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FoPIA-Surefarm Case-study Report France

[Partner's No.8, INRA/French Livestock Institute]

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Abstract

The workshop FOPIA-SUREfarm for the French case study of the SURE-farm project took place on February 14th 2019 in Saint Gérand le Puy (Allier departement). A total of 26 participants took place in the workshop. They were part of the regional livestock chain: farmers/breeders, agricultural chamber, association (or NGO), producers' organisations, agricultural school, administration, research institute, press.

On average, the function receiving the highest importance (but also the highest variance about stakeholder groups) was "Food Production". A high importance was assigned also to "Economic Viability", "Quality of Life", "Natural Resources" and "Biodiversity and Habitat Quality". Also "Animal Health & Welfare" was considered important, but many participants did not consider it as a function but as a normal practice that should be applied. Different stakeholder groups assigned scores differently to functions. For example, members of "Cooperatives" preferred "Food Production" while members of "NGOs" preferred public functions. "Farmers", instead, assigned equal importance to all the functions.

By analyzing the perceived performances assigned to the indicators, we could compute the performance of the functions. The function performing the best was "Animal Health and Welfare", however we considered this a bias because of the remark already expressed (it is a practice and not a function). Other functions performing well were "Food Production" (with "Quantity of Beef Produced" as best performing indicator), "Natural Resources" (with a good performance of "Hectares of Natural Grassland", "Artificial Nitrogen Consumed", and "Management of Excretions"), and "Biodiversity and Habitat" (with "Length of Hedges" as best performing indicator). We consider the good performance of these three functions as a sign that the system is well coupled with local and natural capital. "Economic viability" was considered to perform not very well and at the same time it was considered and important function.

We considered four types of challenges: internal social challenge (e.g., quality of work and life), economic challenge (e.g., market prices increases), climatic challenge (e.g., droughts or floods), and external social challenge (e.g., changes in consumer expectations). The main strategies applied by the actors were the following: adopting practices that fulfill social expectations (external social challenge), improving slaughter conditions (external social challenge), developing farmers associations or groups (economic challenge), adopting practices to fight the excess of water (economic challenge). Concerning the relationship between the strategies and the three aspects of resilience (robustness, adaptability, and transformability), most of the

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strategies were found to have a positive impact on the three of them with some exception. The evolution of policies was considered potentially a good strategy to improve resilience, but also, at the same time, something potentially deleterious (if applied the wrong way). We found some trade-offs (i.e., strategies that could impact positively on a resilience aspect and negatively on another): developing grass fattening on the area can indeed transform the system (creating more workplaces, new know-how and practices) but can make the system more vulnerable (eroding robustness) to droughts. Strategies for coping with climatic challenges consist of long-term modifications of the system and for this reason they could enhance robustness but decrease adaptability and transformability.

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1 Introduction

1.1 Case-study

This workshop was conducted in the Bourbonnais region (coinciding more or less the department of Allier), located in Central part of France, and traditionally dominated by extensive beef production systems. The agricultural branch reaches 5.1 % of the workforce of the region (being 2.5 % the value at the national scale). About 10 000 people work in farms in the department of Allier. The beef sector is the main activity of the region (42%), followed by the crops (16%) and the goat/sheep production (12%). 483 000 ha are available for agricultural activities. There are 5,523 farms in Bourbonnais, among which 3,102 beef farms (200,000 cows Charolais breed), mainly specialized breeder system. The average total size of the beef farms is 88ha, which is quite big for the region. The number of farms decreased with 25 % between 2000 and 2010: -33% for dairy cows, -17% for beef farms, -52% for beef & dairy farms, -41% for the other herbivores, -42% for polyculture.

The region (which is part of the Bassin Charolais) traditionally sells the weanlings (male and female) to Italian butchers: 75,518 weanlings were sold in 2014. The females are finished (butchery). The farms located in crop areas also finish the males. Due to competition with Burgundy and Limousin (two regions that produce meat), lots of farms produce "off season": early calving (autumn) to sell the weanlings before the other region, which enables maintaining a higher price but involves higher production cost (concentrated feed).

A number of challenges and opportunities, both internal and external to the region, are present (see Table 1). The region benefits from a number of official labels (notably the "label rouge"): 1,472 farms produce under that label. Two slaughterhouses are certified for these labels and organic production. The direct sale is also increasing. The sanitary crisis of 2015 (FCO) weakened the Bourbonnais farms, with a closure of the markets (for example, the Turkish used to buy lots of weanlings at a very good price but stopped due to the FCO). More generally the market is unstable (e.g., fluctuation of prices, uncertainty of sales). The "bocage Bourbonnais" has been claimed as a sensitive natural region, thanks to its emblematic hedges that stock carbon. Some farmers got involved in a GHG emissions reduction program, supported by industrials like Mc Donald's. However two consecutive droughts in the past two years have endangered the financial situation of the farms that were already facing a low meat price.

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Table 1. SWOT analysis, i.e., identification of Strengths, Weaknesses, Opportunities and Threats (risks or challenges) for the Bourbonnais region

Internal STRENGHTS	**Internal WEAKNESSESS**
Existence of quality labels, with technical support and operators (slaughterhouse) Lots of farms with production "off season": early calving (autumn) to sell the weanlings before the other region, which enables maintaining a higher price but involves higher production cost (concentrated food) Beautiful natural environment, claimed as sensitive natural area, with conservation. "Postcard of France". Wood resources (heat, litter, animal welfare while outside) Family farming	Opening of the Turkish market: good strengths but dependent on sanitary constraints Concurrence with Burgundy and Limousin Decreasing of farms ; no taking over of the existing farms Over mechanization: higher production costs
External OPPORTUNITIES	**External THREATS**
CAP reform: label grasslands as natural sanctuaries Lots of grasslands with good amount of rain	CAP reform: authorization of grassland reversal Subject to drought: 2 consecutive years lately Less meat consumption, more social expectations about farming ; competition with "white" meat Possibility of diversification (laying hens, label poultry)

The main challenges faced by the region are of four types: social, economic, environmental, and institutional. Social challenges are mainly long term pressures related to the quality of life and work in the region (internal social challenges), and the social expectation from consumers (external social challenges). Internal social challenges are related to the fact that the Bourbonnais is mainly a rural region, human development index is average, but 15,5% of the inhabitants live below the poverty line. Incomes are lower than in the region (Auvergne) or in France, and unemployment rate is higher than in the region (11,1% vs 9,6%). Another internal social challenge is related to demography of farmers: indeed young people aspirations are less and less compatible with livestock farming. Considering external social challenges, the region has to face increasing social expectations related to red meat production, i.e., use of land, greenhouse gas emissions, sanitary aspects and animal welfare. Farmers in the region are more and more tempted to switch their animal production to cereal, less controversial and above all more remunerative. However, the Bourbonnais region remains a rural region and is a bit more protected from these attacks than livestock farms around big cities. In fact, its agriculture already reaches some of the social standards that are currently expressed: open-air farms, production itinerary, etc.

Economic challenges are also long term pressures, and are mainly related to low meat prices, economic difficulties for the farmers, few investments, higher environmental expectations

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translating into higher costs for the farmers. Institutional (and also economic) challenges are long term pressures related to an uncertainty about the CAP context.

Environmental challenges are both shocks and long-term pressures. Shocks are droughts and floods. However, we can consider as a long-term pressure the increased frequency of droughts in the last years. Long-term pressures are the irregular maintenance of hedges, ditches and banks and the fact that hedge rows are decreasing in some areas, endangering biodiversity. Overall, we remark that, despite evident challenges, the region has solid environmental strengths. Half of the department (whose surface is 503000ha) is always in grassland and livestock is mainly fed in pasture or hay. This gives a positive impact also on the aesthetics of the territory (hedges, grasslands, walls).

1.2 Workshop details

The workshop took place on February 14th 2019 in Saint Gérand le Puy (Allier departement). The Conservatory of natural areas of the Allier co-organised the workshop with the French Livestock Institute.

A total of 26 participants took place to the workshop, all of them attending from the beginning to the end. Participants were part of the regional livestock chain: farmers/breeders, agricultural chamber, association (or NGO), producers' organisations, agricultural school, administration, research institute, press. Slaughterhouses and local municipalities were invited but did not come (see details in Appendix A).

Participants were divided into four groups of 6 to 8, each group being invited to sit around a table with a workshop facilitator. Activity S1 was done individually by each participant. Concerning activity S2, each group was assigned two essential functions and discussed collectively the indicators. After that there was a plenary discussion about the indicators from each group. Activity S3 on indicator performance was done collectively within each group. The groups were heterogeneous in terms of the profiles of the participants, this assured that different points of view were considered in the collective discussions. Grouping the participants for activities S2 and S3 (though deviating for the FoPIA guidelines) was considered necessary because we managed to invite participants to the workshop through the angle of exchanges with other stakeholders. Due to the limited time, we chose to focus on exchanges between participants instead of having them completing individual surveys.

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1.3 Farming system

The farming system was already discussed in the framework of another research project with the same type of actors. Consequently we decided not to treat this part during the workshop. The general figure of farming system provided by the SURE FARM project (Meuwissen et al., 2018) is in the line with the actual Bourbonnais farming systems. However, a few actors specific to Bourbonnais had to be added.

The farming system is composed of (see Figure 1) the following elements:

- The farms of the territory (number, size, density, orientation, number of people working, type of products etc.)
- The operators that provide inputs to the farms (feed companies, machinery, etc.)
- The buyers of the products: slaughterhouses, producers organisations
    - Producers' organisations provide advice to the farmers. They also organise the selling of the products. Bourbonnais farms benefit from a high density of producers' organisations.
    - Slaughterhouses are often connected to producers' organisations.

Among the first circle, Bourbonnais' specifications are as follows:

- Most of Bourbonnais's farms are producing weanlings that are sold to Italy. Hence the farms are much dependent on international markets and sanitary controls.
- Bourbonnais farms are quite self-sufficient in feed, with a large amount of grass in the ration, but with the droughts this characteristic is fluctuating.

Among the second circle, farmers have on the one hand to count more and more with NGO expectations about meat consumption. On the other hand they can count on an extensive production system that suits to social expectations.

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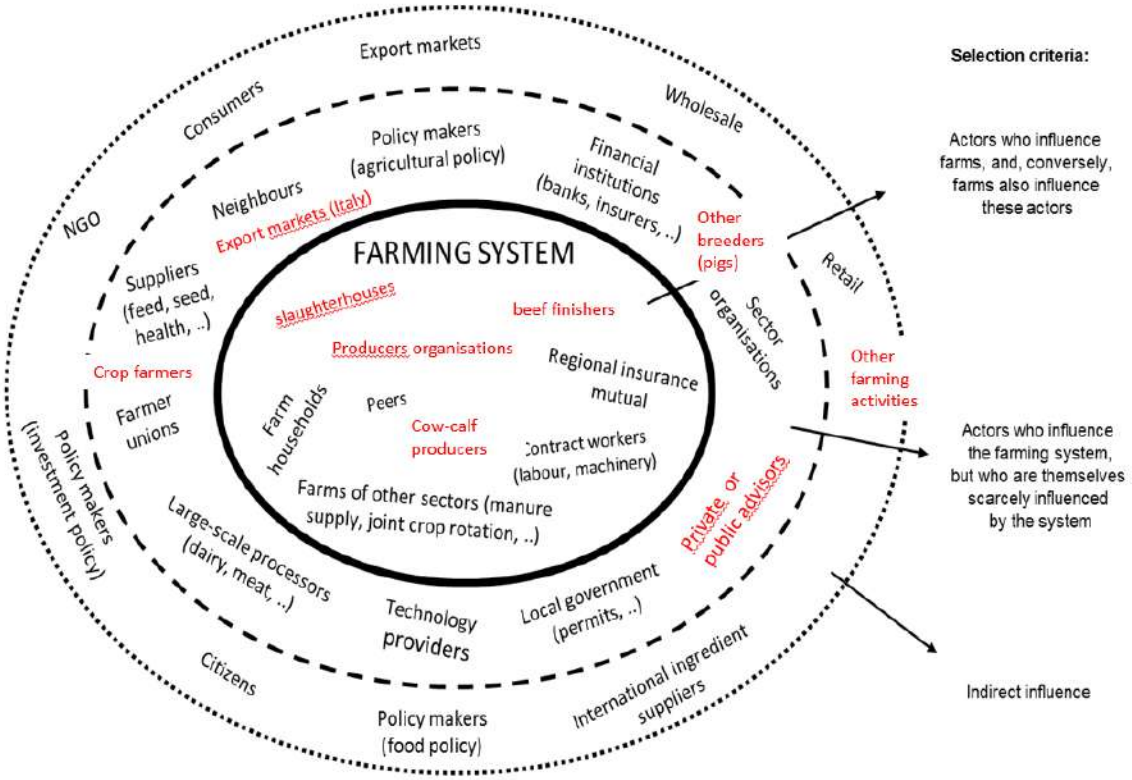

Figure 1. Farming system visualization. Actors in black font are also in the original example of the SURE-Farm framework (Meuwissen et al., 2018), actors in red font are specific to Bourbonnais.

2 Functions

As required by the guidelines, each participant individually allocated 100 points, according to the perceived importance, to the different farming system functions: "Food production", "Bio-based resources", "Economic viability", "Quality of life", "Natural resources", "Biodiversity and habitat", "Attractiveness of the area", "Animal health & welfare", being the first four private goods, and the last four public goods. Results are presented in Figure 2 (aggregated per stakeholder group) and more in detail (mean values and standard deviation in total and per stakeholder group in Appendix B). On average, the essential function that was assigned the highest importance was "Food production", which is indeed the main vocation of the territory (beef production). However, this function was also the one having the highest standard deviation among the different participants, having participants (especially among members of NGOs) that assigned very low importance. The lowest importance was assigned to "Bio-Based Resources", with also the lowest standard deviation among stakeholder groups. Indeed the

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territory is highly specialized on beef production and not much effort is dedicated on bio-based resources. What falls in the category of "Bio-based resources" are mainly the hedges valorisation (wood for litter or heating) that is increasing a lot in the area. The co-products of beef production (wood, litter, slurry or electricity production) are related to the principal function "Food production". In fact, all the indicators chosen (see next section) are related to co-products.

Relatively high importance was assigned to "Economic viability", "Quality of life" "Natural Resources" and "Biodiversity and habitat". This shows that people care about their quality of life to be in equilibrium with the conservation of natural resources. "Attractiveness of the area" doesn't seem to be of high importance to people (only *NGO* participants assigned a relatively high score). This implies that tourism and attractiveness are not seen as a priority as much as the self-sufficiency and the quality of life of people living in the area itself. Indeed tourism is not highly developed in the area despite a potential for green tourism. "Animal Health and Welfare" was not assigned a very high priority, however, it has to be said that some participants were not convinced that "Animal health and welfare" is a function (as remarked in comments left on the forms filled and discussed in plenary), but rather the basis of every farmer's job and should consequently be more generally included in farming practices. Overall, what emerges is a picture that gives a balanced importance to private and public goods, with a clear preference to food production over non-food production (reflecting the homogeneity of the territory). The picture also shows a balanced importance to economic viability and quality of life, as well as to the natural resources and biodiversity (reflecting a preference for autonomy and care about the territory in both environmental and social aspects).

Farmers were the most balanced in giving the importance to all the functions. It is to be noted that, with *Territorial Authorities*, they were the most sensitive to "Animal health and welfare". The scores assigned by *Farmers* were the most equilibrated between private and public functions. *Cooperatives* were clearly oriented to "Food production" (although having a very high standard deviation within the stakeholder group itself) and to private functions over public functions. On the contrary, *NGOs* were mostly oriented to public functions over private functions, being the ones assigning the least importance to "Food production". *Territorial Authorities* assigned higher importance to "Food production" but also to "Economic viability" and "Quality of life", and, among the public functions, to "Animal health and welfare".

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Discussion went well, people are used to speak about the different functions of farming, since some recent projects have dealt with this topic.

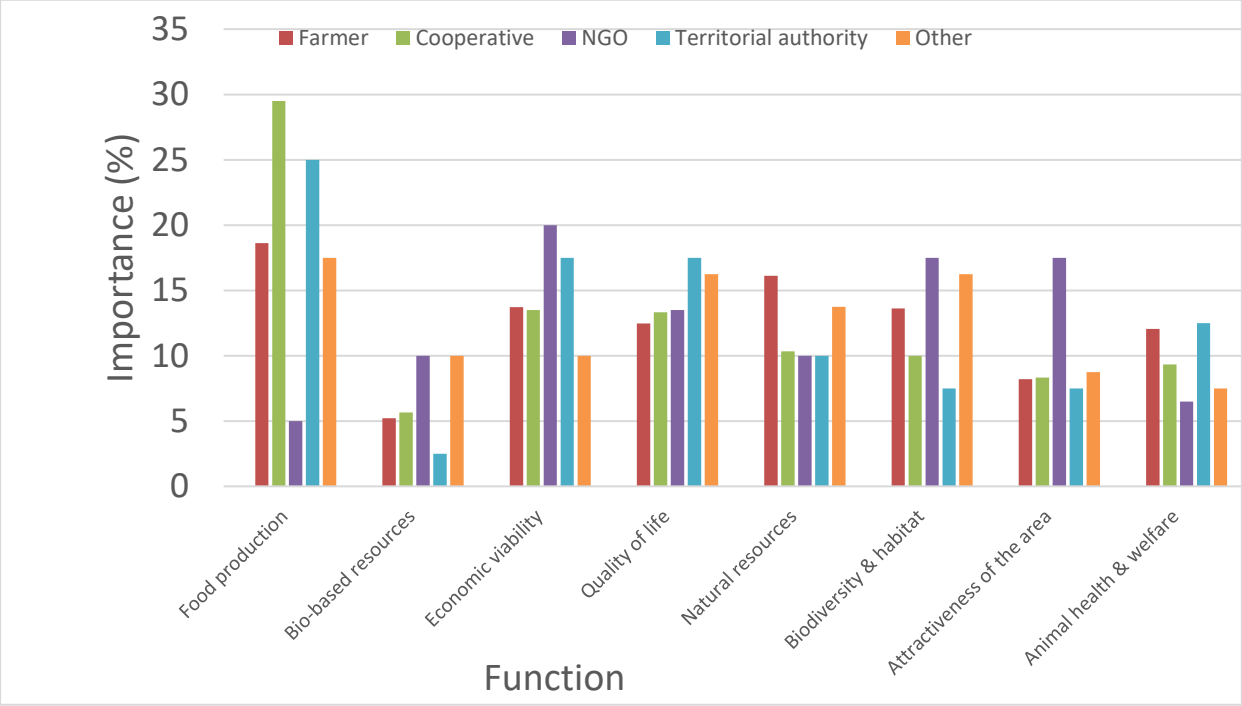

Figure 2. Bar graph with scoring per function, aggregated by stakeholder group. 100 points needed to be divided over 8 functions.

3 Indicators of functions

3.1 Indicator importance

Each of the four groups was assigned two essential functions and participants in groups discussed the relevant indicators. This deviates from the guidelines, however we considered it necessary because stakeholders were very much more willing to engage in group discussions rather than answering to individual (and impersonal) surveys. This kept their interest to the workshop higher, as exchanges of opinions and points of view from other stakeholders were enriching for them. In order to speed up the process (that was already taking longer than expected), we decided to assign two functions per group. The chosen indicators were then presented and discussed in a plenary session. There were very lively discussions both within the groups and also in the plenary sessions. We provided to the participants a set of indicators. Some of them were accepted, some were rejected, and the participants proposed also new indicators (Table 2). For the following analyses we only considered those accepted and the new ones proposed by the participants. It is to be noted that participants proposed the indicators of

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"Food self-sufficiency" and "Added value on the territory per hectare", reflecting the importance they give to the sense of self-sufficiency and identity of the territory.

The assignment of the importance of the indicators within each function was done group by group, following the same reasons provided for the indicator selections. Each group was assigned two functions and got to a collective decision about the importance of the different indicators. However, some participant accepted to fill the indicator importance form individually. Some focused only on some functions returning the form only partially filled. We present the outcomes in two steps: (i) the importance of the indicators (one value per indicator, with no standard deviation) assigned within each group via collective discussion, and (ii) the importance of the indicators assigned individually divided by classes of stakeholders, keeping in mind that not all participants filled the form and not all people filled all the functions.

Within the "Food production" function, the qualitative aspect "Fraction of beef produced under label and taste quality and regularity of beef" is preferred over the merely quantitative aspect "Total quantity of beef produced". It is to be noted that a relatively high importance is assigned to "Food self-sufficiency". The indicators preferred for the "Food production" function denote that beef production is part of the sense of identity of the territory and not seen as something to maximize for selling. Within the "Economic viability" function, the revenue is by far perceived as the most important indicator. Within the "Quality of life" function the most important aspect is related to the amount of workplaces created ("Number of people working on the exploitations"). Within the "Natural resources" function, grassland is by far assigned the highest importance. Indeed grassland is the main land cover in the study area and is indeed able to provide the double benefit of sustaining grazing livestock and promote biodiversity and carbon sequestration. Within the "Biodiversity and habitat quality" function the highest priorities are assigned to *species number* and the "Length of hedges". The indicator related to agroforestry is probably perceived less important as that is a relatively recent practice in the Bourbonnais and because the others indicators are emblematic to the region (hedges and grasslands). In the "Attractiveness of the area" function the number of visitors per se is not perceived as important as the indicators related to direct selling and to the number of villages with commercial activities. Within animal welfare the more important indicator is considered to be the fraction of the lifespan of animal spent grazing. The Bourbonnais region benefits from a high surface of grasslands, hence most of the animals spend lots of time outside (weanlings and females mainly). Indeed the territory is specialized in raising calves on grassland before fattening. Some farmers are also trying to finish the fattening on grass. Thanks to the natural qualities of the area, farmers do not have too many troubles to fulfil the existing welfare schemes.

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Table 2. List of indicators per function. The column "Participant reaction" informs whether the indicator was accepted as proposed (ACC), added as a new indicator (ADD) or rejected the way it was proposed (REJ)

Function (and numbering)	Indicator	Participant reaction
1. Deliver healthy and affordable food products	Total quantity of produced beef [tons]	ACC
	Food self-sufficiency [quantity of food bought]	ADD
	Taste quality and regularity of beef [marbling of the meat, tenderness]	ACC
	Fraction of beef produced under quality label [% of total number of tons produced]	ACC
	Health quality of beef [number of negative sanitary results]	REJ
2. Deliver other bio-based resources for the processing sector	Total quantity of co-products produced and delivered [m3 of wood produced]	ACC
	Number of beneficiaries of co-products [number of people]	ACC
	Sustainable management of co-products [m2 of solar panels]	ADD
	Number of co-products used or valorised	ADD
3. Ensure economic viability	Meat cost "from farm to fork" [€/kg]	ACC
	Revenue per FTE [€/FTE]	ACC
	Beef price (for the consumer) [€/kg]	ACC
	Added value on the territory per hectare [€/ha]	ADD
	Gross agricultural production [tons]	REJ
4. Improve quality of life in farming areas by providing employment and offering decent working conditions	Number of people working on the exploitation [/]	ACC
	Work productivity [kg/worker]	REJ
	Number of weekends and days off [/]	ACC
	Number of accidents [/]	ACC
	Revenue per FTE [€/FTE]	ADD
	Number of farmers active in representative functions [/]	REJ
5. Maintain natural resources in good conditions	Hectares of permanent grassland [ha]	ACC
	Artificial nitrogen consumed [kg/ha]	ACC
	Fuel consumed [L]	ACC
	Management of slurry [storing units adapted to slurry production, no flows on the farm]	ACC
6. Protect biodiversity of habitats, genes, and species	Number of species (animal and vegetal) [/]	ACC
	Hectares under environmental contract [ha]	ACC
	Length of hedges [km]	ACC
	Agroforestry [surfaces dedicated to it, number of trees]	ACC
7. Ensure that rural areas are attractive places for residence and tourism	Number of tourists visiting the area [/]	ACC
	Number of tourists infrastructures [hotels, campsite…]	REJ
	Number of exploitations proposing direct selling	ACC
	Number of villages with a commercial activities and a school	ACC
8. Ensure animal health and welfare	Number of farms following an animal welfare scheme	ACC
	Fraction of grazing on the total animal lifespan [% of days]	ACC

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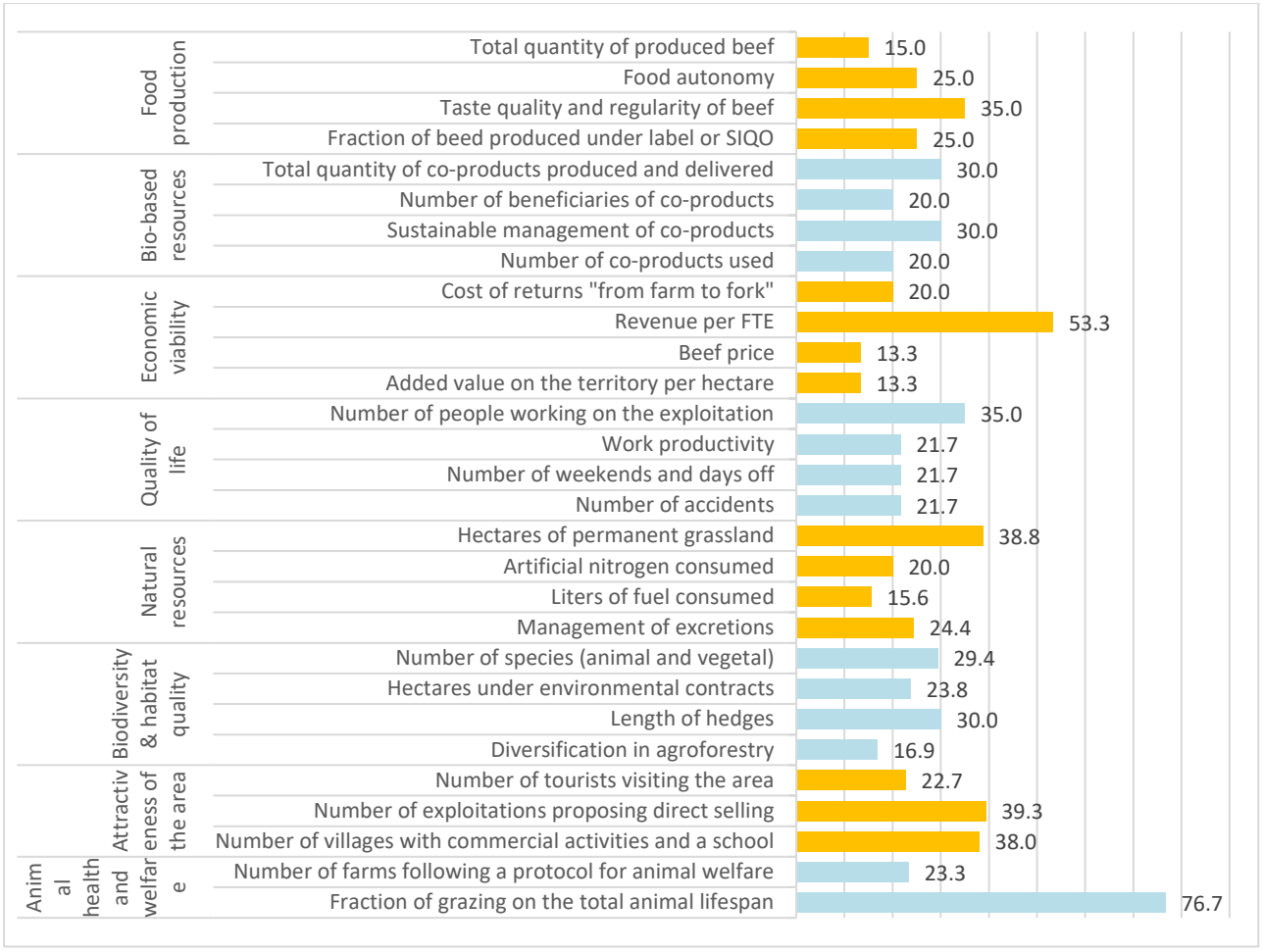

Figure 3. Bar graph with scoring of importance per indicator. Per function, 100 points were divided over the indicators.

In the analysis of the individual assignments of importance by participants not much can be said about private functions. The forms returned were filled mostly on the indicators related to public functions. No participant belonging to the category *Territorial Authority* filled the form. Within the "Quality of life" function, farmers assigned less importance to "Number of weekends and days off" and more to "Number of people working on the exploitations". For cooperatives indicators were all equivalent, except for a lower importance given to "Number of accidents". Within the "Natural resources" function the hectares of grassland is perceived as the most important indicator. Other than that, farmers were also sensitive to artificial nitrogen and fuel consumed, whereas *NGOs* and *Cooperatives* were sensitive to the management of slurry. Within biodiversity, the hectares under environmental contracts were clearly preferred by associations and this is in contrast with the other people categories that were mostly focused on the indicators related to hedges and animal species. This can be explained by the fact that environmental contracts are often seen as a constraint by farmers (and indirectly by their

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advisors) whereas associations value the existence of these contracts as an obligation and a proof of good practices. Concerning the "Attractiveness of the area" and the "Animal health and welfare", the preferences expressed by all the categories were in line with the outcomes of the collective discussions.

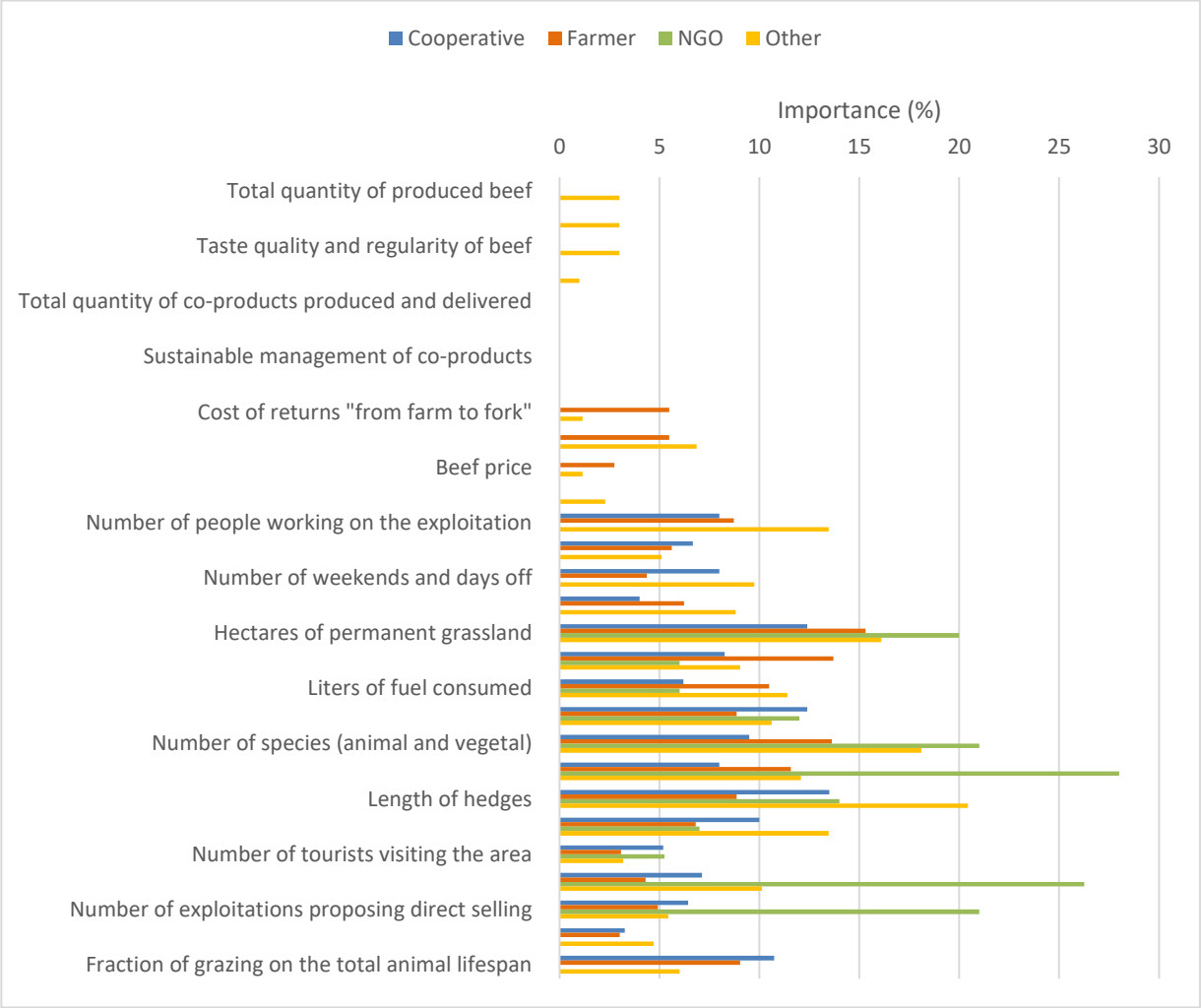

Figure 4. Bar graph with scoring of importance per indicator, aggregated by stakeholder group. Per function, 100 points were divided over the indicators. Values are transformed to include the importance and number of indicators of the function that the indicator. Indicators related to private goods in the top of the graph were often not scoredoutcomes of the collective discussions.

3.2 Indicator performance

The indicator performance was assessed via collective discussion within groups, for the same reasons as expressed before. Each group was assigned two functions and discussed the perceived performance of the indicators collectively. Thus, for each indicator one performance value was assigned and the statistics referred to the stakeholder groups could not be

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performed. Among the indicators, two of them had a reversed scale, meaning that higher values of them represented worse situations for the system. The participants assigned a score *x* according to the real meaning of the indicator, however, for homogeneity with the other indicators (not in a reversed scale), we transformed the score into 6 – *x*. These indicators are "Artificial nitrogen consumed" , "Liters of fuel consumed" and "Number of accidents".

Performance of each indicator in Bourbonnais was evaluated in groups, hence we only have on value per indicator and cannot build the graph with scoring of performance of indicators. We had to make this choice regarding the lack of time and essentially because people accepted to take part to the meeting in order to exchange with other participants.

We represented the perceived performances of the indicators in the Bourbonnais in Figure 5, where the y-axis represents the performance and the size of the bubble represents the perceived importance of the indicator (see 3.1). The indicators receiving maximum score were "Total quantity of beef produced", receiving the maximum score without hesitation nor disagreement from the participants, "Length of hedges", and "Fraction of grazing on the total animal lifespan", being these last two an important characteristic of the extensive beef systems in the study region. The only indicator performing the minimum score was "Total quantity of co-products", reflecting the poor quantity of agricultural production beyond beef.

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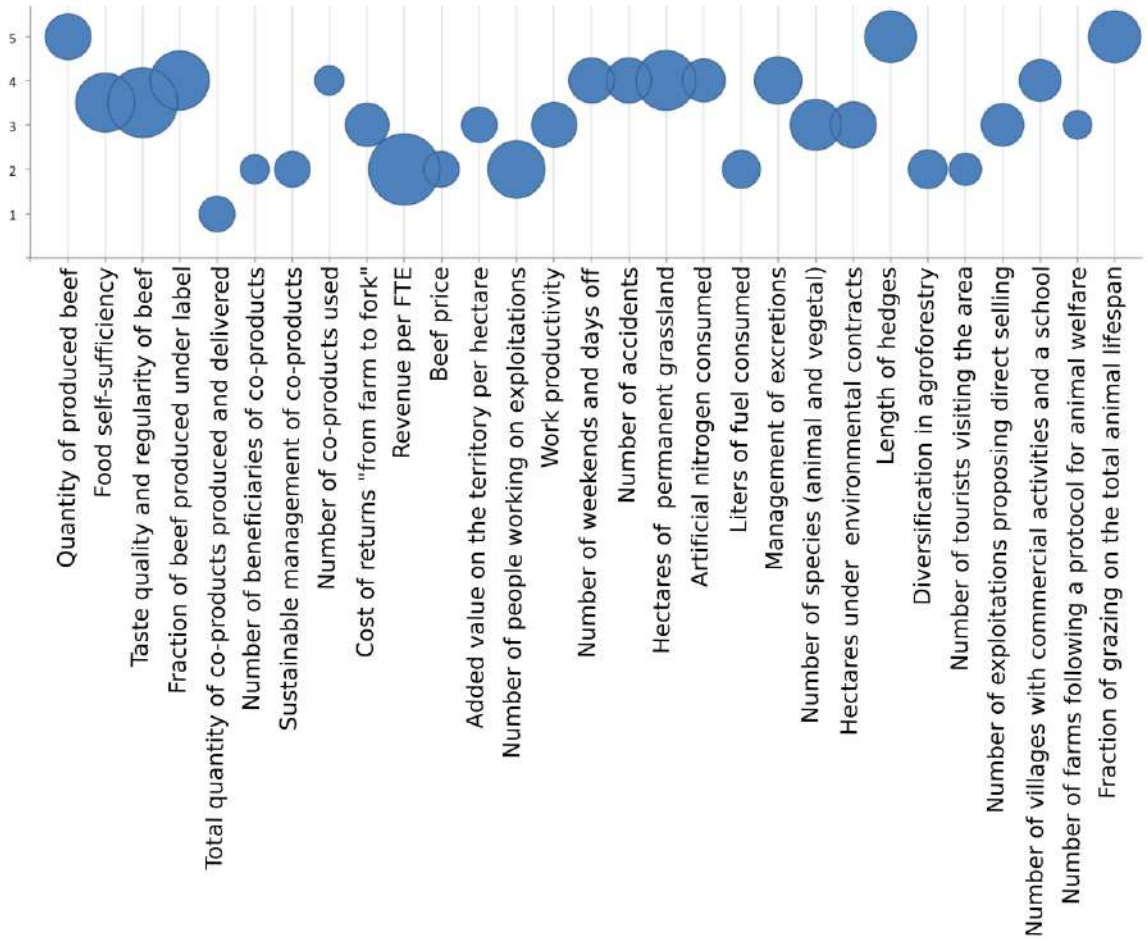

Figure 5. Bubble graph presenting scores on performance of indicators (from 1 to 5), while also indicating their importance (size of the bubbles), relative to each other.

Once the performance and the relative importance (within each function) was available, we calculated the perceived performance Y of each essential function in the Bourbonnais. This was computed with a weighted average:

$$Y_i = \sum_{j=1}^{n_i} y_{j,i} \cdot \frac{\omega_{j,i}}{100}$$

Where $Y_i$is the perceived performance of the function *i,* $y_{j,i}$is the perceived performance of the indicator *j* within function *i,* n_i is the number of indicators within function *i* and $\omega_{j,i}$ is the relative importance assigned to indicator *j* within function *i*. The performances of the functions, are represented in the bubble graph in Figure 6, where the size of the bubble represents the

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perceived importance of the function. The perceived importance of the function was considered as the average importance assigned by all the stakeholders, without dividing into stakeholder types, we could not proceed stakeholder by stakeholder as the indicator performances and importance were assigned collectively.

The function performing better was "Animal health and welfare", however, we remark that this was not really perceived by most of the participants as a function, but as a normal part of the practices and an obvious outcome of the type of husbandry carried on in the study area (it is indeed normal to expect that the animals spend a high fraction of their life time on pasture). Apart from that, the function performing better, according to the scores assigned, was considered "Food production", which is the main vocation of the territory and assigned high importance, along with "Natural Resources" and "Biodiversity and habitat", still considered important. This shows how the stakeholders perceive their agricultural practices as coupled with the natural capital and in with positive outcome on environment. The function performing the worst, but also the one assigned the least importance, was "Bio-based Resources" as not much is produced beyond beef. Apart from that function, "Economic viability" was assigned to perform poorly compared to other functions, but was considered quite important.

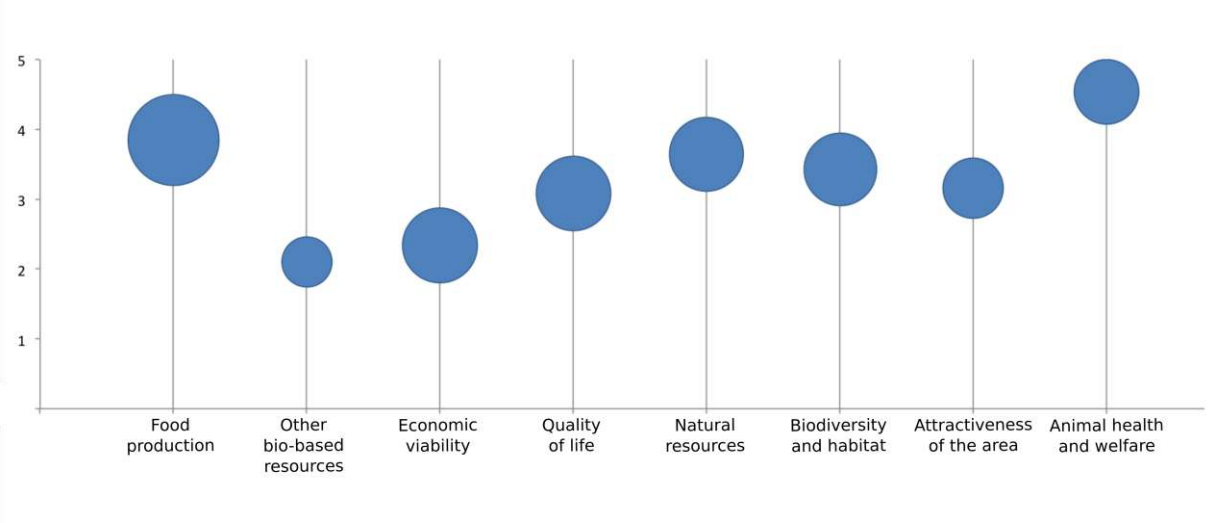

Figure 6. Bubble graph presenting averaged scores on performance of functions (from 1 to 5), while also indicating their importance (size of the bubbles), relative to each other.

3.3 Indicator selection

Based on the importance assigned to functions we can say that indicators related to "Food production" are the most important. Within those, highest relative importance is assigned to

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autonomy and quality (taste and regularity of beef). Other essential functions considered important were "Economic viability", "Quality of life", "Natural resources", "Biodiversity and habitat quality", for which the main indicators are "Beef price", "Revenue per FTE", "Number of people working on a exploitation", "Hectares of permanent grassland and Length of hedges" (or "Number of species"), respectively.

4 Resilience of indicators

We adapted this part to our time constraints and did not do this exercise in group. Instead we decided to use two relevant indicators (according to the previous exercises of functions and indicators) that had already been described in the literature in studies based on farm data from the area [source: Inosys – Réseaux d'élevage]. We represented the "Production costs" ("Cost of returns "from farm to fork") and the "Revenue per FTE". The two indicators selected were presented and discussed in a plenary session. First all challenges related to the indicators were discussed.

For the past 10 years, hazards of all kinds have been linked together.

The period 2007/2015 was a period of major uncertainties:

- The most important and most impacting for farms was undoubtedly the highly increasing prices of raw materials and energy in 2007 and 2008. This "price surge" implied an increase in costs of +18% for food (cereals and soya) and +30% for fuel and was reinforced by a continuous increase in fixed costs. This event was particularly memorable because it marks the beginning of a period of disruptions on commodity prices in the face of the growing global food demand.
- Right after the prices surges, cattle farms faced a first outbreak of sheep catarrhal fever causing delayed disorders on the reproduction of herds but even more directly from market disruptions due to retention of unvaccinated animals.
- The 2009 dairy crisis also left its mark on these beef farmers, the influx of milk reforms leading to variations in meat prices, while the economic situation of the cereals was also highly volatile, increasing food price volatility (2010 and 2015).
- In terms of climate, the period is not marked by a memorable calamity, but rather by several events randomly affecting the area. In 2010 and 2011, episodes of drought have made it difficult to manage animals on grass and to harvest winter stocks. In some good years reserves were built up, but the recurrence of these unforeseen and intense events

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has resulted in an overall decrease in autonomy of providing own food and protein. 2017 and 2018 have also been impacted by severe droughts during summer and autumn.

- Finally, the 2014 CAP reform and the convergence of supplies have had a particular impact on the beef cattle farms. The conversion of support to the second pillar, oriented towards more extensive management, has benefited to grassland breeder systems. However, aid fell overall over the period (-6% for beef and veal).

4.1 Indicator 1 – production cost

Production costs are directly linked to "Beef price" and "cost of returns from farm to fork", hence we chose this indicator that illustrates well the evolution of beef prices. As a result of the high price volatility of income and expenses, the incomes of breeders are highly variable from one year to the next. Also between holdings of the same type, income is variable. However, farms with good income maintain their income over a long period. They even reach up to consistently 2.5 times the income level of the lower third of farms.

This is a sign that beyond the crises, the farms with higher incomes are more able to cope and to benefit from favourable economic conditions. One of the explanations lies in their ability to contain their expenses as illustrated by Figure 7. The so-called resilient farms maintain a relatively low level of costs of production, despite the rise in prices of the costs of the soybean price and energy. As a result, these farms are a little more effective, i.e. they produce more gross surplus of operation for the same product and the production is also more stable over time. On the other hand, the lower third of farms have higher production costs and are more affected by rising input prices as in 2012 and 2013. There is no evidence of specific problems or unpredictable effects affecting these producers more.

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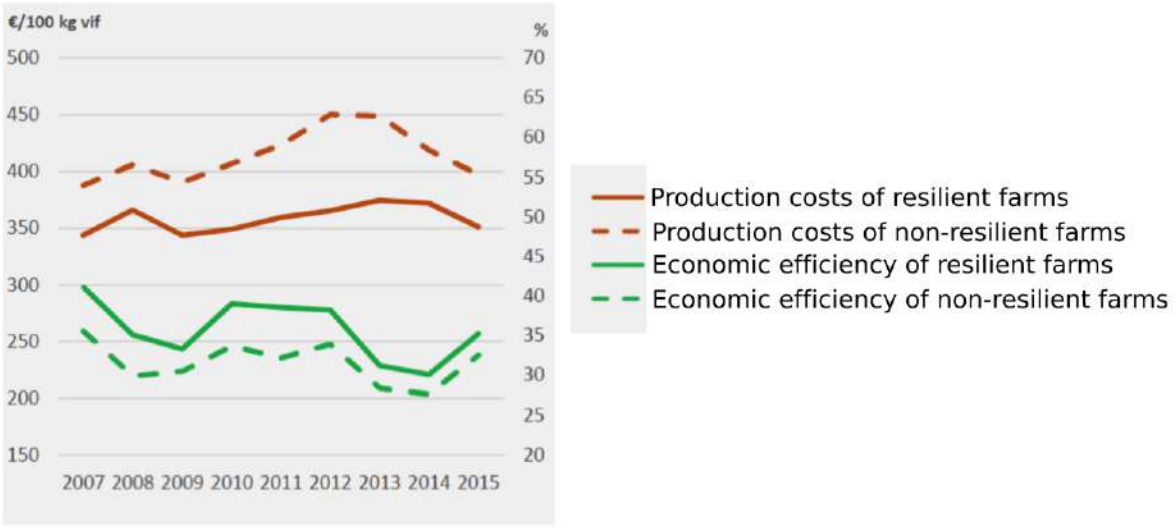

Figure 7. Changes in production costs and economic efficiency for resilient (47) and non-resilient farms (47)[1]. Source: Inosys Réseaux d'élevage. La resilience des systems bovins viande face aux aléas. 2017.

4.2 Indicator 2: Income per FTE

Economic performance and income follow a trend of very significant inter-annual variations (see figure 8). Some farms are able to maintain a level of income fairly constant and are therefore quite "robust". The amplitude of income does not exceed 30%. These are smaller farms than others, specialized and more autonomous in terms of food. They use more grass, are specialised in weanlings and are less confronted with the volatility of input prices. Thanks to significant levels of supplies linked to the second pillar support, they benefit from high economic efficiency. Other farms are more "flexible", with an income range greater than 30%. These are mainly farms that Combine polyculture (different kind of crop cultures, among which a part is sold outside the farm) and breeding activities, which have been affected by the volatility in the prices of cereals and field crops. These farms are larger and benefit from high labour productivity. Over time, these farms are a little bit more fragile. Finally, some farms can be considered as more transformable (=plastic) because during the period, they have followed a significant livestock

[1] The study focused on 94 breeder and breeder-fatteners farms, with or without crops, followed by the Inosys-Réseaux d'Elevage system. In each of these situations, the so-called farms "resilient" are in the top third in terms of average income over the period. They are compared lower third farms called "non-resilient".

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growth (more than 30%) or have made a change in the production process (e.g. stopping or moving to fattening). They are also well oriented towards the search for economical herd management or the economic monitoring of their land or herd expansion.

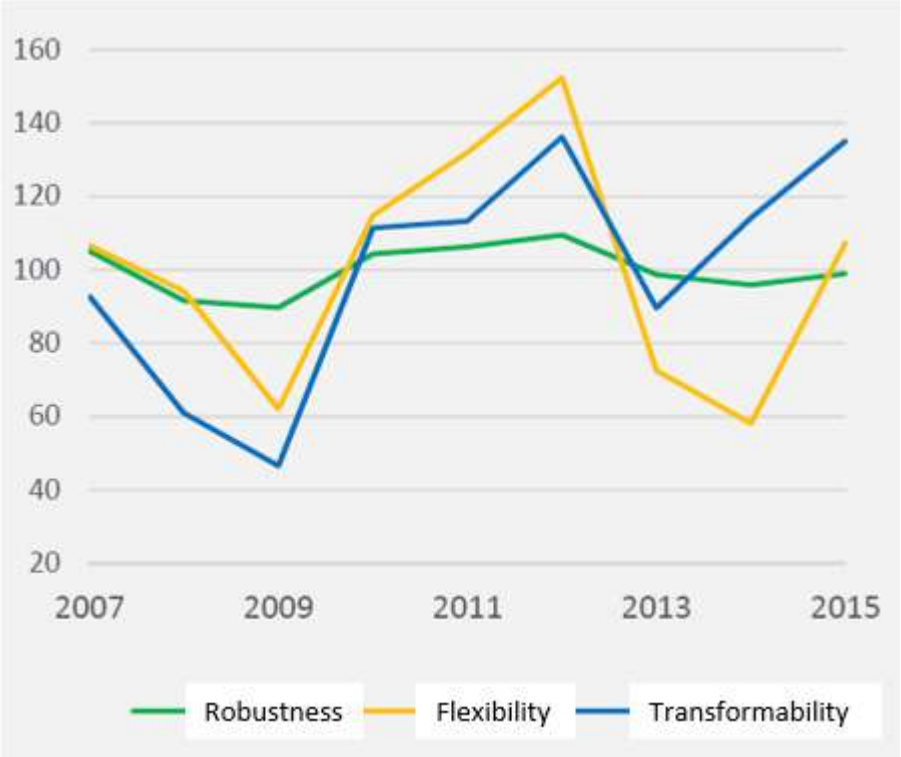

Figure 8. Variability of disposable income per FTE for resilient farms (average = 100) distinguished into 3 groups of income variability

5 Resilience attributes

5.1 Case-study specific strategies

5.1.1 Challenges and related strategies

We considered four different types of challenges. The first challenge was economic and was related to production, market and policy. The second challenge was social (internal) and related to demography, labour, and other human aspects. The third challenge was climatic and was related to droughts and floods. The fourth challenge was social (external) specifically related to the expectations of the consumer. Each of the four groups was assigned a challenge and discussed of different strategies (implemented or potentially implementable) to face the challenges in the Bourbonnais. Such an exercise, based on collective discussions, was appreciated by the participants as it made it possible to have interesting exchanges and points

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of view from other stakeholders on the same challenge. The strategies were then briefly discussed in plenary.

Strategies for facing economic challenges (group 1) were the following:

- ("Establishing specific requirements on products") Establishing specific requirements on products, promoting an evolution of practices (more traceability and development of labels) to increase added value and products valorization
- ("Building a positive image of the Bourbonnais") Communicating from breeders on their know-how towards consumers, valorizing the natural positive image of the Bourbonnais. Opening the farms and explaining the practices
- ("Evolution of policy") Evolution of political supplies which are unsure, which make investments difficult to carry on because of uncertainty of supplies.
- ("Grass fattening in the region") Developing fattening in the region (instead of exporting the calves for being fattened elsewhere) to keep local labor force (currently mainly weanlings). Valorizing grass fattening to fulfill social expectations. Developing complementarity with neighbor regions to exchange cereals and manure.

Strategies for facing (internal) social challenges (group 2) were the following:

- ("Developing farmer associations") Developing farmer associations or groups, as the only way of surviving, in order to work together on social issues (labor issues, transmission, on-call duty…) but also economic ones (sharing of an employee, material sharing, cooperatives to sell animals etc.)
- ("Facilitating young farmers installation") Facilitating young farmers' installation: ergonomics, work organization, professionalized labor, give more sense to the activity, bank support
- ("Professionalize the workforce") Professionalize the workforce: improving training and recognition of the employee job
- ("Developing direct sale") Developing direct sale: this would trigger off reconnection with consumers, would facilitate employment and would encourage new skill development and advising systems.

Strategies for facing climatic challenges (group 3) were the following:

- ("Practices for contrasting water excess") Adopting better practices to fight against the excess of water: hedges, soil cultivation, ditch maintenance, plot drainage, water reservoirs…

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- ("Practices for mitigating droughts") Developing practices against the drought: fodder storage, creation of water reservoirs, drainage, tree planting, production diversification
- ("Reinstating hedges") Reinstate hedges to protect against wind, limit soil erosion and promote plant evapotranspiration

Strategies for facing external societal challenges (group 4) were the following:

- ("improving communication to the consumer") Improving the communication to the consumer about farmers' activities and promoting more transparence. Labels are a good way to do that, however they need less labels but more reliable (otherwise they are kind of inflated)
- ("Developing a link between farmers and consumers") Developing the link between farmers and consumers: Opening farms, developing direct sale. People is more in need of proximity to the farm than to BIO.
- ("Adopting practices that fulfill social expectations") Adopting practices that fulfill social expectations (quality of the product, grazing, label)
- ("Improving slaughter conditions") Improving the slaughter conditions (e.g., mobile slaughterhouses, debate about ritual slaughter)
- ("Establishing sanctions when common practices are not respected") Establishing sanctions when farmers do not follow the common practices

5.1.2 Level of implementation of the strategies:

Some strategies are already well developed in the Bourbonnais region, others need to be implemented from scratch (see Figure 9). The local stakeholders consider that they are already well organised in groups regarding the farm associations (score 4 to 5) but it could also be developed to improve labour force organisation (sharing of an employee for instance – score 3). Regarding the social expectation of working conditions (incoming farmers want to have time for hobbies, holidays and weekends) and in order to encourage young people to engage in livestock farming, they consider that they should improve the facilitation of their installation (ergonomics, work organisation, professional labour, bank support… score 3 to 4), even if a real progress has been observed lately.

As far as climatic practices are concerned, farmers have already adopted practices against the excess of water (score 4) but definitively need to develop practices that help fighting against the drought (score 2), which can be explained by the fact that in the past 3 years the region has been severely impacted by droughts.

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The region benefits from a high potential to fulfil social expectations (rural area, lots of grasslands and hedges, animals staying outside…). But for the moment farmers do not communicate enough on their practices and natural environment, hence they gave a low level of implementation score for the strategies "communication from breeders on their know-how", "developing the link between farmers and consumers" and "reinsuring the consumers".

For the moment, the production is mainly centred on weanlings. Developing fattening to keep local labour force and more added value on the final product is one of the strategies envisaged by the stakeholders, but is moderately applied for the moment.

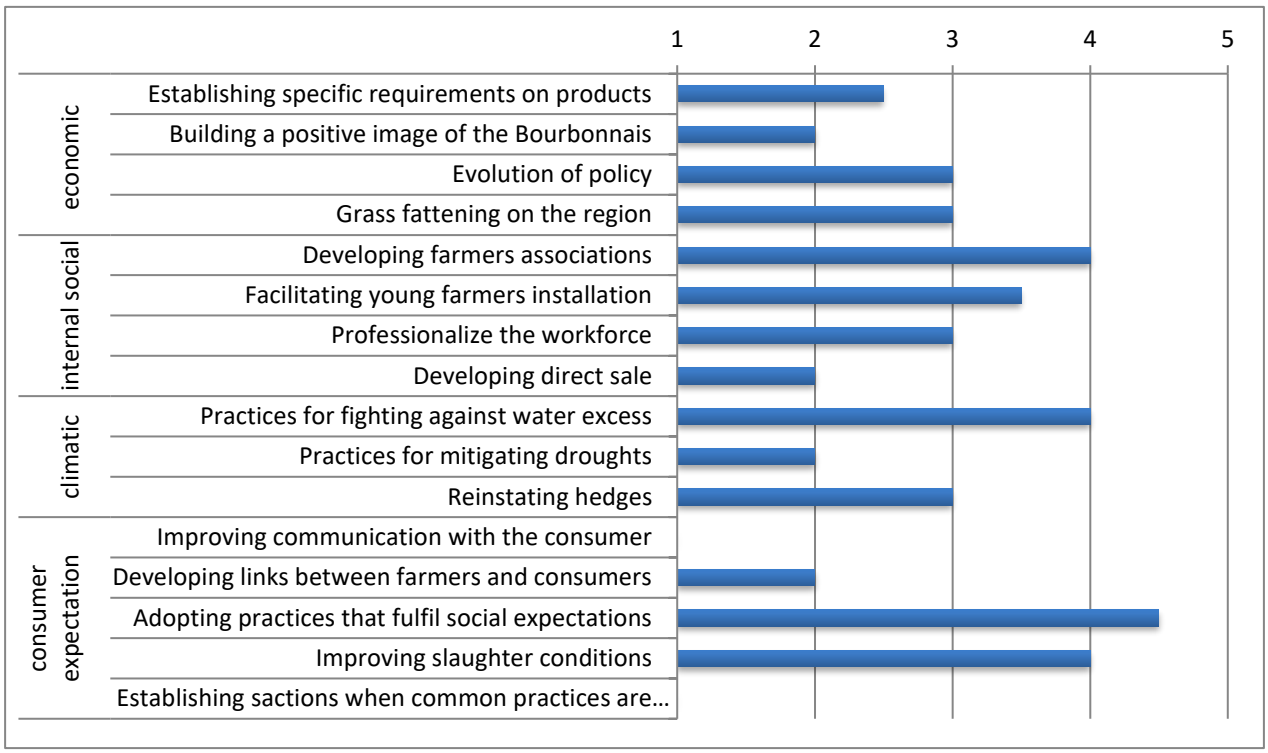

Figure 9. Bar graph showing level of implementation of strategies. 1 = not applied, 2 = slightly applied, 3 = moderately applied, 4 = adequately applied, 5 = perfectly applied.

5.1.3 Contribution of strategies to robustness, adaptability and transformability of the farming system.

Strategies discussed during the workshop were meant to improve resilience towards specific challenges. Hence they mostly contribute positively to resilience in the farming system. At first, stakeholders had trouble in giving a precise score (they globally agreed on positive "+" or

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negative "-" impact) because the concept of resilience was quite new and abstract and not very known to them, and secondly because of the diversity of situations among farms in Bourbonnais, which explains why some of the scores are only rated as positive (sign "+") and not more precise ("+1" or "+2" for instance). Because of the high number of scores not given by the stakeholders, we prefer to give results in tabular form (Table 3) rather than in bar graph. In the example of the strategy 2a, associations of farmers have a very strong positive impact for farmers who have not been working in groups yet. It can help farmers to buy less machinery (less investment, more robust), or to help them sharing ideas that are benefit for adaptability (change in feed system for instance) or transformability (conversion to organic for instance). Scores go from 1 to 3 because the result depends on the farm, the farmer, the existing organisation etc.

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Table 3. Scoring (or scoring ranges) of effect of strategies on robustness, adaptability and transformability of the farming system. A 0 implies no relationship, a 1 or -1 a weak positive or negative relationship, a 2 or -2 an intermediate positive or negative relationship, and a 3 or -3 is a strong positive or negative relationship.

		Robustness	**Adaptability**	**Transformability**
Strategy for facing ...	**Strategy Code**	**Score**	**Score**	**Score**
Economic challenges	Establishing specific requirements on products	NA	0 to +3	-2 to +3
	Building a positive image of the Bourbonnais	+3	NA	+3
	Evolution of policy	-3	-3	-3
	Grass fattening in the region	-3	NA	+1
Internal social challenges	Developing farmers associations	+1 to +2	+1 to +3	+1 to +3
	Facilitating young farmers installation	NA	NA	NA
	Professionalize the workforce	NA	NA	NA
	Developing direct sale	NA	NA	NA
Climatic challenges	Practiced for fighting water excess	NA	+3	+2
	Practices for mitigating droughts	+3	-3	0
	Reinstating hedges	0	+1	+3
External social chalenges	Improving communication with consumers	+3	+3	+3
	Developing links between farmers and consumers	NA	NA	NA
	Adopting practices that fulfill social expectations	NA	NA	NA
	Improving slaughter conditions	NA	NA	NA
	Establishing sanctions when common practices are not respected	NA	NA	NA

Three strategies may have a negative impact on farm systems' resilience:

- " Evolution of policy"– robustness, adaptability and transformability. Bourbonnais farming systems have very low flexibility to evolve (farms already too big for one person, low availability of land, part of grass already very high etc.) and an evolution of the supplies requirements could be difficult to be achieved, hence the stakeholders evaluated negatively the relationship between strategy and resilience attributes.

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- "Grass fattening in the region" – robustness. The development of local fattening needs more feed for the animals, which may have a negative impact on robustness because it makes the system more vulnerable to the multiplication of droughts and difficulties to provide feed at a regular price.
- "Practices for mitigating droughts" – Adaptability. Practices against the droughts are important for improving the robustness however they are usually huge long-term changes to the system that cannot be changed easily if external conditions change.

5.1.4 Trade-offs and synergies

Participants of the meeting had troubles to understand the differences between the three resilience capacities, so, unfortunately, we couldn't have an extensive discussion on trade-offs and synergies. However, there were a few points where participants could highlight and discuss a couple of trade-offs:

- "Grass fattening in the region" – fattening calves in the region shows a trade-off between robustness and transformability. Indeed, such a strategy would make the system more economically self-sustainable and more economically transformable (income diversification, added value capitation). However it would make the system less robust to uncertainties both climatic (droughts) and economical (price of feed).
- "Practices for mitigating droughts" – practices to make the system more resistant to droughts leads to a trade-off between robustness and adaptability. Indeed, in general, when a practice consists in a medium to large modification of the system it improves robustness but makes the system less adaptable or transformable to changes, if needed. Even if this was not explicitly mentioned or considered by the stakeholders in the workshop, we believe that this interpretation extends also to other strategies that consists in medium to large modifications to the system.

There were some strategies that were considered as having positive impacts on more than one resilience aspect:

- Strategies "Building a positive image of the Bourbonnais" and "Improving communication with the consumer": indeed communication and the valorisation of a positive image of the Bourbonnais contributes surely to the three aspects of resilience. It increases robustness in the sense that it would prevent external social challenges (e.g., raised expectations of the consumer about animal welfare and quality of the product). It increases adaptability and transformability in the sense that it would be adaptable to

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expectations of different external social groups, and indeed it has the potential to develop new activities, e.g., direct selling and green tourism, who are actually not sufficiently developed in the area and would constitute a transformation of the system.

- Strategy "Developing farmers associations", indeed the development of association might increase robustness, adaptability and transformability at the same time. The sharing of materials, tools and employees would buffer against economic shocks (robustness) and would make the system more able to find solutions for re-organization and know-how sharing in face of more long-term economic or climatic challenges (adaptability and transformability)

5.2 General resilience attributes

5.2.1 Current performance of resilience attributes:

The resilience attributes were assigned to and discussed in each group. Participants came up with assigned scores according to their perceived performance of resilience attributes.

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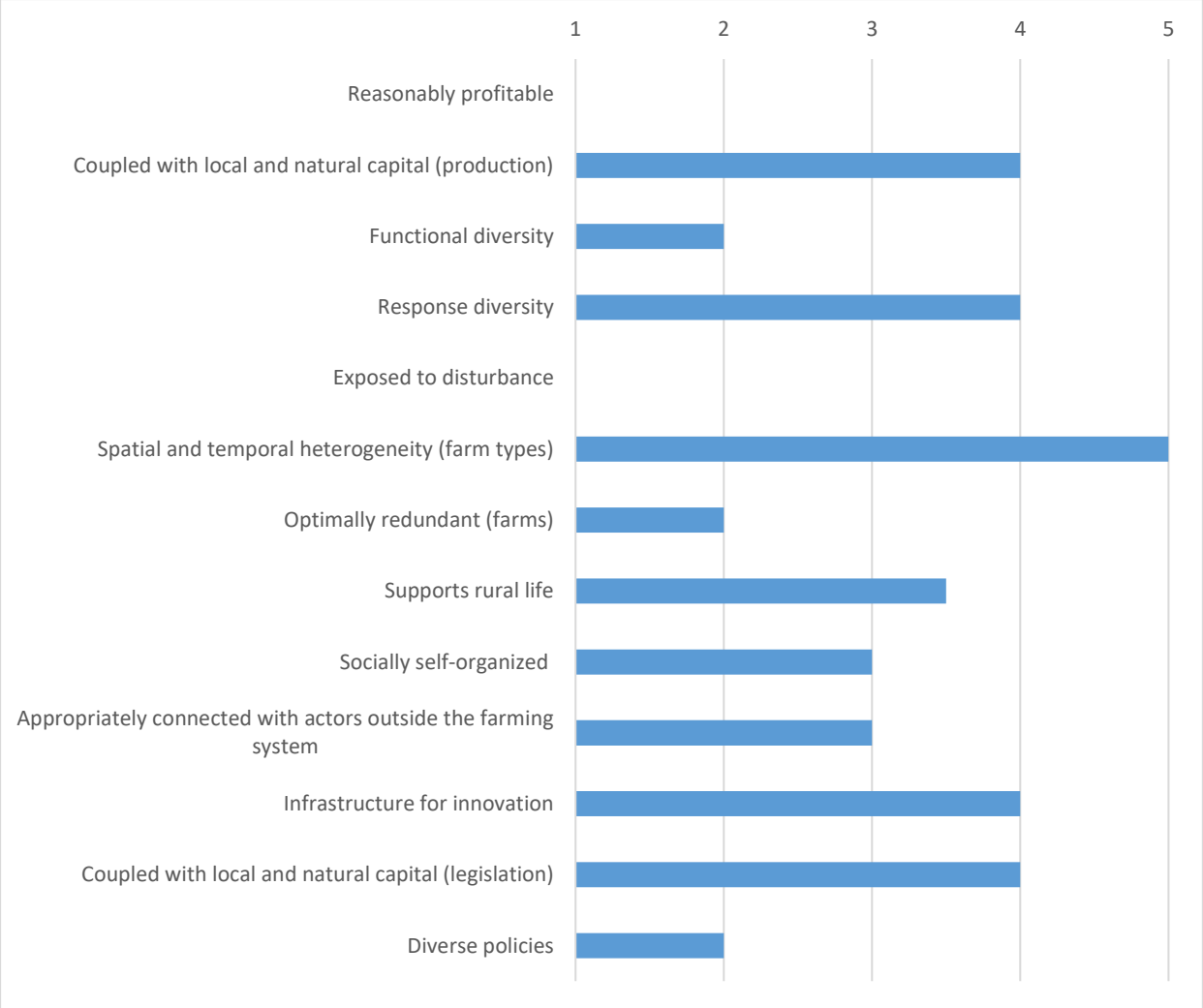

Figure 10. Bar graph showing current performance level of resilience attributes. Performance is scored as 1 = not at all, 2 = small extent, 3 = moderate extent, 4 = big extent, 5 = very big extent.

Participants assigned the maximum performance to the heterogeneity, highlighting a high heterogeneity of farm types. Indeed, meat production is characterised with a high diversity of production systems: type of farm (only weanlings, only fattening, weanlings and fattening), type of animals being fattened (heifers, male, both etc.), type of feed (only grass, polyculture and grass if the farm is located in an area where we can produce cereals), etc. This relates to the general resilience principle of Diversity. Another resilience attribute that is perceived to perform well is "Coupled with local and natural capital". Indeed, the system is strongly related to grasslands without a strong need of supplementary feed. The region is in fact characterized by high feed autonomy, with also a local reutilisation of organic manure and co-products and maintenance of soil fertility. Participants also highlighted that local legislation is adapted to the

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ecological conditions of the region. Response diversity is also well seen by stakeholders, as the region benefits from a high diversity of risk management (many operators to sell the farm's products in particular).

5.2.2 Contribution of the resilience attributes to robustness, adaptability and transformability of the farming system

As participants had trouble to evaluate the effect of the attributes on resilience, we chose to adapt the exercise by asking them to vote for the 3 factors that had the most importance on the Bourbonnais farms' resilience (each participant was given 3 stickers to paste on three different factors). Results are presented in Figure 11. The factor that obtained the highest score is the reasonably profitability of the farms, which is coherent with the different indicators identified before (meat price, farmer's income etc.).

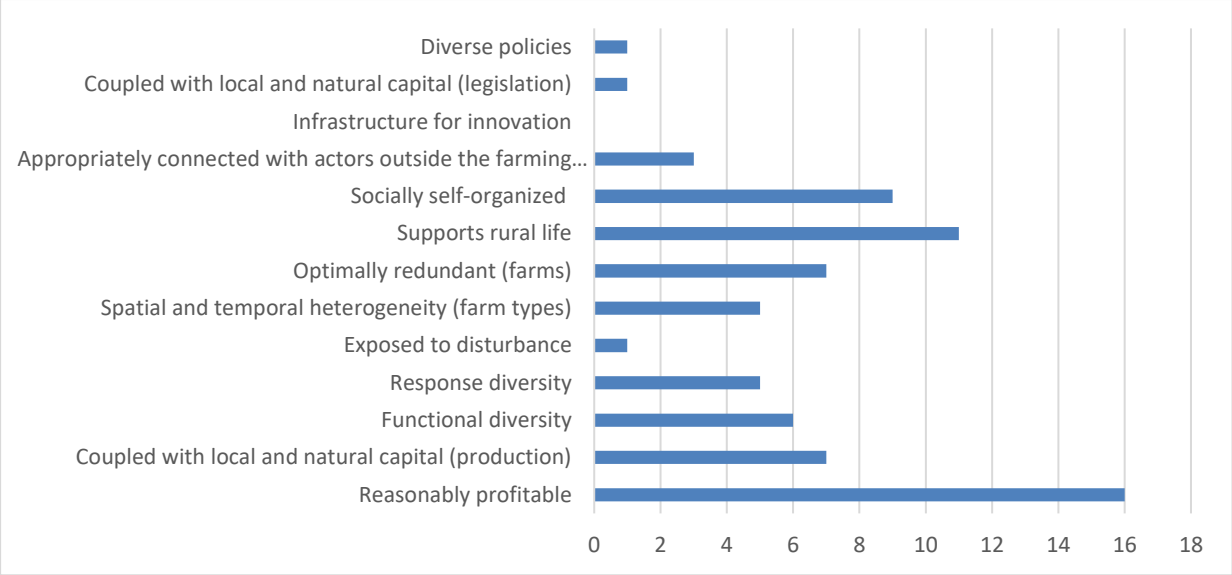

Figure 11. Bar graph showing scoring of perceived effect of attribute on robustness, adaptability and transformability.

Definitely the economic aspects ("Reasonably profitable") are perceived as the most important to enhance the resilience of the system. "Socially self-organized" and "Supports Rural Life" were also seen as important. They are two attributes that strengthen and support the identity of the territory, in contrast with "Appropriately connected with actors outside the farming system" that refers to the enhancement of the attractiveness of the area. We find that this is in contradiction with some of the strategies proposed (for example, building a positive image of the Bourbonnais) that refers to relating to outside the region. We find that this tension between prioritizing internal identity and self-sufficiency, and recognizing in the strategy the need of improving the relationship with actors outside the farming systems (mainly consumers) is a sign

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of potential for transformability. Also "Coupled with local and natural capital (production)" is seen as moderately important, confirming that the actors acknowledge the value of the grasslands in the territory, however, this attribute is already perceived to perform well (Figure 11). We note that the actors do not see policy and legislation ("Diverse policies" and "Coupled with local and natural capital (legislation)"as a reliable way to improve resilience, maybe for a potential contradictory outcome of an evolution of policies (we remind that an evolution of the policy is seen as a potential strategy to face challenges, but, if not done in a good way, it can be deleterious for robustness, adaptability, and transformability). Not importance at all was assigned to "Infrastructure for innovation", probably because the actors do not need substantial infrastructures or new technologies, they rather prioritize social aspects.

5.2.3 Trade-offs and synergies between robustness, adaptability and transformability:

What is related to the natural capital is perceived to be already well performing in the region of interest. An improvement in that attribute is still desirable, but its performance, as perceived by the stakeholder, suggests that the system is resilient in its ecological component (see more detail about this in the next session). The social component of the system shows a lower resilience, as participants suggested mostly strategies to improve the resilience of this part. However, the system has the potential to implement those strategies on the social side, such as improving the communication for building more transparency for the consumer, promoting farmers associations.

6 Discussion

6.1 Functions of the farming system

The region is characterised by extensive beef cattle, it is homogeneous in terms of production type (meat) but with a wide diversity of production systems. Non-food-related biological production is not developed if not in the valorisation of co-products of beef production or services dedicated to it (litter). It is not surprising that "Food production" is perceived as the most important function (even though there is some disagreement among stakeholders). Within such a function, indicators related to quality ("Beef taste and regularity" and "beef produced under label") and food self-sufficiency are preferred over the quantity ("Quantity of beef produced"), denoting that quality of food produced is considered as part of the identity of the territory.

Among the private functions also "Economic viability" and "Quality of life" were considered important, and the most important indicators are the "Revenue per FTE" and the "Number of

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people working on the exploitation", respectively. The public functions are also perceived important, especially "Natural Resources" and "Biodiversity and habitat quality". The most important indicators are the "Hectares of permanent grassland" (which is intrinsically related also to food production) and the length or hedges or the number of species.

"Bio-based resources", "Attractiveness of the area", and "Animal health and welfare" were not considered as important as other functions for different reasons according to our view. Concerning "Bio-based resources", the territory has a main vocation and is highly specialized in beef production. Therefore non-food related production is sub-ordinated to food production being related to co-products. Our interpretation to the less importance assigned to the "Attractiveness of the area" is that in the territory the tourism is not much developed and the territory is more caring about its identity and autonomy rather than attracting people, even if they have in mind to develop this activity ("green" tourism). Within that function the preferred indicators, indeed, are the number of exploitation doing direct selling and the number of villages with commercial activities, rather than the number of visitors. However, among the strategies, participants indicated as strategies a better transparency and a better communication towards people outside of the territory. Concerning "Animal health and welfare" we perceived that participants did not consider it as a functions, but as a normal thing occurring in their farms. All the farms were based on extensive grazing, which is already something good for enhancing animal welfare.

Apart from "Animal health and welfare", for which we already remarked the thinking of the participants, the best performing functions were "Food production" (with maximum score assigned to the indicator "Quantity of beef produced"), "Natural resources" ("Hectares of grassland", "Management of excretions", "Quantity of artificial nitrogen used"), and "Habitat Quality" ("Length of hedges"). The good performances assigned to these three functions show that the system is well coupled with natural capital and ecologically self-regulated. Following the resilience attributes provided by Cabell and Oelofse (2012), this is a sign of resilience on the ecological component. This is confirmed by the high scores assigned to these resilience attributes by the participants.

Bourbonnais territory has been used lately as a case study for a couple of projects. Hence the participants had already worked on functions and were quite coherent with the other projects outputs.

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6.2 Robustness, adaptability and transformability of the farming system

Based on the workshop results, the system shows some robustness, adaptability and transformability on its ecological component. The ecological part of the system provides enough natural capital to have self-sustainment, with ecological infrastructures (hedges) that might contribute in lowering flood risk and productivity. Also, the region is relatively autonomous in relation to feed, and to nitrogen input (local recycling of organic manure). This is reflected in the answers given by the participants along the different phases of the workshop. Maintenance of natural resources and habitat quality was perceived to be an important function, and this reflects the awareness of stakeholders, especially farmers, that the ecological part of the social-ecological system is important for other functions, mainly food production. The system appears to be well-coupled with the natural capital and ecologically self-regulated, signs of resilience, according to Cabell and Oelofse (2012). However, some lack of robustness is still perceived in relation to climatic challenges. The ecological component provides also seeds for adaptability and transformability. New emerging practices, indicated by the participants as strategies to face some challenges, are grounded in the valorisation of local resources, i.e., the valorisation of hedges and the fattening of calves in the region (some are beginning to explore the possibility of grass fattening).

In general, participants manifested a big sense of territorial identity (they prefer quality over quantity of production, they care about food self-sufficiency) and this provides the potential to increase the robustness and adaptability of the system. Some strategies, suggested by participants, that reinforce the identity of the system and, at the same time, its robustness and adaptability on the social component are “Developing farmers associations” and “Facilitating young farmers installation”. According to Folke (2003), this provides the opportunity for self-organisation. However, we interpret this as signs that the system remains in the phase of “Equilibrium” according to the adaptive cycle proposed by Holling and Gunderson (2002). According to the classification of the external challenges (Meuwissen et al., 2018), the system seems to experience more long-term pressure (decreased beef prices, pressures from consumers’ social expectation) than shocks. Sign of transformation occur while stakeholders get aware of that. Some stakeholders admit that some transformation could be needed in order to improve some situations, especially the ones related to Economic viability and to the external social challenges. In the workshop, we spotted signs of transformability, as the participants demonstrated that in order to improve their quality of life, it is important to rely on actors outside of the region. Also they mentioned the need to improve communication and the

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support of rural life. We interpret these as signs of transformability (phase of "transformation" according to Fath et al (2015)) as they show capacity of renewal, re-organization and development (Holling and Gunderson, 2002)

Farmers are also suffering from a high price fluctuation and low prices of the meat market. All the stakeholders explained that the economic resilience of the farm was endangered by this economical context, which moreover does not offer to farmers the financial security they would need to set up new strategies on the farm (which often need some cash flow). Low meat prices are definitively reducing resilience of Bourbonnais' farms.

We provide the correspondence between strategies and resilience attributes in a tabular form (Table 4). We believe that the attribute related to heterogeneity is transversal to all the strategies, as most probably these strategies will not be implemented homogeneously everywhere in the region.

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Table 4. Correspondence between strategies and resilience attributes

Strategy	**Resilience attribute and why**
Establishment of specific requirements promoting an evolution of practices (more traceability and development of labels) to increase added value and products valorisation	This strategy contributes to *Reasonably profitable* as the production under label may provide a better income. It is also related to *Local and natural capital*, as label production is generally less intensive.
Communication from breeders on their know-how towards consumers, valorising the natural positive image of the Bourbonnais. Opening the farms and explaining the practices	This strategy would improve the *functional diversity*, as it would add a new function (cultural) of the system. It would also contribute to *Reasonably Profitable,* by offering the chance to the farmers of a new sources of selling or income. It also contributes to *Appropriately connect with actors outside the farming systems*. It may also bring some positive effect on *supports rural life*, as a better knowledge of the farms brings people more positive and supportive about farming.
Evolution of policy	This strategy is related to *Diverse policies*, so that the farms are more coherent with the political supplies.
Developing fattening to keep local labour force (currently mainly weanlings). Valorising grass fattening to fulfil social expectations. Developing complementarity with neighbour regions to exchange cereals and manure.	This would contribute to increasing *functional diversity*, coupled with *local and natural capital* (especially for grass fattening), and *socially self-organised*, as it would imply that the local farmers would create new work opportunities and new markets
Development of farmers associations or groups, as the only way of surviving, in order to work together on social issues (labour issues, transmission, on-call duty…) but also economic ones (sharing of an employee, material sharing, cooperatives to sell animals etc.)	This strategy contributes to *Socially Self organized* as the strategy itself is to better organise the farming collective work.
Facilitating young farmers installation: ergonomic, work organisation, professionalised labour, give more sense to the activity, bank support	This strategy contributes to *Socially Self organized* (better working conditions for farmers thanks to collective organisation and development of farmers' skills) and *Supports to rural life / Optimally redundant* factors, because if the young farmers installation is ensured, retiring farmers will have no trouble to find successors.
Professionalising the workforce: improving training and recognition of the employee jobs	This strategy contributes to *Supports to rural life* and to *Reasonably profitable* (and human capital) as better skills for farmers and employees are beneficial for economic results of the farm.
Development of direct sale: triggers off reconnexion with consumers, employment… and implies new skills and advising systems.	This would contribute to increasing *functional diversity*, coupled with *local and natural capital*, and *socially self-organised*, as it would imply that the local farmers would create new work opportunities and new markets.
Adopting better practices to fight against the excess of water: hedges, soil cultivation, ditch maintenance, plot drainage, water reservoirs…	This strategy strengthen the *local and natural capital* (better environmental practices) but mainly the *reasonably profitable*, as it will help the farms to overcome the climatic stresses.
Developing practices against the drought: fodder storage, creation of water reservoirs, drainage, tree planting, production diversification	This strategy strengthen the *local and natural capital* (better environmental practices) but mainly the *reasonably profitable*, as it will help the farms to overcome the climatic stresses.
Reinstate hedges to protect against wind, limit soil erosion and promote plant evapotranspiration	This strategy strengthen the *local and natural capital* (better environmental practices)
Reinsuring the consumers: Better communication and more transparency with consumers	This strategy would improve the *functional diversity*, as it would add a new function (cultural) of the system. It would also contribute to *Reasonably Profitable.* It also contributes to *Appropriately connected with actors outside the farming systems*.
Developing the link between farmers and consumers: Opening farms, developing direct sale	This strategy would improve the *functional diversity*, as it would add a new function (cultural) of the system. It would also contribute to *Reasonably Profitable.* It also contributes to *Appropriately connected with actors outside the farming systems*.
Adopting practices that fulfil social expectations (quality of the product, grazing, label)	This strategy would improve the *Reasonably Profitable* as it may help the farmers to sell more products or at a better price. It also contributes to *Appropriately connected with actors outside the farming systems*.
Improving the slaughter conditions (mobile slaughterhouses, debate about ritual slaughter…)	This strategy would contribute to *Appropriately connected with actors outside the farming systems* as it would suit to social expectations.
Establishing sanctions when farmers do not follow the common practices	This strategy would contribute to *Appropriately connected with actors outside the farming systems* as it may suit with social expectations of denouncing bad practices

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With particular reference to the study region we believe that the natural capital provides opportunity for contributing to the three resilience concepts, especially adaptability and transformability. As Cabell and Oelofse (2012) point out, a system that is relying on the on regulating ecosystem services has better opportunities to be resilient as these ecosystem services provide the ecological feedbacks necessary to adapt to both internal and external changes. Improving resilience attributes related to the social part of the system (reasonably profitable, socially self-organized, appropriately connected with actors outside the farming system), would in fact imply a transformation of the system, as, at moment, those resilience attributes are not well developed in the study area. This is why, we believe that resilience attributes related to the social part of the system are related to the transformability of the social system.

6.3 Options to improve the resilience of the farming system

We believe that the strategies suggested by the stakeholders are useful for increasing the resilience of the system and we give more detail about this in 6.2.

6.4 Methodological challenges

- As participants accepted to contribute to the workshop notably because of the possibility of exchanging with other stakeholders, we focused on group discussion instead of individual filling of the forms, which led to interesting and insightful discussions.
- Translating the concept of robustness, adaptability and transformability in a language that was accessible to the participants was very challenging and difficult. Participants were very responsive to functions, indicators and strategies, because these were something concrete related to their everyday life and to something they care about. However, for more abstract concept like resilience categories, it was much more difficult as participants would have needed a time for appropriation of the concepts. Therefore we do not consider the information collected on differences between robustness, adaptability and transformability as much reliable as the work done on functions and indicators. For future workshops we suggest to focus on strategies to grab information needed without having to explain abstract concepts to the stakeholders,
- We (or our colleagues) work with these stakeholders regularly. Hence we find it very important to adopt a win-win approach, so that everybody (facilitators and participants)

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comes back with the feeling of both having given and received something from the workshop. This is why during the workshop we focused more on exchanges between stakeholders. Otherwise we fear we might discourage them from participating to future meetings or workshops (disconnected to Sure Farm project).

- The framework in theory is very well structured and progressive. However during the application with the stakeholders, it was very difficult to reach the required degree of precision because of many reasons occurring when translating theory into practice and for the relatively high number of stakeholder whose attention had to be kept high.

Other recent projects focusing on Bourbonnais (ERANET SUSAN Animal Future (www.animalfuture.eu), PSDR New Deal (Dumont and Rapey, 2016) showed that the perception of stakeholders during workshops is in line with the context.

7 Conclusion

The answers given by the participants of the workshop showed that the Bourbonnais is a region well coupled with the natural capital. The ecological component of the system provides natural infrastructures (hedges) that might contribute in lowering flood risk and productivity. Also, the big amount of grasslands makes the region relatively autonomous in relation to feed and to nitrogen input (local recycling of organic manure). Although being coupled with the natural capital is in general a sign of resilience according to Cabell and Oelofse (2012), some lack of robustness is still perceived in relation to climatic challenges. Signs of adaptability and transformability are currently seen in the possibility of valorisation of local resources, i.e., the valorisation of hedges and the fattening of calves in the region (some are beginning to explore the possibility of grass fattening).

Results of the scores assigned to the functions by participants highlight that the natural capital is important in “Food production”, “Natural resources”, “Biodiversity and habitat” and “Animal Welfare”. Within the “Food production” food production, not only the mere quantity was important, but also the aspect related to quality and to food self-sufficiency. The presence of labels (e.g., Label Rouge) for beef production is a sign of territorial identity and linkage between food production and natural capital. The good perceived performance of “Natural Resources” and “Biodiversity and Habitat”, along with the good performance of “Food Production” enforce the linkage between food production and natural capital. The high performance of “Animal Welfare” (although not properly considered as a “function” by some participants, but more a “normal practice”) is a consequence of the coupling between food production and the natural

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capital, as animals are mainly fed on grass and spend a big part of their lifespan open air. If the functions "Bio-based product" scored badly is because in the last decades, the region was mainly focused on food products, with very little importance considered to non-food products. It is only recently that hedges are being valorised strategically.

In the past decades and in the current years, a big characteristic of the region was its isolation. The landscape is mainly rural and of difficult access from the cities. This could explain the bad performances of some functions related to the social-ecological part of the system, i.e., "Economic viability", "Quality of life" and "Attractiveness of the area". In particular, "Economic viability" was perceived to perform badly and also considered as a very important function. The isolation from cities protected the region from some social movements (vegans, animalists), but also posed severe challenges to economic viability and quality of life. Participants to the workshop indicated strategies related to the development of farmers associations, the facilitation of young farmers installations or the promotion of the image of the region. These strategies were mainly related to the increase of the self-organisation and to the connections with actors outside the farming system, sign of transformability of the system

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Appendix A. Workshop memo

The workshop took place on a very sunny day in winter time (hence the temperature inside the room was too high), in a rural city central in the Bourbonnais. The room was very big and very practical to organise a workshop. We had lots of tables and chairs to adapt the room to our needs. We were equipped with microphones in order to provide good listening conditions for everyone. Contrasts of the video projector was bad especially because the sun was shining a lot! Lunch was served at the back of the same room, avoiding loosing too much time. Lunch was provided by local farmers (burger, bread and cheese) in order to valorise and emphasise the quality of the food produced in the area. Participants showed lots of interests in participating to the workshop.

Start time: 2pm (after lunch); End time: 4.30pm

Total break time (estimation): 0

Table A1. Stakeholder overview

26 participants took part to the workshop (Table A1) and the research team consisted of four persons (30 people in total).

Table A1: Overview of participants in the workshop.

Organization	Function	Stakeholder group
Chamber of agriculture	Chief of environmental service	Agricultural chamber
Chamber of agriculture	Project manager	Agricultural chamber
Chamber of agriculture	Intern	Agricultural chamber
Conservatoire d'espaces naturels	Project manager	Association
SOCAVIAC	Technician	Producers' organisations
FEDER	Technician	Producers' organisations
SICABA	Technician	Producers' organisations
CCBE	Technician	Producers' organisations
Missions Haies	Project manager	Association
Lycée agricole de Moulins	Teacher	Agricultural school
La musette	Shop manager	Producers' organisations
Farmer	Farmer	Breeder
Farmer	Farmer	Breeder
Farmer	Farmer	Breeder
Farmer	Farmer	Breeder
Farmer	Farmer	Breeder
Farmer	Farmer	Breeder
Farmer	Farmer	Breeder
Farmer	Farmer	Breeder
Farmer	Farmer	Breeder
Farmer	Farmer	Breeder
DDT	Territorial agent	Administration
DDT	Territorial agent	Administration
INRA	Researcher	Research institute
INRA	Researcher	Research institute
Vetagrosup	Researcher	Agricultural school

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Appendix B. details on ranking and rating the functions and indicators

-Table A2. Mean and standard deviation of scores per function per stakeholder group and for all participants. 100 points needed to be divided to 8 function.

Table A2: Mean and standard deviation of scores per function per stakeholder group and for all participants. 100 points needed to be divided to 8 function.

Table A2

	Farmer		Cooperative		Association		Territorial Authority		Other		Total	
Function	Mean	StD.	Mean	StD..	Mean	StD.	Mean	StD.	Mean	StD.	Mean	StD.
Food production	18,63	9,36	29,50	20,33	5,00	0,00	25,00	7,07	17,50	6,45	20,40	13,10
Bio-based resources	5,21	6,26	5,67	2,16	10,00	7,07	2,50	3,54	10,00	4,08	6,21	5,27
Economic viability	13,71	5,52	13,50	5,96	20,00	0,00	17,50	10,61	10,00	0,00	13,87	5,61
Quality of life	12,46	7,70	13,33	6,02	13,50	4,95	17,50	3,54	16,25	7,50	13,71	6,68
Natural resources	16,13	7,43	10,33	4,97	10,00	0,00	10,00	0,00	13,75	4,79	13,48	6,30
Biodiversity & habitat	13,63	8,20	10,00	5,44	17,50	17,68	7,50	3,54	16,25	4,79	13,02	7,70
Attractiveness of the area	8,21	5,59	8,33	4,08	17,50	3,54	7,50	3,54	8,75	2,50	8,98	5,02
Animal health & welfare	12,04	7,26	9,33	2,16	6,50	2,12	12,50	10,61	7,50	2,89	10,33	5,86

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