure on the system´s viability.

The performance of the specified resilience attributes coupled with local and natural capital (production & legislation), were scored as to a moderate extent (3). Coupling with local and natural capital in a production sense, refers to producing in a way that resources are maintained or even increased. A system that is highly coupled with natural resources has little need for external inputs (Cabell & Oelofse, 2010). The moderate score for this subject is somewhat contrasting to what would be expected of an intensifying system. In literature it is argued that intensification often results in a negative resource balance (Tscharntke et al., 2005). However, the participants of the workshop argued that nowadays less input is needed for a higher output due to the higher production efficiency. The challenges that were found show that there are several problems that arose from an unbalanced extraction of resources. Especially long-term pressures such as; soil degradation, poor water quality and an increasing pest and disease pressure can result from a poor complement with natural capital in a farming system (Tscharntke et al., 2005). Although during the workshop it became clear there are many regulations that intend to reduce the negative impacts on the natural environment of agro-systems, the participants scored the coupling with local and natural capital in a legislative sense slightly lower. This attribute describes whether the norms, legislation and regulations are adapted enough to the local conditions (Meuwissen, 2018). For both these attributes (production & legislation) there is room for improvement.

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According to the participants the rural life is moderately supported by the farming system. This means that the participants think there is a moderately balanced population in sense of age and that there is a moderate availability of facilities (Meuwissen et al., 2018). The participants seemed to be mostly worried about the low succession rate within the farming system. From literature and previous interviews, it was found that there are some other challenges that are related to this attribute; including gender gaps, ageing of the countryside and labour shortages (Table 1). The score (3) for the current performance for infrastructure for innovation was already described under the general resilience attribute openness.

It can be concluded that, according to the participants, the general resilience of the system regarding the system reserves is rather high. However, from literature and workshop discussions it was also noted that there have been many problems regarding the reserves. For natural resource use, it seems that the system has become more balanced by e.g. a decreased trend of resource depletion. However, the system seems to have problems with social resources. A low succession rate might finally lead to a loss of knowledge and a lack of skilled labour. Also, the low profitability the system is currently going through is a pressure on the system´s reserves. However, one can argue that the current low profitability is a transition phase towards a more resilient system that is less dependent on subsidies. The recently increased openness can help the system to, through natural selection, strengthen its profitability.

6.2.1.4 Tightness of feedback

The current performance of tightness of feedbacks (socially self-organised and appropriately connected with actors outside the farming system) scored as to a moderate extend (3) (Figure 14). Self-organisation scored slightly higher. Social organisation was a topic highly debated during the workshop. In the Flemish case study, agricultural organisations fulfil an important role. Many stakeholders within the farming systems internally organised themselves to improve their bargaining power (Table 1). However, during the workshop, it became clear that some farmers felt that their influence on the course of these large organisations (cooperatives) had decreased in the last 20 years. The increasing sizes and commercialization of these organisations made these farmers feel left out. As an answer to this, a group of farmers started a new cooperative (FaireBel) to improve their social self-organisation. This example depicted that the system is capable to organise itself.

The connection of the farming system with actors outside the system scored somewhat lower. However, during the workshop another example came up, whereby a large retail organisation provided farmers with financial support when milk prices dropped beneath a critical value. This example proves that the system was able to rapidly react. However, from literature and from interview outputs, it was found that there was still much to improve regarding the aspects of

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connection with outside actors. Important challenges that are related to this are the changing societal opinion, the competition with other careers and the low succession rate (Table 1). However, other challenges that are known to influence such feedback loops were not named during the workshop, such as the connection with larger governmental organisations like the federal government and the EU. In general, the workshop results indicate that the tightness of feedback within the system is quite high. The high degree of self-organisation and the connections with outside actors enable the system to quickly react to crisis situations. It might be even a positive sign that the behaviour of governmental organisations was not heavily debated, as more levels of governance tend to lead to slower procedures (Resilience Alliance, 2010).

6.2.1.5 Modularity

For the general resilience principle 'modularity', the following specific resilience attributes are important: optimal redundancy and spatial and temporal heterogeneity . Spatial and temporal heterogeneity was scored as the best performing attribute by the participants. This means that the participants think that there is a wide diversity in farm types regarding their economic size, degree of intensification and of specialisation (Meuwissen et al., 2018). However, during the workshop it was argued by farmers that the course of the system will always be towards scale enlargement and intensification. The market is constantly pushing farmers to be more efficient and to deliver high quality products for lower prices. Not all stakeholders agreed with this trend, as they also saw an increase in diversification. There were not many challenges found that could be directly related to this resilience attribute (Table 1). Over-production is a challenge that can be related to a lack of diversity within the farming system. However, it is a logical consequence of the high rate of specialization in the farming system. The optimal redundancy of the system was scored low (2). Farming systems that show redundancy allow for farmers to exit the system without this posing a threat to its continuation and the easy entering of new farmers into the system. For the dairy farming system in Flanders, the exiting of farmers does not seem to be a big threat. However, the participants often mentioned the difficulty for new farmers entering the system during the workshop. The high capital intensity and the low availability of land are the main causes of this problem (Table 1). Although there would also be negative consequences when entering is too easy, ,this critique lack of options to enter the system tends to negatively influence the resilience of the system.

Although there is no optimal level of modularity (Resilience Alliance, 2010),it can be concluded from the workshop that the lack of land and the high capital intensity are threatening the redundancy of the system. However, the historical dynamics of the system's indicators show that the system is able to absorb shocks. . Another characteristic of a modular system is that, when a challenge is encountered, sub-systems can quickly reorganise to avoid a collapse. However, during the workshop it was mentioned by a stakeholder that it is very difficult for a system that mainly

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produces one product to be flexible. Moreover, it is even harder for the typical family owned farming businesses that are very capital intensive. He argues further that, after making a large investment, the farmer has to continue in that direction for a long time in order to earn back that investment. The modularity of the system is thus on one side backed by the high capacity of the system to absorb shock and on the other side being pulled by the low flexibility of the system.

6.2.2 Main processes

Often when studying resilience, researchers only look at the process of agricultural production. It is however debated that it is necessary to assess multiple processes to be able to fully understand the development of a farming system. (Meuwissen et al., 2018). Within the FoPIA-Surefarm framework, three other main processes are added, to provide a holistic multi-dimensional approach to the resilience of the farming system. Next to agricultural production, farm demographics, governance and risk-management are used to describe the resilience of the system.

6.2.2.1 Agricultural production

Agricultural production comprises all the activities that support the production of private and public goods at farms (Meuwissen et al., 2018). The general resilience principles that are embedded within this cycle are: openness, system reserves and modularity (Meuwissen et al., 2018). The farming system in Flanders is strongly focused on agricultural production through the recently increased economic openness of the system. A shift towards an increasing diversity might have been expected. However, due to the high innovative capacity, large changes to the system did not occur. By constantly updating the technology upon the occurrence of challenges the production processes gradually improved over time without large changes in the functions of the system. Some farmers exited the system, some farmers adapted other practices (Dessein et al., 2013). Anyway, the production of milk only became higher throughout time (Lenders & Deuninck, 2018). It can thus be concluded that this main process remains in a very robust phase. In Literature this phase is often referred to as conservation (Meuwissen et al., 2018; Cabell & Oelofse, 2012; Holling, 2001).

6.2.2.2 Farm demographics

Farm demographics are related to the provision and availability of labour within the farming system. This main process is linked by Meuwissen et al. (2018) to the general resilience attributes diversity, modularity and tightness of feedbacks. It was found that the current performance of diversity of the system was low. As described above, there are many challenges concerning the workforce and succession rate of the farming system. It is argued that openness of the system would contribute towards the diversity of the farming system, through for example exposedness to perturbations (Cabell & Oelofse, 2012). However, the concept of the adaptive cycles is strongly

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applicable to this case (Meuwissen et al., 2018) as it is found that the openness has only led to further intensification. The smaller, less efficient farms exited the system and larger farms could take over their assets. Openness would contribute to the diversity when the system finds itself in the reorganisation phase of the adaptive cycles. However, currently the system finds itself within the conservation phase and maybe even in the growth phase, as milk production and technical efficiency are still increasing. A possible explanation for the system to remain within these phases could be the high degree of modularity. Modularity functions like a buffer between the two general resilience attributes (diversity and openness). A high openness might decrease the modularity of the system for a long period, but it will not strongly affect diversity as long as the modularity functions as a buffer. Another buffer in this main process is provided by the high tightness of feedbacks. Especially the high degree of self-organisation within the system facilitates quick responses towards challenges. Therefore, extreme system fluctuations can be prevented. For farm demographics it can be concluded that the system remains in an equilibrium. Automation is an increasing feature of the system, therefore the provision and availability of labour force decreases and farm demographics develop in parallel with that trend.

6.2.2.3 Governance

The main process of governance comprises of the process of societal organisation through steering mechanisms to reach certain collective goals (Meuwissen et al., 2018). Meuwissen et al. (2018) link the general resilience attributes diversity, openness and modularity to this process. However, as governance is about the steering of the system and lays within another adaptive cycle, it is possible that it remains in a different phase (Meuwissen et al., 2018). As described in table 1, recently there has been an increasing pressure on the agricultural sector to innovate due to price fluctuation, over-production, environmental challenges and competition with other markets. The high robustness of the system allowed it to remain productive throughout difficult times. However, as described above this might negatively affect the buffers of the system and is not sustainable. Risk management

Risk management is used to protect the system against shocks. By reorganizing resources and processes, total collapses can be prevented, or the system can return to the status quo (Meuwissen et al., 2018). Meuwissen et al. (2018) link the general resilience attributes openness, system reserves and modularity to this main process. During the workshop it became clear that the recent price fluctuations in the milk price and the frequently changing policies (Table 1), have induced many new initiatives by farmers and other stakeholders within the system. The increasing openness of the system has put pressure on the system reserves, which was felt by the farmers during the milk crisis in 2015 (LARA, 2018). In order to prevent that from happening again, stakeholders are looking for new ways of protecting themselves from such events in the future. For the historical dynamics exercise it proved challenging for the participants to find different strategies. Most of the strategies could be placed under intensification, scale enlargement and innovation. It can therefore be concluded that this main process is in the reorientation phase.

6.2.3 Resilience attributes and resilience capacities

Participants were asked during the workshop to score the contribution of each specific resilience attribute to the resilience capacitates (robustness, adaptability and transformability) (Figure 15). According to the participants, almost all resilience attributes contribute stronger to robustness and the least towards transformability. A similar pattern was found during the scoring of the strategies for the historical dynamics (Figure 13). The strongest contributor to robustness was the reasonably profitability of the system. This was at the same time also the lowest contributor towards the transformability of the system. Also, spatial and temporal heterogeneity, coupling with local and natural capital, functional diversity, response diversity, appropriately connected with actors outside the system, social self-organisation, optimal redundancy and diverse policies were scored as to be stronger contributing towards robustness. Furthermore, infrastructure for innovation and exposure to disturbances contributed strongest towards adaptability according to the participants. The highest scores for transformability were spatial and temporal heterogeneity, infrastructure for innovation and diverse policies.

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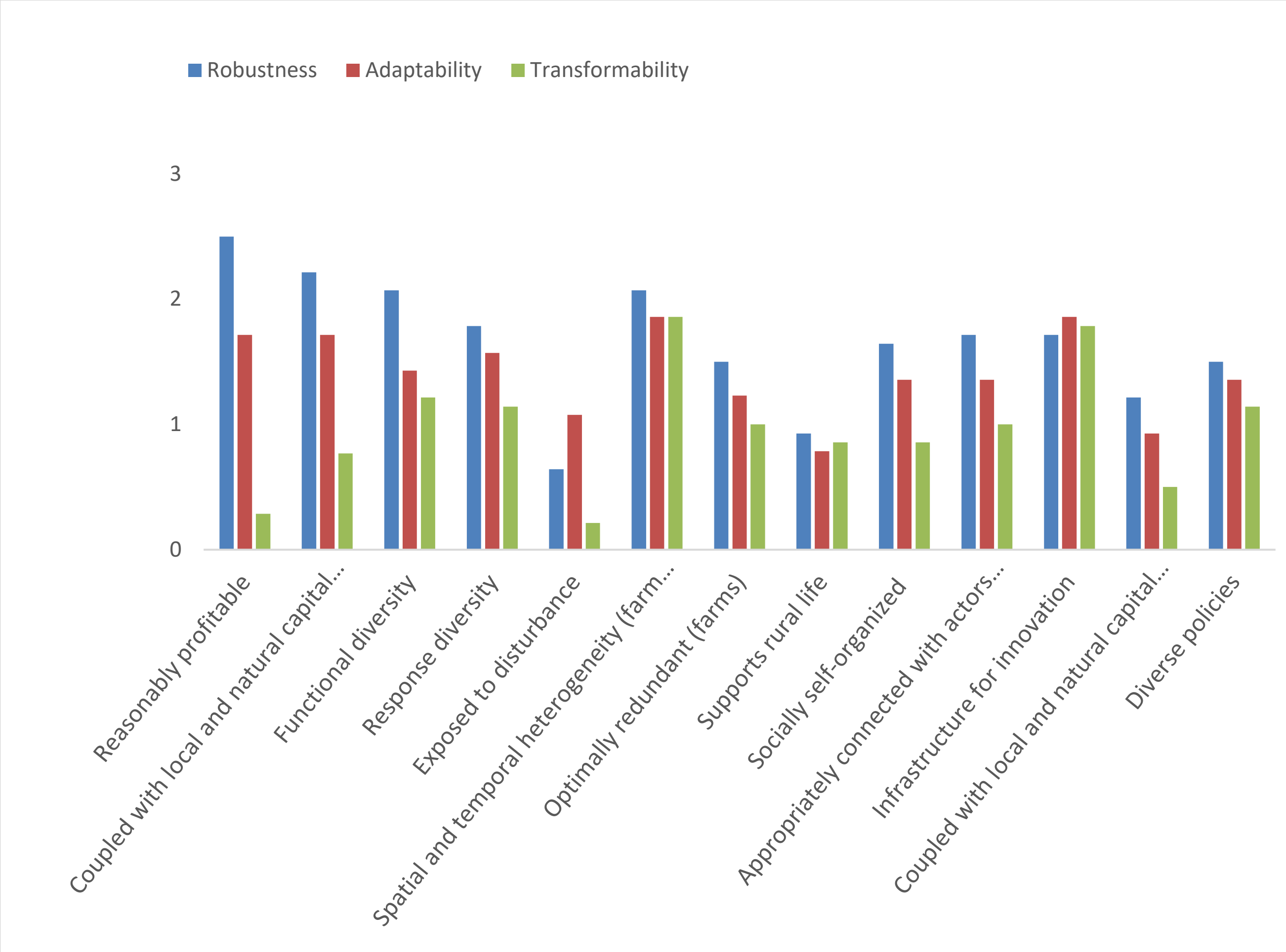

Figure 15. Bar graph showing average scoring of perceived effect of attribute on robustness, adaptability and transformability. A 0 implies no relationship, a 1 a weak relationship, a 2 a relationship of intermediate strength, and a 3 is a strong relationship. (n = 15)

Some of the attributes, such as 'reasonable profitability' show a strong contribution towards robustness and a very low contribution towards transformability. Some participants even scored the contributions as negative (Figure A11). Similar trade-offs are 'coupling with local and natural capital' and 'exposing to disturbances'. On the other hand, there are some clear synergies between spatial and temporally heterogeneity, infrastructure for innovation and supporting rural life. according to the stakeholders, these attributes contribute almost equally towards the three resilience capacities.

When combining the results for the current performance of the attributes and their contribution towards the resilience capacities (Figure A12), it can be concluded that the most important attributes for the system are the spatial and temporal heterogeneity and the infrastructure for

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innovation. Other important attributes are appropriate connectedness, social self-organisation and response diversity. These are, based on the workshop outputs, the attributes with the highest potential to contribute towards all resilience capacities. For robustness, coupling with local and natural capital and functional diversity are also important. The lowest contributors towards the system resilience are exposing to disturbances, supporting rural life and diverse policies. The biggest opportunity for improving the resilience of the farming system might lay in these attributes.

6.3 Resilience attributes

From examples from the workshop and the literature it can be concluded that the resilience attributes contribute towards the resilience capacities as follows;

- Reasonably profitable: contributes mainly to robustness and to lesser extend to adaptability. Cabell & Oelofse (2018) argue that by accumulating capital within the system, it becomes increasingly resistant to shocks. Also, the higher amount of capital allows the system to invest and make changes and thus contributes to adaptability. Furthermore, too high levels of profitability are a risk as the capital tends to concentrate on the larger companies and resources become unavailable to other stakeholders. We conclude that the participants' scores are similar to what is found in literature.
- Coupled with local and natural capital (production): Both the participants and literature agree that this attribute contributes tos all three resilience capacities (Cabell & Oelofse, 2012). However, this attribute is scarcely applied in western European dairy farms. The decoupled production from the natural capital results in a depletion of resources (Van Apeldoorn et al., 2011). Systems that over extract resources are decreasing their transformability. Furthermore, robustness is strongly affected by coupling with local resources. When a system becomes fully dependent of external inputs, it is very sensible to external events, such as an economic crisis. Furthermore, the legislative counterpart (Meuwissen et al., 2018) of this attribute contributes equally towards the resilience capacities. Legislation should facilitate coupling with local and natural capital.
- Functional and response diversity: Functional diversity is an ecological concept that highly applies to agro-ecosystems. According to our participants, it contributes towards all three capacities. In literature this is also argued. A functionally diverse system has many buffers to protect itself from perturbations (Cabell & Oelofse, 2012). High capacities to resist shocks and pressure is argued to

be mainly contributing towards robustness (Urruty et al., 2016). However, Holling (1973) argues that the heterogeneity of the landscape and the diversity of the inputs and outputs strongly contribute towards resilience, by describing a population that can always find a place to thrive due to the diversity of the island. This example shows adaptability, by addressing new resources from new places, when environmental conditions change a system is adapting (Folke et al., 2010).

- Exposed to disturbance: on this attribute, participants seemed to disagree with literature. A system being exposed to perturbations increases its resilience through natural selection (Cabell & Oelofse, 2018). Although this might be intuitive when thinking about the farming system as a whole, it is also understandable that from the participants perspective this is seen as a negative influence towards their own resilience. This attribute strongly contributes towards adaptability, as it produces incentives to system entities to change their production processes and activities. This will then create a more diverse system.
- Spatial and temporal heterogeneity (farm types): the workshop participants scored this attribute as equally contributing towards all resilience capacities. This is also argued in literature. Meuwissen et al. (2018) describe this as a farming system with a diversity in farm types, regarding sizes, activity, modernisation etc., This diversity strongly contributes towards the transformability of the system, as a diversity in farm types means that there are high levels of social capital (varying skills, knowledge) (Meuwissen et al., 2018; Folke et al., 2010). It contributes towards adaptability because high diversity in farms means that there is also a high diversity in addressable resources and output products, and thus is a system with a large safe operating space (Meuwissen et al., 2018). Cabell & Oelofse (2012) underline the contribution towards robustness of a system with a high level of heterogeneity. They state that such a system is less sensitive to shocks like disease outbreaks.
- Optimally redundant (farms): both the participants and the literature state that optimal redundancy contributes to all resilience capacities. (Low et al., 2003). The redundancy of institutes and farms, however, can also have negative effects when too strong. Meuwissen et al. (2018) define as main feature of optimal redundancy that farmers can easily exit the system and new farmers can easily enter without causing large distortions to the system. For the case of Flanders, exiting of farmers is not that problematic, however, entering of new farmers is cumbersome (Calus, 2008). The degree of redundancy in terms of demographics might be much too high in Flanders, which has a negative influence on resilience. It can thus be concluded that redundancy has an optimum; and depending on how far the actual

situation lies from the optimum it contributes differently towards all three capacities.

- Supports rural life: Supporting rural life contributes equally towards all three resilience capacities. Supporting rural life is the demographic version of farm heterogeneity (Meuwissen et al., 2018). It is represented by a mixed multi-generational workforce of multi-level backgrounds, with a high availability of facilities. A healthy rural community supports the resilience of a farming system McManus et al., 2012). Farmers strongly depend on their relationship with the local community because it contributes strongly to their sense of belonging. A healthy social environment can give people the energy to cope with their problems and enable fast recovery, especially when confronted with a shock (Maguire & Hagan, 2007). Social belonging thus contributes to robustness. Moreover, a healthy rural society contributes both to adaptability and to transformability, as there is more stakeholder engagement, knowledge transaction and a large availability of social capital (Meuwissen et al., 2018).
- Socially self-organised: This resilience attribute is stated as one of the most important attributes, meaning that a resilient system always possesses a high capacity to socially self-organise (Cabell & Oelofse, 2012). However, the participants of the workshop did not rate these attributes as equally important as they are stated to be in literature. High degrees of self-organisation contribute strongly towards the adaptability of a farming system (Cabell & Oelofse, 2012). It is argued that self-organised stakeholder groups are faster in responding to actual needs, compared to top-down initiatives that often misinterpret the needs of the stakeholders. From the workshop output, it became clear that self-organisation also contributes to robustness. In this context, the historical event was discussed where a sector confederation intervened in order to guarantee a minimum price for the farmers. However, it is questionable whether this action contributed to a resilient relationship between the dairy farmers and the retail sector. High degrees of social self-organisation are also contributing towards social capital, as knowledge will be passed on and stakeholders will be more active in the community. This also contributes to transformability (Meuwissen et al., 2018).
- Appropriately connected with actors outside the farming system: when self-organisation is insufficient to be able to cope with complex challenges, it should be easy for farmers to reach out to politicians, policy makers and other stakeholders up the hierarchy (Meuwissen et al., 2018). Connectedness is divided into two types: high and weak connectedness and low and strong connectedness (Cabell & Oelofse, 2012). High and weak connectedness is debated to contribute

strongly towards resilience (adaptability and transformability) (Low et al., 2003). Strong connections might be able to contribute towards robustness in a certain extent (when a strongly connected supplier pays better prices for a product), however, it is also making the system more vulnerable (when the supplier goes bankrupt because of that); leading towards a lower overall resilience (Cabell & Oelofse, 2012).

- Infrastructure for innovation: the participants of the workshop scored this attribute as one of the most important contributors to all resilience capacities. A well-established infrastructure for innovation enables the system to quickly transfer knowledge (Meuwissen et al., 2018). Innovation can only result from the learning capacity of a system, either through single-, double- and/or triple-loop learning cycles that contribute to robustness, adaptability and transformability respectively (Meuwissen et al., 2018).
- Diverse policies: The participants scored this attribute as potentially fostering all three resilience capacities. Meuwissen et al., (2018) state that this attribute indicates that policies address all three resilience capacities. By preventing that policies focus only on one of the resilience capacities, a higher overall resilience of a system becomes more likely (Meuwissen et al., 2018). In order to achieve this, policies should create a safe environment in which flexibility of the farming system is supported and structural changes can be easily made.

6.3.1 Synergies and trade-offs between the attributes:

Some synergies and trade-offs were found among the specific resilience attributes. First of all, the attribute 'exposedness to perturbations' is strongly contributing to the general resilience attribute 'diversity', as it creates incentives towards change. Functional/response diversity is thus in fact the same attribute within another phase (Holling, 2001). Second, spatial heterogeneity (farms) and functional diversity largely encompassesthe same concepts (Cabell & Oelofse, 2012; Meuwissen, 2018). A variation in the occurrence of different farm types throughout different regions (spatial heterogeneity) can be seen as a sub-aspect of the functional heterogeneity of the system. A third trade was found between 'optimal redundancy' and 'reasonable profitability'. , It can be stated that a high level of redundancy entails a high level of transformability. However, this doesn't count as increasing redundancy decreases the efficiency and profitability of the system. On the other hand, a low redundancy might make the system highly profitable, but this was argued to be negative for the resilience of a system. It can be concluded that it is important that these two attributes are carefully balanced (Cabell & Oelofse, 2012). The last synergy was found between supporting rural life, farm heterogeneity, self-organisation and infrastructure for innovation (Cabell & Oelofse, 2012; Meuwissen et al., 2018). All these attributes partially contribute towards the social capital by increasing the amount of knowledge that is exchanged within a community. As a high social capital makes a system more transformable, these attributes all strongly contribute towards transformability (Meuwissen et al., 2018).

7 Discussion

7.1 Functions of the farming system

The most important functions within the system of intensifying dairy farms in Flanders are providing viable income, realising food production, animal welfare and maintaining natural resources respectively (Figure 4). These were the functions were all stakeholder groups agreed on their importance.

The most important indicators within those functions were real price of milk for consumers; labour income; soil quality and cow longevity. These indicators combined with the functions they represent, also shape the basis of the identity of this system. The identity of the farming systems is thus strongly output oriented and the system highly depends on environmental conditions. From the workshop discussions, it became clear that the system has become more production-oriented over the last 20 years and the scale of production increased. At the same time, the influence of public opinion increased, resulting in the rise of the attention to animal welfare and maintenance of natural resources.

The real milk price for consumers scored relatively high (3). However, there seems to be a big disagreement between farmers and the industry on this indicator (Table A4). This is probably because the industry wants to keep the products as affordable as possible for the consumers and the farmers want to receive a fair price for their products.

Real prices of milk steadily increased in the last 20 years and from 2007 onwards, but the evolution followed a more erratic increase. During the workshop, the banking crisis and the Arabic spring were mentioned as possible drivers for the increasing prices; however in literature it is stated that linking price fluctuations to single causes is (Tadasse, et al., 2016). Tadasse et al., (2016) found that oil prices were an important driver for the rise of soybean prices. There is little evidence that the Arabic spring had an influence on oil prices, however, there were some single events in Arabic oil producing countries that drove up the speculation on the prices (Kilian & Lee, 2014). Also, a rise in oil prices entails a rise of biofuel prices; of which soybean is an important ingredient.

For the real milk price, it is difficult to determine its actual current performance as it can be viewed from two different perspectives. When interpreting an increased price as a high current performance, we can conclude that the perceived current performance was high. From the indicator dynamics exercise, it seems that the participants did not expect that the real prices have increased since 20 years ago.

The current performance of labour income over the last 20 years was scored low by the participants (Table A4). Especially the “other” group gave a very low score. The income of farms is strongly correlated with milk prices. Due to the abolition of the quota regime, the volatility of milk prices was severe during the last several years (LARA, 2018). At the time of the abolition of the milk quota, the prices were high, which tempted many farmers to invest into expansion of the business. The establishment of the Russian dairy embargo together with the decreasing Chinese demand effectuated a price collapse, provoking the dairy crisis. The average income for Flemish dairy farms from 2007-2012 amounted nearly 60.000 euro (Lara, 2014), increasing towards 76.000 euros in 2013 (ILVO) but thereafter again dramatically decreasing farm incomes due to remaining high variable costs (Figure A13). One of the most important variable costs are the feed prices while the profitability of farms depends highly on feed prices (LARA 2018). When comparing the prices of feed costs with milk prices, both curves have a similar development until 2013. However, from 2013 onwards, feed prices remained stable while the milk prices plummet (LARA, 2018). As these incidents occurred recently, this could be the reason that the participants of the workshop scored the current performance low. the economic situation of the Flemish dairy sector is similar to other neighbouring countries(Figure 15A).

It is thus hard to understand why exactly the current performance of labour income was scored so low and especially by the ¨other¨ group. A possibility might be that the media hyped the milk crisis, and that the situation was in fact less dramatic than portrayed (LARA, 2018). Another possible cause is the high costs of investments that some farmers made after the abolition of the quota. As one of the participants said during the workshop; “*For me and my farm the milk prices of last years were fine and I earned enough to live a normal live, however, for some farmers that heavily invested after the quota abolition the milk prices were not enough to pay their debts.*”

The current performance of soil quality was rated quite high by all stakeholder groups, especially the industry and the farmers group. There wasn´t much discussion about this indicator. However, a participant stated that if there would have been more participants representing NGO´s, the current performance for soil quality would have been lower. Moreover, evidence is found in literature about significant problems concerning current soil quality. For example, there has only been a slight increase in carbon content levels since 2007; after it had been continuously decreasing for over 30 years (Figure A16). Also, in the amount of polluted soils in Flanders is increasing (MIRA, 2012). Furthermore, events of erosion are more and more occurring; especially in the south of Flanders. Moreover, high soil levels of Nitrogen and Phosphorous are threatening environmental quality (Lara, 2018). There has been little improvement about problems

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concerning Nitrogen, Phosphorus and animal manure over the last 25 years, despite many European efforts to reduce them., . Although the amount of measurement locations that exceed the critical N or P concentration has stagnated in more recent years, the intended necessary decrease delayed. For example, the targeted reduction of 5% in the amount of negative measure points has only been accomplished by two regions in Flanders. Between 2011 and 2016 the total use of nitrogen increased by 24%. Most of the Nitrogen is applied to dairy grasslands. Results from literature are thus contrasting with the participants' perception about the current soil quality performances.. It was found that there was little willingness among farmers to adopt further soil conservation practices and that they have a negative image of those practices (Wauters et al., 2010). This study also found that younger farmers (below 35) and farmers with higher education were more likely to embrace such practices. The average age of the farmers during the workshop was above 35. The reason why they overestimated the current performance of soil quality might be the effect of farmers being subjected to an increasing number of rules to protect the soil quality (LARA, 2018), combined with their negative image the about these measurements.

The current performance of cow longevity received a slightly positive overall score; a result of the positive scoring by the farmers and the industry group while the "other" group scored this indicator slightly negative. Recently, animal welfare has become much more important for the dairy sector, as the consumers demand this from farmers when buying their products (LARA, 2018). Cow longevity is an important indicator for animal welfare (FAO SAFA, 2014), but it is also an economic indicator for efficiency (Campens & De Mey, 2010). However, when cows reach a certain age, production starts to fall dramatically. Consequently, the average age of cows in the intensifying dairy system in Flanders falls around 5 years (CRV, 2017). The dairy sector is looking for genetic improvements to prolongate the high productivity period. There is little data available on the development of cow longevity in Flanders. Available data from the Netherlands show that cow longevity remained relatively stable (CRV, 2017). The different scores of the current performance of longevity between the stakeholder groups is likely a result of different perceptions. The farmers see the increasing cow longevity in the first place through an economic viewpoint, while the "other" group primarily links this indicator to animal welfare. This difference in perceptions on animal welfare in Flanders was also found in literature (Vanhonacker et al., 2008).

7.2 Robustness, adaptability and transformability of the farming system

Robustness in this farming system comes from the high degree of intensification, efficiency and the large-scale of production. The system is adaptable due to high interconnectivity of farmers with other stakeholders through for example cooperatives and associations, which provide the

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stakeholders with access to knowledge and new technologies have. Changes in the functions of the system are hard to make due to the high capital intensity; therefore the system is not very transformable yet. However, the participants gave a high score on current performance of the resilience attribute 'spatial and horizontal heterogeneity' (regarding diversity in economic size, intensity, orientation and degree of specialization of farms; following Cabell & Oelofse, 2012); stating that this attribute strongly contributes to the systems transformability. . In literature it is argued that although there has been a trend of diversification in the latter years (Dessein et al., 2013), due to the high land and labour prices and many other normative constraints the farms are still mainly pushed towards intensification and that thus the heterogeneity is not that high (van den Pol et al., 2015). We conclude that despite the system is currently low in transformational power, there is a significant potential of increasing it by improving the contribution of the transformation-enabling system attributes. . Concerning the low succession rate in Flanders, further research is needed to determine whether certain types of farms are more likely to be continued compared to other types.

7.2.1 Indicated strategies

Six main strategies were identified during the historical dynamics exercise: intensification, diversification, scale enlargement, innovation, financial support and risk management.

In literature, the strategies of intensification, scale enlargement, specialization etc. are often grouped under the modernisation paradigm of farming (Van Der Ploeg et al., 2000; De Roest et al., 2018; Bjørkhaug & Knickel, 2018). Therefore, intensification and scale enlargement will be further discussed as modernisation. Farmers aim for more resilience by creating a larger exploitation, with a larger output and with access to more resources , (Bjørkhaug & Knickel, 2018). Larger, more intensive farms seem to come with many benefits regarding the cost of production (Struik et al., 2014). There are several factors influencing these benefits of scale. First, large-scale farmers can buy inputs in larger quantities and therefore have a stronger bargaining power on prices. Second, they often have a higher investment capacity, which allows them to invest in more advanced technology. Another important aspect is that machinery and equipment can work closer to its maximum capacity on large intensified farms (Hall & LeVeen, 1978). According to the participants of the workshop, the strategy of modernisation is strongly focussed on improving the robustness of a system. However, in literature it is also mentioned that modernization can have a negative effect on the resilience of a farming system (de Roest et al., 2018; Meuwissen et al., 2018). Modernisation can increase the vulnerability of a system due to its sensitivity to the market and changes in policies. Another problem is the highly skilled labour that is needed for this type of production. This reduces the succession rates and makes it more difficult to transform into another system (Meuwissen et al., 2018). Furthermore, strongly modernised farms in Flanders tend to have higher debts and loans with financial institutions (Van der Straeten, et al., 2012).

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These aspects mean that there is much more involved when an intensified large-scale farming system needs to transform compared with a smaller scale system. Also, the high financial assets of larger farms are one of the main causes of a decreasing succession rate (Calus et al., 2008). Furthermore, due to a change in management structures of larger farms, often incorporating more decision makers, different perspectives might lead to a slower decision-making process. Farms that are in debt with banks and other lending institutions must also involve those institutions within their decision-making process; making it additionally more complex and cumbersome. The strategy of modernisation is mostly connected to – but not to a very large extent – the resilience attributes 'reasonably profitable' (Cabell & Oelofse, 2012) and 'infrastructure for innovation' (Meuwissen et al., 2018). In conclusion, modernisation helped farmers to reach a higher income, but also highly decreased their flexibility. Meuwissen et all (2018) described infrastructure for innovation "to timely adopt new technologies" as a characteristic of resilient farming systems. From the workshop it became clear that the main barrier for implementing innovation is that it negatively affects the farmer's flexibility by determining the path for the future for a long time. So that. To conclude on this, it is in fact rather surprising that it is hard to find a resilience attribute in literature that matches the strategy of modernisation (intensification, scale-enlargement, specialisation) while this in fact has been one of the major strategies that was implemented in the system since the second world war (Struik et al., 2014).

Besides intensification of production, more and more farmers are resorting to diversification by broadening their economic activities. After opening the dairy trade of Flanders to the international market, the farming system was exposed to highly fluctuating prices and stronger competition. Many farms were not able to cope with these challenges and exited the farming system (Debruyne et al., 2011). Other farms were forced to adopt other strategies than modernisation to survive the low milk prices. This led to diversification of business practices in Flanders (Dessein et al., 2013). Although diversification in history was a common strategy, it had been increasingly repressed by intensification during the last decades. According to the participants, diversification addresses to all three capacities of resilience in contrast with the above described strategies that only focus on robustness. A farm with different economic outputs is less sensitive to fluctuation of prices. When one of their outputs make less profit, they can rely on other outputs. Diversified farms also pose a lesser threat to the local biosphere. For example, diseases spread less easy between animals of different races. When farms focus on different products, there is less need for intensified production and efficiency and therefore there can also be less pressure on the environment. Also, a high degree of diversification positively contributes towards landscape attractiveness (Rogge et al., 2007), as it strongly fits in with the image of authentic family farms that are favoured over the intensified systems by the public opinion.

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Diverse farms and farming systems have a strong ability to adapt. There is expertise on many different areas and as production systems are less specialized there is more room for adaptation. The same goes for transformability, when there is no strong concentration of capital it is easier to transform a system. Meuwissen et al. (2018) state that diversity within the region, strongly contributes towards the transformability of the system. Furthermore, heterogeneity between farms contributes mainly towards adaptability and enterprise diversification leads to a higher robustness. The main benefit of a diverse system is that there is a certain functional diversity (Cabell & Oelofse, 2012). This means that different farms occupy different niches and thus that when resources from that niche become depleted, it does not affect other farmers. Another attribute, that is embraced by the strategy of diversification is 'optimal redundancy' (Cabell & Oelofse, 2012). This includes the response diversity of a system. This is argued to decrease the efficiency but increase the robustness and adaptability as it creates several response options.

The strategy of innovation was already partly discussed above. However, some of the strategies under the innovation strategy (investments from cooperatives and cyclic agriculture) are more revolutionary compared to others. The participants of the workshop found these strategies to be more contributing towards robustness and adaptability and scored them with one of the highest implementation scores. Meuwissen et al. (2018) distinguish incremental innovation from radical innovation, whereby incremental innovation contributes towards robustness and radical innovation towards adaptability. Incremental innovations are innovations that address available knowledge and technology and that only require minor changes in organisational structures (Martin et al., 2013). Some strategies from modernisation (intensification, specialisation) thus fit under innovation as well. Radical innovations mean a change in the production process as well as in the output product (Martin et al., 2013). Investments of the cooperatives in improving the production processes are thus more of an incremental nature and the cyclic agriculture (change in management structures) is thus a radical innovation. The participants of the workshop seem to agree with Meuwissen et al. (2018) on the stronger contribution of cyclic agriculture towards the adaptability of the system (Figure 13) (looking at the relative difference between the contribution towards the capacities). A third type of innovation (triple loop) is when a complete shift in activities, management or outputs occurs (Meuwissen et al., 2018). This shows that the system is transformable. However, during the workshop this seemed not to be very applicable to the farming system in Flanders.

Financial support is a strategy that comprehends subsidies and other financial aid from outside the system. According to the participants, this contributes positively towards robustness and adaptability; while strongly negatively towards transformability. However, Cabell & Oelofse (2012) relate the attribute 'reasonable profitability' with a system that is not too dependent on external subsidies. Meuwissen et al. (2018) found that financial support mainly contributes

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towards robustness. Cabell & Oelofse (2012) mention support from institutions within the optimal redundancy attribute. They state that within an optimally redundant system several institutions operate parallel to the farming system and are therefore able to quickly respond to crises. There are several organisations in the farming system in Flanders that have indeed some overlap regarding their functions e.g. the Flemish government, the federal government, the EU, etc. The financial support from Fedis (Comeos), discussed above, was a singular event and was more a result of social self-organisation (protesting farmers at supermarkets) than a reliable source of financial support. The fact that Cabell & Oelofse (2018) see support as a characteristic of optimal redundancy, is contrasting to what the participants thought. Because optimal redundancy is argued to be a contributor towards transformability (Low et al., 2003). However, redundancy is not the same as optimal redundancy, it might be that in the farming system of Flanders there is too much redundancy. It might be that financial support was given too quickly and easily to create an incentive for the system to transform. These supports were mainly based on maintaining the system reasonably profitable (Cabell & Oelofse), which is argued to strongly contribute towards robustness. This might be the reason the participants seemed to disagree with the literature on this aspect.

The last strategy that was discusses during the workshop is risk management. The participants saw 'entering the futures exchange' as a contributor towards robustness and adaptability. Meuwissen et al. (2018) also see the strategy of risk management as a contributor towards adaptability. The futures give certainty on the milk price, it is a concept that is already very common other agricultural businesses. However, for dairy farmers there is a problem with the cooperatives as they have a delivery contracts and cannot always sell their milk through the futures exchange (Wolf, 2012).

7.3 Options to improve the resilience of the farming system

The current farming system of intensifying dairy in Flanders has proven to be resilient when it comes to robustness. It is a well-organised system, with a strong safety net when challenges occur (high redundancy). Through the various cooperatives and associations, farmers are granted access to knowledge, technology and the market (socially self-organised and appropriately connected). The system is moderately coupled with local and natural capital, which makes it robust towards climatic events and able to maintain a high production. However, too high degrees of robustness are not always supporting resilience (Cabell & Oelofse). For example, when the system is not sustainable and causes environmental degradation but is resistant to transformations (Cabell & Oelofse, 2012). This might be the case for this system as it seems to be to a lesser extent adaptable and to a far lesser extent transformable. The high degree of intensification and the increasing

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scale of production are the main drivers for the poorly performing resilience capacities (adaptability, transformability). One of the main findings from the workshop output and literature, was that increasing the diversity of the farming system could be a useful strategy to improve the adaptability and transformability of the system (Meuwissen et al., 2018; Cabell & Oelofse, 2012). This is particularly underlined by the results from the resilience attributes exercise whereby the participants needed to score to which extent resilience attributes would contribute to the three capacities. The highest scores for adaptability and transformability were given to the resilience attributes concerning diversity. For example: functional diversity, diverse policies and spatial and temporal heterogeneity. Another attribute that could benefit all three resilience capacities according to the participants, is infrastructure for innovation. In order to make the highly specialised intensifying dairy sector in Flanders more resilient, it will be necessary to focus more on diversity. By deregulating the E.U. market protectionism the first step towards creating diversity within the sector might already have been made (exposedness to perturbation). However, due to the high redundancy of the system, farmers received financial support from different institutions during difficult times, when in fact this also decreases the incentives for diversification. There seems to be a need for more supportive policies and possibilities to facilitate change within the system. At last, during the workshop a discussion arose about the schooling of farmers. They were confronted with only one way of farming: intensification, which was framed by their teachers as the only way to go if you would like to make it as a farmer. In order to teach new farmers alternative options, changes should be made within the educational system. Educating both future farmers, policy makers and other stakeholders in alternative ways of farming is thus a major step required for improving the overall resilience of the farming system.

7.4 Methodological challenges

Although overall the workshop was successful, there was room for improvement. First of all, the workshop took a lot of time. Towards the end, it was noticeable that participants lost focus and motivation. This reduced the quality of the input from the workshop towards the end.

Most of the exercises were understood well and participants were able to complete them. However, some problems arose in the exercise whereby the dynamics of the indicators were sketched. It proved to be difficult to clearly state what the crucial challenges were for shaping the curve of the indicator. It was even more difficult to define the strategies that were used as a response. Further, this part of the workshop went differently in the case of an indicator with a dynamic that was perceived as good compared to the case of an indicator with a dynamic that was perceived as bad. For the latter, it proved more easy to think in terms of external challenges and responses. Another approach to this exercise might have prevented this problem. If we would have prepared more precisely the challenges and strategies by revising literature and interview

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data, we could have given the possible challenges and strategies as options to the participants within this exercise. They could then choose from an array of possibilities which challenge affected the dynamics and what strategies were responding.

Another problem that might have influenced results is that the concept of resilience is somewhat complex. Especially the resilience capacities robustness, adaptability and transformability were hard to explain. Robustness is the easiest to understand, next comes adaptability and the most difficult capacity is transformability (Meuwissen et al., 2018). This might well have influenced the results.

Throughout the discussion many comparisons were made with the results from the workshop and the information found from literature. Many of the results strongly coincide with scientific data. That goes for, indicator performance, historical dynamics, strategies and resilience attributes. There were some differences between the workshop output and the scientific data. The most important dissonance; the current performance of the environmental indicators was scored rather high by the participants, however in literature this is contradicted (MIRA, 2012; LARA, 2018). Other than this, it can be concluded that the participants of this workshop were highly informed stakeholders, and their input was very reliable.

The last point of methodological discussion also concerns these highly informed stakeholders, more precisely we want to emphasize the possible effects of the workshop participants' composition. Ahead of the workshop many invitations were send to a large group of stakeholders. Only a few people responded to the invitations and attended the workshop. As there are many other farming-related research-initiatives, focus groups, workshops, interviews etc., it is highly possible that only the most fanatic stakeholders were interested to come. This means that the participants of the workshop might not be a perfect representation of the average stakeholders within the area. When a different participant group would have been randomly selected, the workshop results may well have been different.

8 Conclusion

The farming system of intensifying dairy production in Flanders is a complex system with many stakeholders. The system has been increasing its' production while decreasing the number of farmers. Some of the largest challenges for the system have been the frequent changes in policies, the high costs of investments, the low availability of land and a decreasing rate of succession. The most important functions of the system are economic viability, food production and the maintenance of natural resources. The most important indicators that represent those functions of the farming system are total milk production, labour income and soil quality respectively. The current performance of the first two indicators was scored as low, while the performance of the soil quality was scored positively. However, in literature it was found that this is probably not the case, as soil quality measurement points in Flanders became increasingly negative over the last 20 years. From a combination of indicator importance and performance, some indicators were chosen to be further assessed by the participants. After drawing the historical dynamics, the challenges for those indicators and the related strategies to cope with those challenges were assessed. From this exercise it was found that the most important strategy was to increase the production capacity while decreasing the costs of production. This trend of intensification has been characteristic for this farming system. However, from a combination of literature and workshop outputs it was found that this strategy mainly contributes towards robustness, while it contributes very little towards adaptability and even contributes negatively towards transformability. Furthermore, the small array of strategies to pick from upon occurrences of challenges indicates a low resilience. This was also found when analysing the performance of the (general) resilience attributes from the resilience framework from Meuwissen et al. (2018) for this system. In average all attributes scored rather low. The attributes with the best performance score were spatial and temporal heterogeneity, socially self-organized and supporting rural life. These attributes are linked to the general resilience attributes; modularity, tightness of feedbacks and system reserves respectively. After further assessing the workshop output it could be concluded that especially the modularity and the tightness of feedbacks were high within this system. Furthermore, it was found that the system currently seems to remain in a reorientation phase, whereby new strategies arise in order to cope with challenges because the strategy of intensification alone seems to no longer be sustainable.

It was found that an important improvement to the system could be to expose the system to more perturbations. This is also, what the E.U. is currently doing by abolishing the milk quota and changes in the CAP. Furthermore, from the workshop it was concluded that there is a need for policies that do not only focus on robustness but also increase the resilience capacities; adaptability and transformability.

It is also concluded that the workshop participants assess their farming system more from a personal perspective than from a system perspective. It was thus hard for them to see that for example a collapse of a farm could lead to resilience for the system. This influenced their output.

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References

BCZ. 2017. 5-Jaarverslag. http://www.bcz-cbl.be/media/193413/5-jaarverslag-2017-belgi%C3%AB_nl.pdf

Bijttebier, J., Coopmans, I., Appel, F., & Gailhard, I. U. (2018). D3.1 Report on current farm demographics and trends. Sustainable and resilient EU farming systems (SureFarm) project report. Horizon 2020 Grant Agreement No. 727520.

Bjørkhaug, H., & Knickel, K. (2018). Rethinking the links between farm modernisation, rural development and resilience.

Calus, M., Van Huylenbroeck, G., & Van Lierde, D. (2008). The relationship between farm succession and farm assets on Belgian farms. Sociologia Ruralis, 48(1), 38-56.

Campens, V., D'hooghe, J., De Mey, K., & Marchand, F. (2010). Samen grenzen verleggen.

CRV. 2017. Jaarstatistieken 2016 voor Nederland.

de Roest, K., Ferrari, P., & Knickel, K. (2018). Specialisation and economies of scale or diversification and economies of scope? Assessing different agricultural development pathways. Journal of Rural Studies, 59, 222-231.

Debruyne, L., Bijttebier, J., & D'Haene, K. (2011). Hoe duurzaam is de Vlaamse melkveehouderij?.

Departement landbouw en visserij. 2019. Landbouwcijfers. https://lv.vlaanderen.be/nl/voorlichting-info/feiten-cijfers/landbouwcijfers

Departement landbouw en visserij. 2015. Landbouwcijfers. https://lv.vlaanderen.be/nl/voorlichting-info/feiten-cijfers/landbouwcijfers

Dessein, J., Bock, B. B., & De Krom, M. P. (2013). Investigating the limits of multifunctional agriculture as the dominant frame for Green Care in agriculture in Flanders and the Netherlands. Journal of rural studies, 32, 50-59.

Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: integrating resilience, adaptability and transformability. Ecology and society, 15(4).

Giller, K. E., 2013. Guest Editorial: Can we define the term 'farming systems'? A question of scale. Outlook on Agriculture, 42(3), 149-153.

This Project has received funds from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 727520

Hall, B. F., & LeVeen, E. P. (1978). Farm size and economic efficiency: The case of California. American Journal of Agricultural Economics, 60(4), 589-600.

Holling, C. S. (1973). Resilience and stability of ecological systems. Annual review of ecology and systematics, 4(1), 1-23.

IRWiR PAN, Instytut Rozwoju Wsi i Rolnictwa. (2017). D-8.2 Case Study management plan (1st draft) Sustainable and resilient EU farming systems (SureFarm) project report. Horizon 2020 Grant Agreement No. 727520.

Kellens, W., Vanneuville, W., Verfaillie, E., Meire, E., Deckers, P., & De Maeyer, P. (2013). Flood risk management in Flanders: past developments and future challenges. Water Resources Management, 27(10), 3585-3606.

Kilian, L., & Lee, T. K. (2014). Quantifying the speculative component in the real price of oil: The role of global oil inventories. Journal of International Money and Finance, 42, 71-87.

LARA. 2018. Landbouw rapport. Departement Landbouw en Visserij.

Lawless, M., & Morgenroth, E. L. (2016). The Product and Sector Level impact of a hard Brexit across the EU (No. 550). ESRI Working paper.

Lenders S. & Deuninck J. (2018) De Vlaamse zuivelbarometer – januari 2018, Departement Landbouw en Visserij, Brussel. Depotnummer: D/2018/3241/007.

Low, B., Ostrom, E., Simon, C., & Wilson, J. (2003). Redundancy and diversity: do they influence optimal management. Navigating social-ecological systems: building resilience for complexity and change, 83-114.

Maguire, B., & Hagan, P. (2007). Disasters and communities: understanding social resilience. Australian Journal of Emergency Management, 22(2), 16.

Maynard, L. J., Wolf, C., & Gearhardt, M. (2005). Can futures and options markets hold the milk price safety net? Policy conflicts and market failures in dairy hedging. Review of Agricultural Economics, 27(2), 273-286.

Martin, G., Martin-Clouaire, R., & Duru, M. (2013). Farming system design to feed the changing world. A review. Agronomy for Sustainable Development, 33(1), 131-149.

McManus, P., Walmsley, J., Argent, N., Baum, S., Bourke, L., Martin, J., ... & Sorensen, T. (2012). Rural Community and Rural Resilience: What is important to farmers in keeping their country towns alive? Journal of Rural Studies, 28(1), 20-29.

This Project has received funds from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 727520

Meuwissen, M., Paas, W., Slijper, T., Dresvyannikova, V., Coopmans, I., Ciechomska, A., Lievens, E., Deckers, J., Vroege, W., Mathijs, E., Kopainsky, B., Finger, R., Mey, Y.d., Poortvliet, M., Nicholas-Davies, P., Midmore, P., Vigani, M., Maye, D., Balmann, A., Appel, F., Termeer, K., Feindt, P., Candel, J., Tichit, M., Severini, S., Wauters, E., Bardají, I., Soriano, B., Zawalińska, K., Lagrkvist, C.-J., Tasevska, G., Peneva, M., Gavrilescu, C., 2018, P.R., 2018. D1.1. Report on resilience framework for EU agriculture. Sustainable and resilient EU farming systems (SureFarm) project report. Horizon 2020 Grant Agreement No. 727520.

MIRA Rapport. 2012. Vlaamse milieu maatschappij

MIRA Rapport. 2014. Vlaamse milieu maatschappij

Rogge, E., Nevens, F., & Gulinck, H. (2007). Perception of rural landscapes in Flanders: Looking beyond aesthetics. Landscape and urban planning, 82(4), 159-174.

Statistics Belgium. 2019. (Statbel - Algemene Directie Statistiek) https://bestat.statbel.fgov.be/bestat/crosstable.xhtml?view=c7cba5dc-ec2c-433c-9594-99bd8f184d0e.

Struik, P. C., Kuyper, T. W., Brussaard, L., & Leeuwis, C. (2014). Deconstructing and unpacking scientific controversies in intensification and sustainability: why the tensions in concepts and values? Current Opinion in Environmental Sustainability, 8, 80-88.

Tadasse, G., Algieri, B., Kalkuhl, M., & von Braun, J. (2016). Drivers and triggers of international food price spikes and volatility. In Food Price Volatility and Its Implications for Food Security and Policy (pp. 59-82). Springer, Cham.

Tscharntke, Teja, et al. Landscape perspectives on agricultural intensification and biodiversity–ecosystem service management. Ecology letters, 2005, vol. 8, no 8, p. 857-874.

Urruty, N., Tailliez-Lefebvre, D., & Huyghe, C. (2016). Stability, robustness, vulnerability and resilience of agricultural systems. A review. Agronomy for sustainable development, 36(1), 15.

Van Apeldoorn, D. F., Kok, K., Sonneveld, M. P., & Veldkamp, T. (2011). Panarchy rules: rethinking resilience of agroecosystems, evidence from Dutch dairy-farming. Ecology and Society, 16(1).

van den Pol, A., Aarts, H., De Caesteker, E., De Vliegher, A., Elgersma, A., Reheul, D., ... & Vaes, R. (2015). Grassland and forages in high output dairy farming systems in Flanders and the Netherlands. In Grassland and forages in high output dairy farming systems (Vol. 20, pp. 3-11).

This Project has received funds from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No. 727520

Van der Ploeg, J. D., Renting, H., Brunori, G., Knickel, K., Mannion, J., Marsden, T., ... & Ventura, F. (2000). Rural development: from practices and policies towards theory. Sociologia ruralis, 40(4), 391-408.

Van der Straeten, B., Deuninck, J., & Van Gijseghem, D. (2012). De melkproductie in Vlaanderen na 2015. Departement Landbouw en Visserij, Afdeling Monitoring en Studie.

Vanhonacker, F., Verbeke, W., Van Poucke, E., & Tuyttens, F. A. (2008). Do citizens and farmers interpret the concept of farm animal welfare differently?. Livestock Science, 116(1-3), 126-136.

Verstraeten, G., Poesen, J., Govers, G., Gillijns, K., Van Rompaey, A., & Van Oost, K. (2003). Integrating science, policy and farmers to reduce soil loss and sediment delivery in Flanders, Belgium. Environmental Science & Policy, 6(1), 95-103.

VILT. 2009. "Fedis zal het landbouwbeleid niet vervangen" 07.09.2009 Dominique Michel - Fedis. (n.d.). Retrieved January 24, 2019, from http://www.vilt.be/Dominique_Michel_-_Fedis_-_Fedis_zal_het_landbouwbeleid_niet_vervangen

Vlaamse milieu maatschappij. (2017). MIRA database.

Vlam, 2018: duurzame zuivel sector symposium.

Wauters, E., Bielders, C., Poesen, J., Govers, G., & Mathijs, E. (2010). Adoption of soil conservation practices in Belgium: an examination of the theory of planned behaviour in the agri-environmental domain. Land use policy, 27(1), 86-94.

Wauters, E., Van Winsen, F., De Mey, Y., & Lauwers, L. (2014). Risk perception, attitudes towards risk and risk management: evidence and implications. Agricultural Economics–Czech, 60(9), 389-405.

Wolf, C. A. (2012). Dairy farmer uses of price risk management tools. Journal of dairy science, 95(7), 4176-4183.

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Appendix A. Workshop memo

The workshop started a little past 10:00 in the morning. Participants were arriving from 9:30. Many seemed to know each other and so they were chatting and enjoying a coffee before the workshop started. The workshop was held at the facilities of I.L.V.O, it was chosen to hold the workshop there because of the convenient location and parking facilities. The room in which the workshop was held was large enough to set all participants tables up in a circle. This created a good participative environment. The room temperature, the sound, the chairs and the facilities were fine. The only downside of this room was that there were no windows, so at the end of the day, lack of daylight might have been somewhat tiresome. However, the wheatear that day would not have allowed for much sunshine. During lunch there was a wide variety of sandwiches, including vegetarian that everybody enjoyed. At the end of the workshop, there were snacks and drinks from a local brewery and a local fruit orchard.

The atmosphere during the workshop was good, people respected each other's opinion and carefully listened when other participants were sharing their perspectives. It was noticeable that some participants were more actively sharing their opinion than others, even though the moderator tried to involve as much people as possible within the discussions. The overall level of motivation was very high, participants had strong arguments and it was noticeable that they were all experts of specific parts of the farming system. Towards the end of the workshop, the last half hour, participants were becoming more distracted and increasingly silent. Because of this the last exercise (examples of resilience attributes) was then done group wise to finish in time. After the workshop, participants stayed for about half an hour to keep on discussing topics from the workshop. Everybody seemed content when leaving the building and expressed their willingness to participate again in the future.

Start time:	10:10
End time:	16:05
Total break time (estimation):	45:00

Appendix B. Details on farming system

Within the first ring of the farming system (Figure 2) the following stakeholders were placed for the following reasons:

Farmers associations: Farmers associations play an important role within the farming system of this case study. Within these associations farmers and other actors meet each other, share information and strengthen their connection with their social environment. These associations can be a source of independent advice and larger associations can also fulfil a lobbying role to pressure policy makers.

Veterinarians: As veterinarians depend on farmers for a provision of their income and farmers depend on them for the health of their animals. For this reason, veterinarians were also placed in the inner ring of the farming system. Veterinarians also play an important role in advising the farms on breeding, hygiene, feeding and medicine use.

Tourism: Although tourism is not a very large economic contributor for the farming systems yet, it can still be an important alternative when farms are not profitable enough. There is a strong mutual influence between tourism stakeholders and farmers. Farmers can decide to include tourism activities within their businesses, and tourists can pressurize farmers in their exploitations.

Other farms: These actors were included as there can be a strong mutual influence between dairy farmers and other farmers. For example, when there is cooperation between them, selling of manure, lending of machines etc.

Local shops: Local shops can sell products from dairy farms. This can help the farms to become more profitable. It also improves the attractiveness of the villages when local products are sold. Furthermore, these shops can also have an influence on the farmers decision on how and what to produce.

Cooperatives: During the workshop the cooperatives were placed in the inner ring. At first, it was decided to place them in the second ring. From interview data it became clear that farmers felt they had little influence on the course of these cooperatives, while the cooperatives had a large influence on the course of the farmers. However, during the workshop there was a consensus that the cooperatives should be in the inner ring.

Dairy farmers: Dairy farmers form the centre of the farming system.

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Local NGO´s: Local NGO´s are active in several sectors. For example, in landscape restoration or biodiversity protection. These NGO´s often disagree with the current way of farming, and the ongoing intensification. Farmers and NGO´s discuss their key points and can compromise on them. They both rely on cooperation of each other and were thus placed in the middle. Of course, the importance of NGO´s differs for different regions within Flanders.

Neighbours: In Flanders farmers practices are often close to villages and neighbours. These practices can create nuisance and can negatively affect the attractiveness of the countryside. As a result, neighbours can submit complaints with the municipality or leave the countryside. Also, neighbours are important social connections for farmers, which can help them in the case of emergencies.

Advisors: From the interviews it became clear that advisors are important within the farming system. Some farmers stated that it has become increasingly difficult to find independent advisors, as many of them are in some way connected to agricultural companies. Advisors in turn, are fully dependent on the farmers for their income.

Household members: Within dairy farms in Flanders, family labour is very important. When a farmer falls ill, he/she fully often relies on family members to assist within the farm. Furthermore, it is important that farming is profitable enough to sustain a family.

Land owners: Land scarcity is an important challenge for the farming system of this case study. There are several large land owners that are not always farmers. For example, one of the largest land owners is the catholic church in Belgium. They can decide who they lease the land to and thus form an important actor.

Environment: The environment can also be seen as an actor. The environment and dairy farmers are very interdepended. When drought reduces yields, this affects farmers. Over exploitation of natural resources negatively affects the environment.

Municipality: As the municipality is the lowest key policy entity within the hierarchical policy system of Flanders, they are mostly affecting farmers. As municipality policy representatives are chosen by its inhabitants, farmers also influence them. However, they can also attend municipality debates and other meetings to make policy makers aware of certain problems.

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Appendix C. Details on ranking and rating the functions and indicators

Table A2. Mean and standard deviation of scores per function (EF) per stakeholder group and for all participants. 100 points needed to be divided to 8 EF. 5 highest results for mean in bold. 5 lowest results for mean with double under script. (n = 16)

	Farmer		Industry		Other		All	
Function	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Food production	17	14	19	5	**24**	13	**21**	12
Bio-based resources	7	5	8	3	4	5	6	5
Economic viability	**38**	16	15	4	**22**	11	**25**	15
Quality of life	14	8	10	0	7	4	10	6
Natural resources	7	4	16	3	17	9	14	8
Biodiversity & habitat	5	4	11	5	8	7	8	6
Attractiveness of the area	4	4	8	3	8	7	7	5
Animal health & welfare	12	9	14	3	9	5	11	6

Table A3. Mean and standard deviation of importance of indicators per stakeholder group and for all participants. Per function, 100 points were divided over the indicators. The bold results depict the highest score per function for the stakeholder group. (n = 16)

	Farmer		Industry		Other		All	
Indicator	Mean	St.dev	Mean	St.dev	Mean	St.dev	Mean	St.dev
Total milk production Flanders	**62**	22	22	8	38	21	40	24
Real price of milk for consumers	38	22	**78**	8	**63**	21	**60**	24
Tons of meat produced	42	12	22	8	**37**	15	34	14
Tons of crops produced	**46**	17	**48**	18	30	10	**41**	16
Total number of farms with bio-gas systems	12	11	30	21	33	22	25	20
Share of total farm income from milk	20	14	26	11	17	13	21	13
Labour income	**41**	7	**38**	15	**56**	26	**46**	19
Gross margin per litre of milk	39	10	**38**	13	27	14	34	13
Average amount of working hours /day/farmer	**44**	15	**51**	17	39	23	**44**	18
Number of fully employed workers per farm	26	17	14	5	20	19	20	15
Pride of profession	30	19	35	16	**41**	8	36	14
Soil quality	**41**	6	26	10	**40**	31	**36**	20
Water quality	34	7	30	4	26	14	30	9
Total carbon footprint	26	6	**44**	11	34	22	35	16
Genetic diversity of livestock	21	13	21	2	21	12	21	10

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Share of ecologically valuable grassland	25	16	**44**	15	**42**	23	37	19
Responsible use of crop protection	**55**	28	35	16	38	24	**42**	23
Extent to which farms are involved in public activities; education, tourism, healthcare.	**36**	10	34	14	**39**	17	**36**	13
Share of farms with outside grazing	35	24	**42**	22	31	13	**36**	19
Income from tourism at the countryside	29	19	24	8	31	6	28	12
Longevity	46	9	**48**	16	**50**	11	**48**	12
Amount of antibiotics/ cow	46	9	46	25	**50**	11	**48**	15

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. The highest 10 results for st.dev are in bold.(n = 16)

	Farmer		Industry		Other		All	
Indicator	Mean	St.dev	Mean	St.dev	Mean	St.dev	Mean	St.dev
Total milk production in Flanders	3,0	3,57	2,8	1,44	3,7	2,45	3,2	2,54
Real price per litre of milk for consumers	2,8	2,19	3,6	**5,11**	3,0	**4,09**	3,1	3,76
Tons of meat produced	2,8	3,46	2,8	1,92	3,0	2,95	2,9	2,81
Tons of crops produced	3,0	3,85	3,2	**4,19**	2,8	2,42	3,0	3,40
Number of farms with bio-gas systems	2,4	1,00	2,6	2,62	2,0	2,62	2,3	2,11
share of farm income from milk	2,4	1,39	3,6	2,42	2,0	0,96	2,6	1,49
Total income	2,2	2,86	3,2	3,53	1,7	3,14	2,3	3,29
Gross margin per litre of milk	2,4	2,72	2,6	3,53	2,0	1,48	2,3	2,44
Average amount of working hours/farmer/day	1,6	3,28	2,6	**4,52**	2,0	2,61	2,1	3,37
total f.t.e in agricultural sector	2,8	1,94	2,6	1,24	2,5	1,33	2,6	1,52
pride of profession	3,4	2,23	3,6	3,10	2,3	2,72	3,1	2,71
soil quality	4,0	**3,89**	4,0	3,07	3,3	3,14	3,7	3,45
water quality	4,0	3,22	3,8	3,54	2,3	2,03	3,3	2,85
total carbon footprint	4,0	2,45	4,0	**5,20**	2,2	2,71	3,3	3,34
genetic diversity of the herd	3,2	2,08	3,4	2,28	2,7	1,75	3,1	2,02
share of ecologically valuable grassland	3,2	2,48	4,0	**4,78**	2,7	3,51	3,3	3,60
responsible use of crop protection	3,6	**5,51**	3,4	3,80	3,0	3,16	3,3	**4,08**
involvement of farms in education, tourism and open days	2,8	3,31	3,4	3,24	3,3	3,54	3,2	3,38
share of dairy farms with outside grazing	3,4	3,22	3,4	**4,00**	3,2	2,78	3,3	3,29
income from countryside tourism	3,0	2,67	2,6	2,29	2,5	2,78	2,7	2,60

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longevity	4,0	3,52	3,8	3,85	2,7	2,55	3,4	3,28
responsible use of antibiotics for cows	4,0	3,52	4,6	3,69	2,7	2,55	3,7	3,24

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. (n = 16)

	Farmer		Industry		Other		All	
Indicator	Mean	St.dev	Mean	St.dev	Mean	St.dev	Mean	St.dev
Food production	2,9	**1,12**	3,3	0,88	3,3	**1,61**	3,2	**1,20**
Bio-based resources	2,8	0,30	2,9	0,25	2,7	**1,13**	2,8	0,69
Viable income	2,3	**1,01**	3,1	**1,13**	1,9	0,50	2,4	0,99
Quality of life	2,5	0,41	3,0	0,88	2,2	0,55	2,5	0,67
Natural resources	3,2	**1,79**	3,9	**1,04**	2,6	0,84	3,2	**1,30**
Biodiversity	3,4	0,70	3,6	0,69	2,8	0,94	3,2	0,83
Countryside attractiveness	3,1	0,65	3,2	0,63	3,0	0,61	3,1	0,59
Animal welfare	3,8	0,68	4,0	0,87	2,6	0,94	3,4	**1,05**

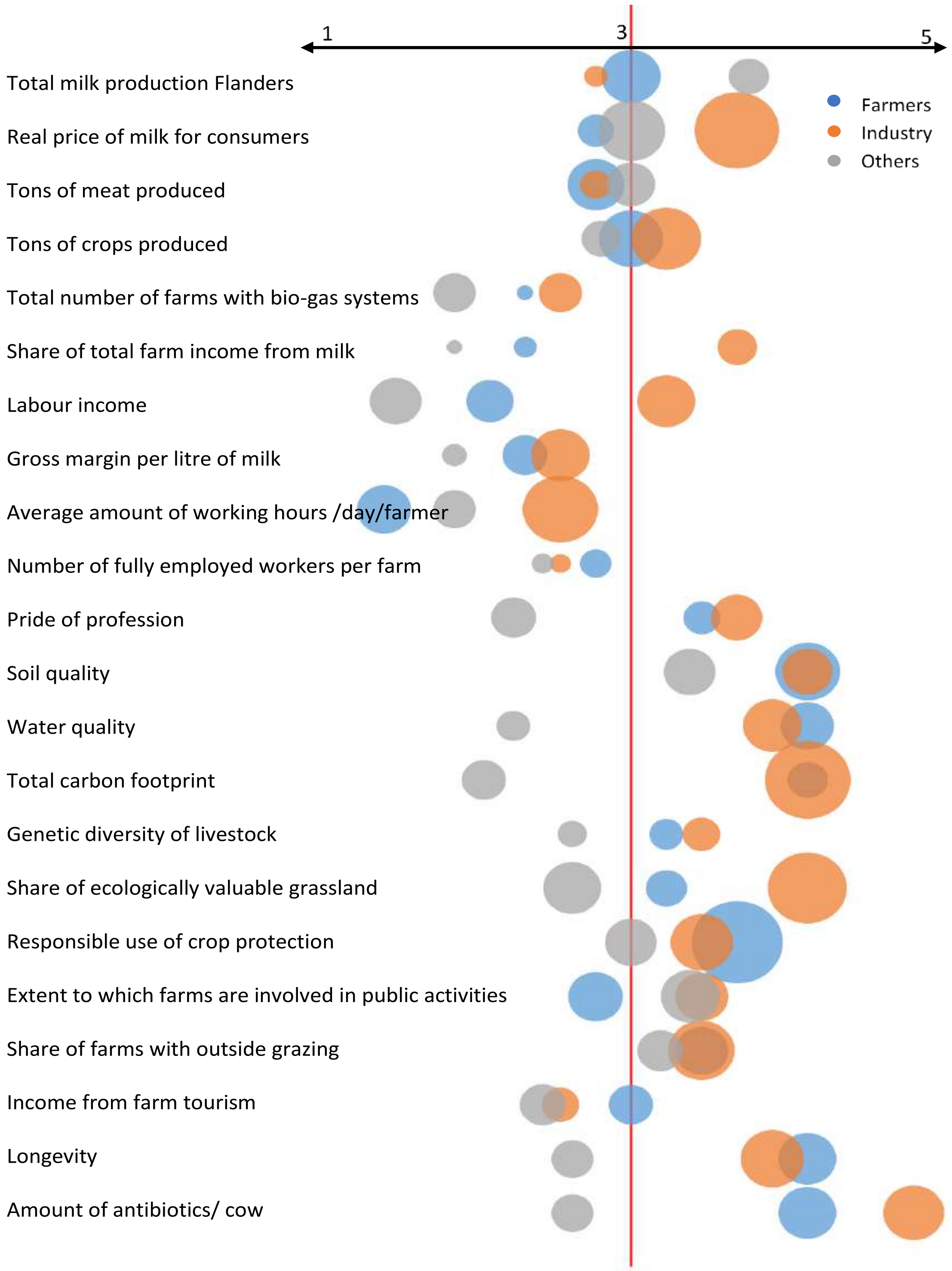

Figure A1. Importance and current performance as scored by each stakeholder group per indicator. The size of the bubble depicts the importance of the indicator and the placement along the x axis is determined by the current performance. The sizes of the bubbles are corrected for the importance of the functions and the different numbers of indicators per function.

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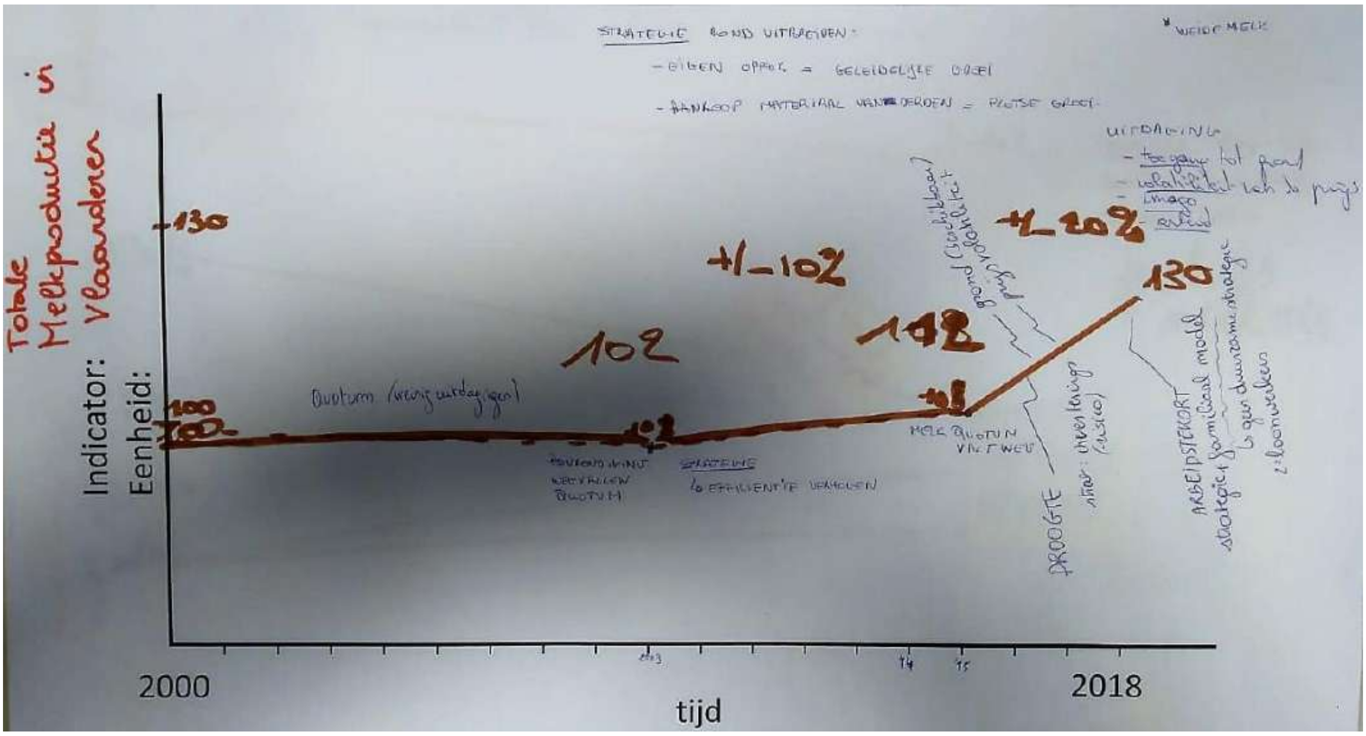
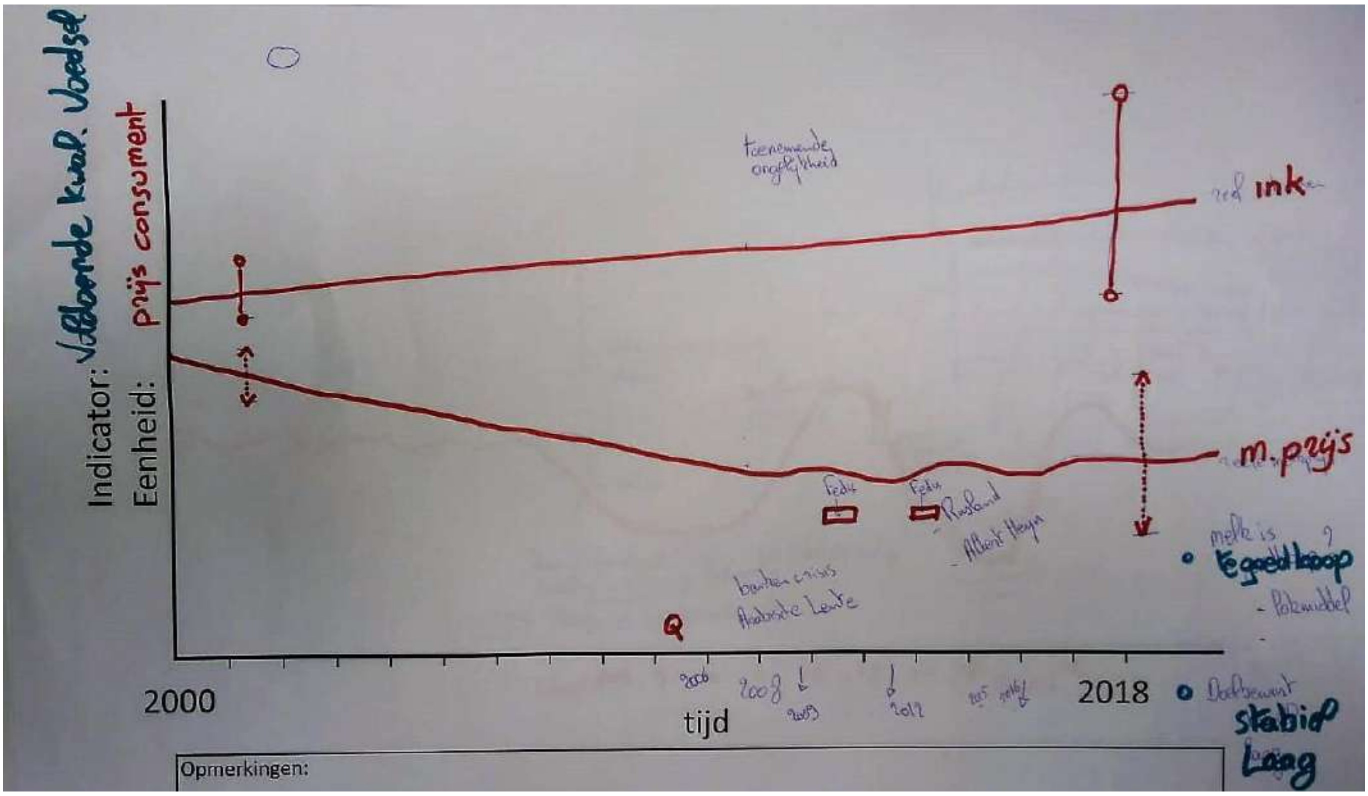
Appendix D. Dynamics of main indicators





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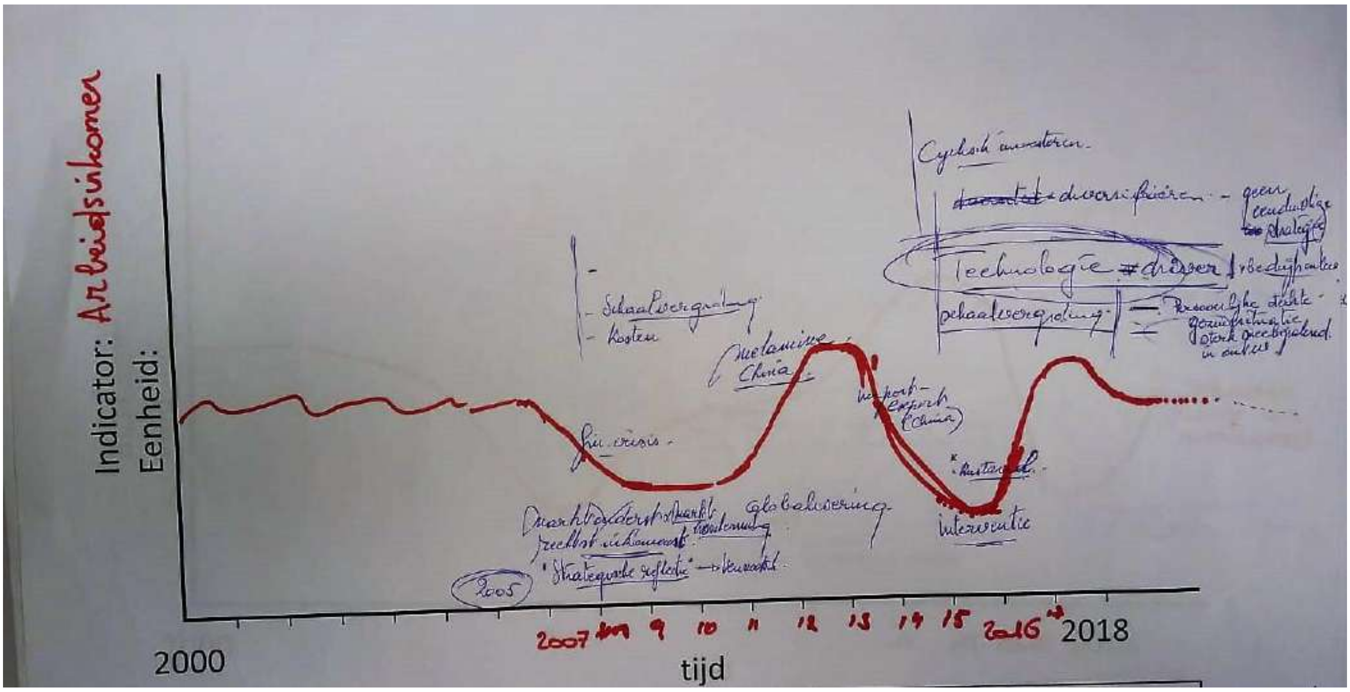
Indicator: Arbeidsinkomen
Eenheid:
2000
tijd
2018
Technologie = driver
Globalisering

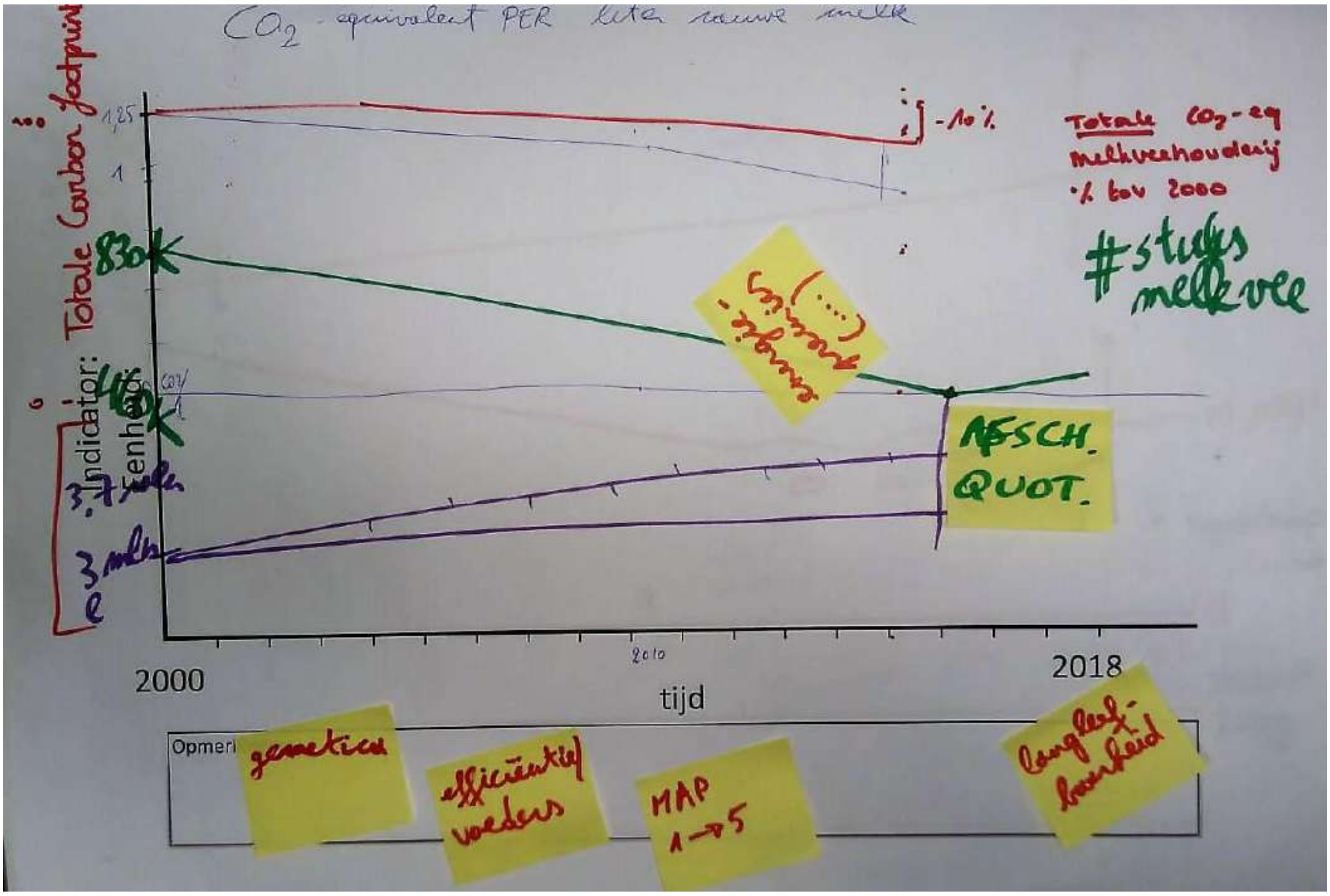
Indicator: Totale Carbon footprint
Eenheid
2000
tijd
2018
genetica
MAP 1→5
AFSCH. QUOT.
Opmer

Figure A (2-5). Photos of the sheets from the workshop.

A2: Total milk production. Workshop participants drew the line as an increasing trend. The total milk production according to them increased in two steps. Before 2013 there was still a quota, so milk production was stable. The first increase started in 2013. After the news of a quota release, the farmers started to invest in production. Each year farmers were allowed to produce a bit more until final relieve. The second step occurred upon the actual quota abolition. After this, milk production increased the most according to the participants. Alongside the line on the graph they named several factors that influenced the development of this indicator.

A3: For the real milk price the indicator group drew two lines. The upper line represents the average income of consumers of the last 20 years and the lower line represents the development of the milk price. The arrows on the lines represent the errors. The development of the real milk price changed according to the participants around 2008. From 2008 onwards, there were some distortions in the market which caused the price to increase, after a long historically decreasing trend. Causes of the distortions were written below the lines; bank crises, Arabic spring.

A4: Labour income was relatively stable until 2007 according to the indicator group that drew the line. From 2007 onwards there two clearly distinguishable peaks and lows for the labour income of farmers. The first low was caused by the financial crises. The first high was caused by the exploding demand from China, due to the melamine scandal, the second low was caused by a decreasing demand from China and the Russian ban on dairy. The cause for the second high was not identified by the indicator group.

A5: Carbon footprint. The line is drawn as a decreasing trend. Alongside the carbon footprint line, the participants drew a line for the number of cows in Flanders. The increased number of cows after 2013, according to the participants does not lead to an increase in carbon footprint.

Appendix E. details on scoring strategies and resilience attributes

Table A6. Mean (and standard deviation) of implementation scores of strategies. (n = 15)

Strategy	Level of implementation Mean	St. Dev.
More efficient feeding	2,50	0,92
Manure recycling/ circular agriculture	2,13	0,58
Production of green energy	2,38	0,85
Increase longevity	2,25	0,48
Genetical improvement	4,00	0,50
Real milk price	3,78	0,82
Fedis support	3,33	**1,09**
Milk powder stocks	4,00	0,58
Open for international market	4,00	**1,00**
Total milk production	3,20	**1,73**
Increase efficiency	4,25	**1,06**
Expansion of business (own rearing)	4,00	0,50
Expansion of business (buying cattle)	3,25	0,82
Broaden business	2,50	0,50
Futures exchange	2,00	0,58
Labour income	3,92	0,82
Intensification and scale enlargement	4,00	0,90
Cyclic investing	4,00	**1,00**
Investments of cooperatives	4,67	0,58
Maintain diversity of dairy farms	3,00	**1,00**

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Table A7. Mean (and standard deviation) of strategy's contribution to robustness, adaptability and transformability (10 highest results for standard deviation in bold). (n = 15)

	Robustness		Adaptability		Transformability	
Strategy	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
More efficient feeding	2,75	0,50	1,25	0,96	0,75	1,50
Manure recycling/ circular agriculture	1,75	**1,89**	1,50	1,00	0,50	**2,38**
Production of green energy	2,25	0,96	1,00	1,41	0,75	**2,22**
Increase longevity	2,00	1,41	0,25	**1,71**	0,00	**2,45**
Genetical improvement	2,00	1,41	0,50	**2,65**	-1,50	**1,73**
Fedis support	1,33	1,53	1,33	1,53	-1,67	1,53
Milk powder stocks	2,00	1,00	1,00	1,00	-1,33	1,53
Open for international market	3,00	0,00	0,67	1,15	0,00	**3,00**
Increase efficiency	2,50	0,58	1,25	0,50	-1,88	1,65
Expansion of business (own rearing)	2,25	0,50	1,25	0,96	-1,75	1,50
Expansion of business (buying cattle)	2,00	0,82	1,00	0,82	-1,75	1,50
Broaden business	1,25	1,50	2,00	0,82	0,25	1,50
Futures exchange	1,75	1,50	0,75	1,50	0,00	1,41
Intensification and scale enlargement	2,33	0,58	0,33	1,53	-1,33	**2,08**
Cyclic investing	2,33	0,58	1,33	0,58	0,33	**2,08**
Investments of cooperatives	2,67	0,58	2,00	1,00	0,67	1,15
Maintain diversity of dairy farms	2,00	0,00	2,00	1,00	2,00	1,00

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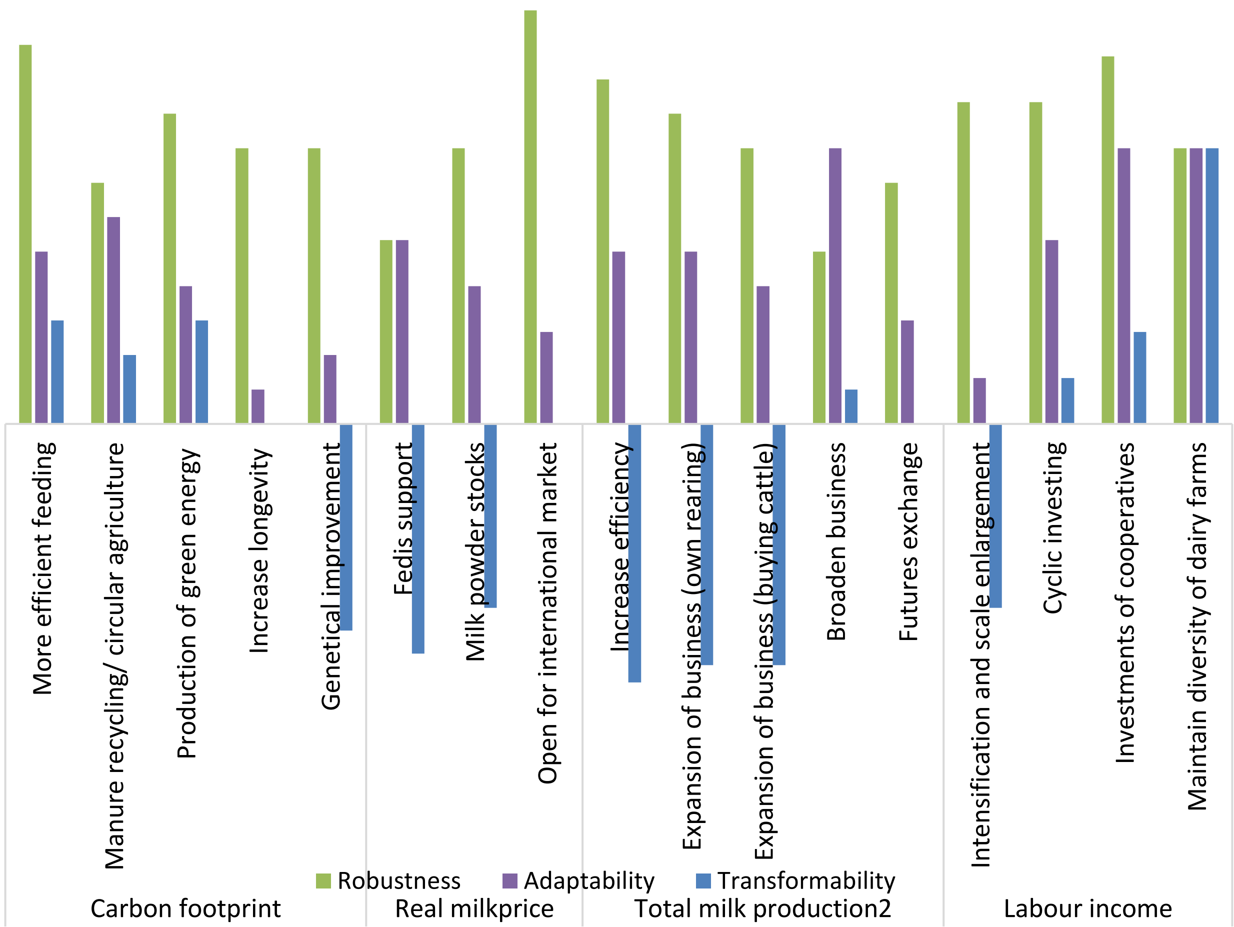

Figure A8. Bar graph presenting total positive and negative points allocated to a strategy's contribution to robustness, adaptability and transformability. (n = 15)

Table A9. Mean and standard deviation of performance scores of resilience attributes. Per stakeholder group and for all participants. (n = 15)

Resilience attributes	Farmer		Industry		Other		Total	
	Mean	**St.dev**	**Mean**	**St.dev**	**Mean**	**St.dev**	**Mean**	**St.dev**
Reasonably profitable	1,25	0,5	1,667	0,6	1,67	0,5	1,54	0,5
Coupled with local and natural capital (production)	3,75	1,0	3	0,0	2,5	1,0	3	1,0
Functional diversity	2	0,8	3	1,0	1,83	0,8	2,15	0,9
Response diversity	3	0,8	2,333	0,6	2,33	1,2	2,54	1,0
Exposed to disturbance	2,75	1,5	2,667	1,2	2,5	1,0	2,62	1,1
Spatial and temporal heterogeneity (farm types)	4	0,8	3	1,7	3,17	1,0	3,38	1,1
Optimally redundant (farms)	2,25	1,3	2,667	1,5	2,33	0,8	2,38	1,0
Supports rural life	3	0,8	3	1,0	3	0,6	3	0,7
Socially self-organised	3,75	0,5	3,333	2,1	2,5	0,5	3,08	1,1
Appropriately connected with actors outside the farming system	3,25	1,0	2,667	1,2	3,17	1,0	3,08	1,0
Infrastructure for innovation	3,5	0,6	3	1,0	2,67	1,0	3	0,9
Coupled with local and natural capital (legislation)	2,5	0,6	2,667	0,6	2,33	0,5	2,46	0,5
Diverse policies	2,5	1,3	2,333	0,6	1,83	0,8	2,15	0,9

Table A10. Mean and standard deviation of resilience attribute's contribution to robustness, adaptability and transformability. (n = 15)

	Robustness		Adaptability		Transformability	
	Mean	St.dev	Mean	St.dev	Mean	St.dev
Reasonably profitable	2,50	0,85	1,71	1,27	0,29	2,37
Coupled with local and natural capital (production)	2,21	0,89	1,71	1,14	0,77	1,88
Functional diversity	2,07	1,07	1,43	1,34	1,21	1,53
Response diversity	1,79	0,89	1,57	0,85	1,14	1,41
Exposed to disturbance	0,64	1,39	1,08	1,26	0,21	0,58
Spatial and temporal heterogeneity (farm types)	2,07	0,73	1,86	0,95	1,86	1,23
Optimally redundant (farms)	1,50	1,22	1,23	1,36	1,00	1,57
Supports rural life	0,93	1,14	0,79	1,25	0,86	1,41
Socially self-organised	1,64	1,15	1,36	1,15	0,86	1,46
Appropriately connected with actors outside the farming system	1,71	1,33	1,36	1,28	1,00	1,36
Infrastructure for innovation	1,71	1,27	1,86	1,23	1,79	1,42
Coupled with local and natural capital (legislation)	1,21	1,19	0,93	1,59	0,50	1,56
Diverse policies	1,50	1,51	1,36	1,82	1,14	1,96

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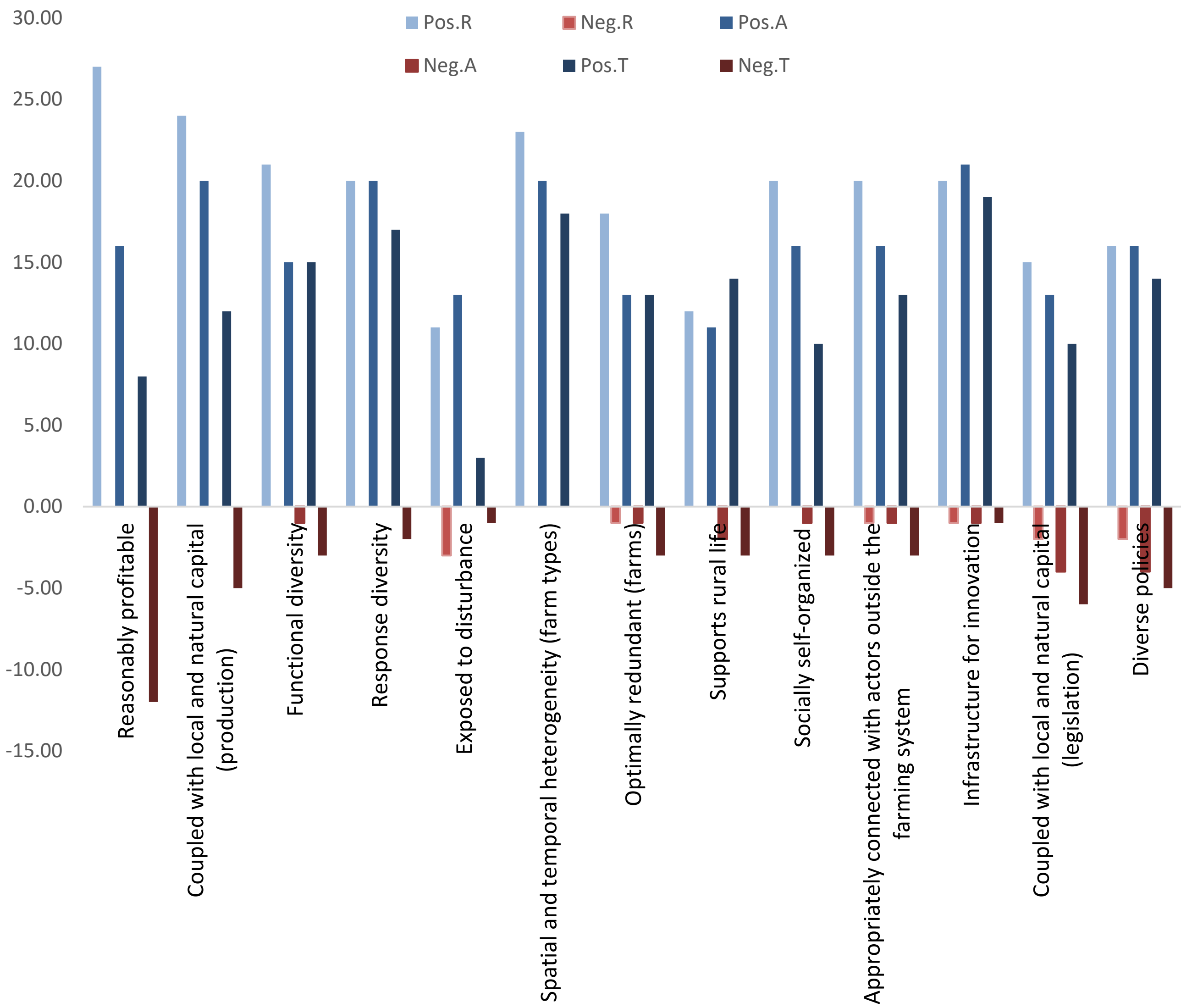

Figure A11. Bar graph presenting total positive and negative points allocated to a resilience attributes' contribution to robustness, adaptability and transformability. R= robustness, A= adaptability, T= transformability. Pos= total positive points and Neg= total negative points. (n = 15)

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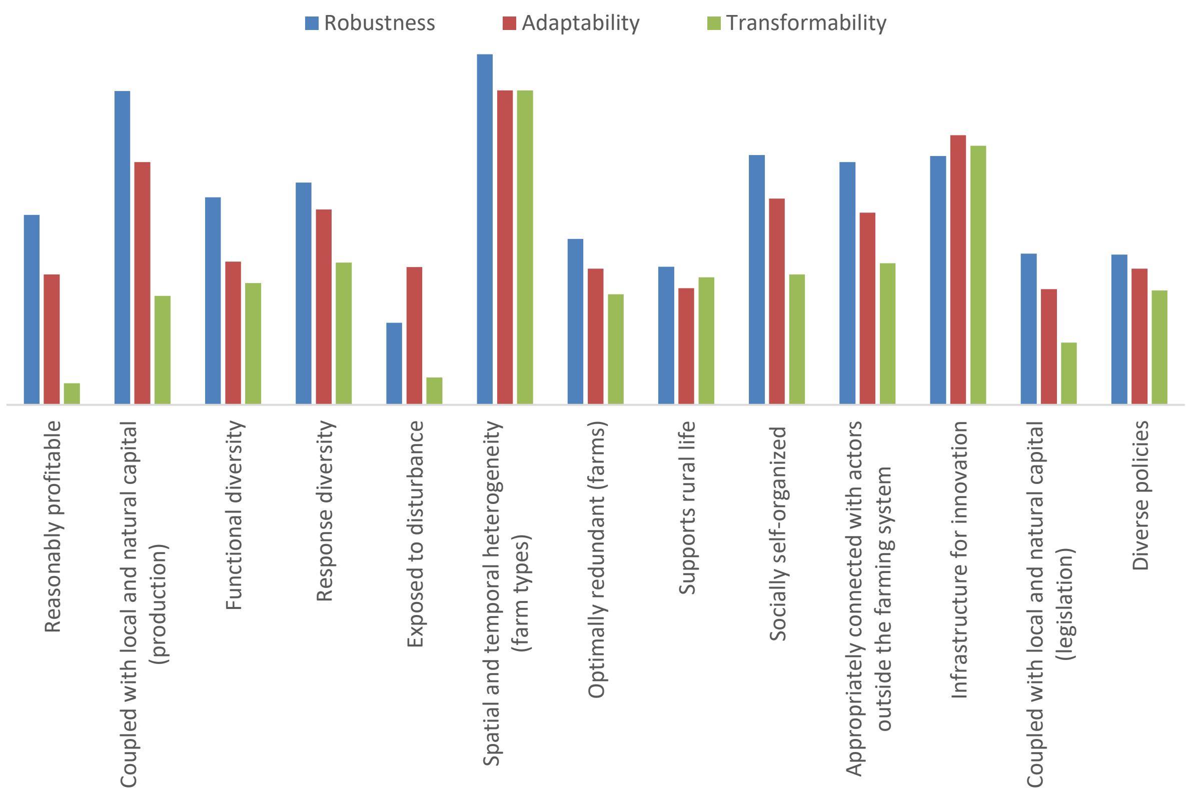

Figure A12. Bar graph presenting the multiplication of the current performance of the attributes with the contribution of the attributes towards resilience capacities. (n = 15)

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Appendix F. Further graphs

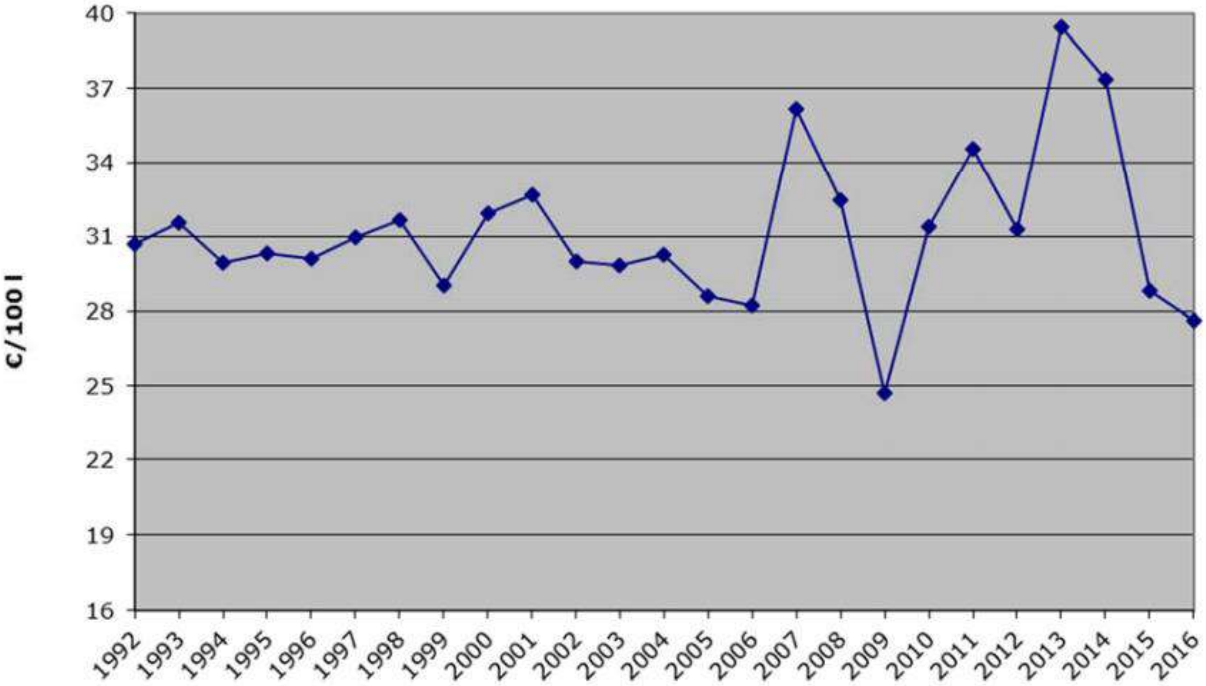

Figure A13. Development of the real milk price paid to dairy farmers in Flanders according to BCZ (2017).

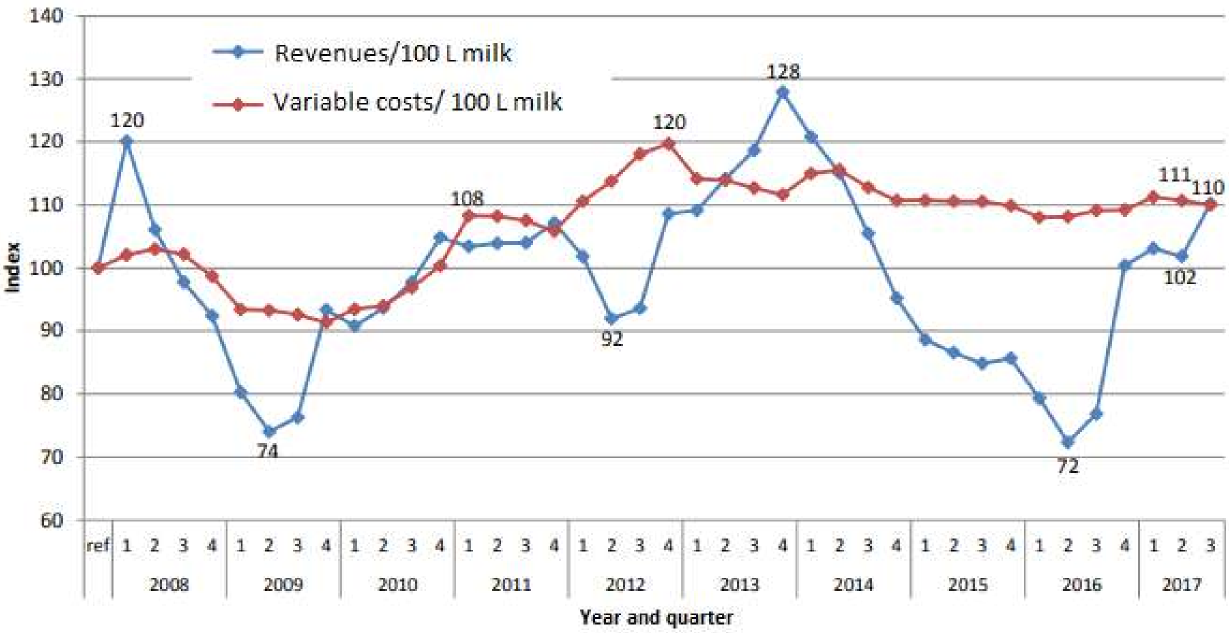

Figure A14. Development of revenues and variable costs. 2008=100. Source: Lenders & Deuninck, 2018.

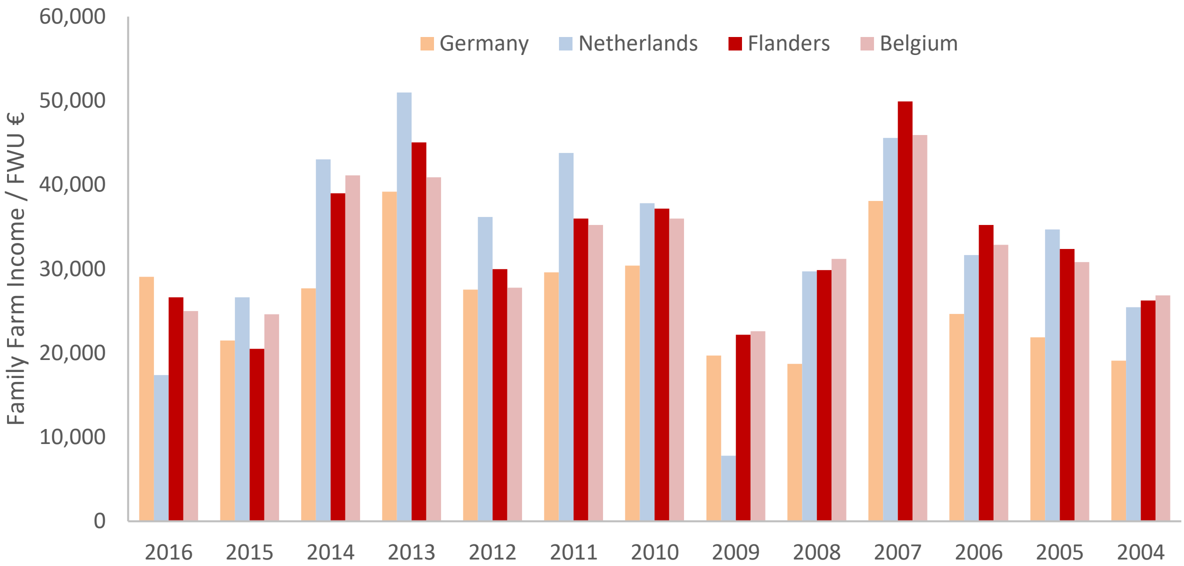

Figure A15. Family farm income of neighbouring countries and regions of Flanders. Source: FADN.

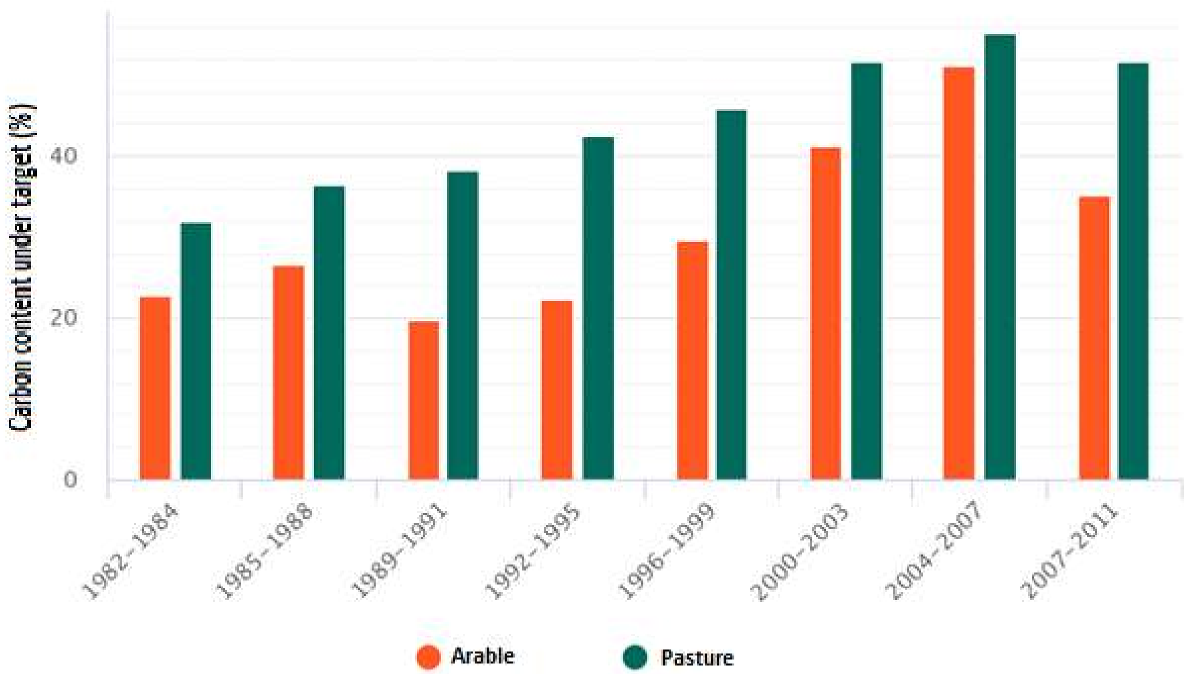

Figure A16. Percentage under target level of soil carbon contents in Flanders. Source: MIRA, 14

Appendix G. Workshop challenges and improvements

Overall the workshop went well, people seemed to enjoy the they and the participants were very active. A lot of interesting discussions arose due to the participative format of the workshop. The ability to show the participants the results, invited them to further think about the reasons for the different approaches of the stakeholder groups to the same issues.

A problem was the fact that it was hard to find enough participants and especially farmers. It took a lot of effort to find people willing and available to attend a workshop of a full day. During the workshop some minor problems were present. Firstly, it took a lot of time to insert the data from the questionnaires into the excel file. This resulted sometimes in a delay of the resulting graphs. This problem was partly solved by showing the participants a provisional version of the results before all data was entered and later there were two people entering the data. The exercise which was carried out in groups were by people draw the dynamics of an indicator caused a lot of confusion and as a result the different groups had a slightly different approach to this exercise. We arranged one FoPIA team member at each table, so they could help to guide the participants during the exercise. This proved to be helpful however, it was sometimes difficult to help guiding and at the same time not influence their input.

A bigger problem for the workshop was its length. Towards the end of the workshop, people were less participative. It was clearly visible that people lost interest in the last two exercises.

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