Scenarios sustainability evaluation:

Cattle fattening on pasture

Deliverable 4.4

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Acronyms

CS: case study
BE-CC1 : Belgian cow calves farm 1
BE-CC2 : Belgian cow calves farm 2
BE-BF: Belgian breeder-fattener farm
BE-F: Belgian fattener farm
BE-D: Belgian dairy farm
FR.CANT-CC: French cow-calves farm in Cantal
FR.LIM-CC: French cow-calves farm in Limousine
FR.CANT-DCC: French dairy and cow-calves farm in Cantal
FR.LOR-BF: French breeder-fattener farm in Lorraine
GE.BAV-F: German fattener far in Bavaria
GE.LS-F: German fattener farm in Lower-Saxony
GE.NRW-DF: German dairy and fattener farm in North Rhine Westphalia
IT-F.226: Italian fattener farm
BB: Belgian blue breed
FRG: Fast rotation grazing
SR: system redesign
DCB-F: Dairy calf breed fattener
DF: Dairy-Fattener
MC-B: Mother cow Breeder
MC-F: Mother cow Fattener
MC-BF: Mother cow Breeder-Fattener

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1 Introduction

Up to now, due to the modelling approach, the modelled innovations aiming at reducing the feed-food competition are limited and considered at the farm scale (see deliverable 4.3[1]).

However, the participative approach highlighted that the implementation of the innovations at farm scale results in changes at farm scale of course, but also requires changes at value chain or territorial levels (including society) – i.e. at food system scale – in order to be materialised. The changes are technical, but also behavioural, structural, etc. As Geels mentions, this highlights that *"system innovations are not merely about changes in technical products, but also policy, user practices, infrastructure, industry structures and symbolic meanings, etc.* […] *social and technical aspects are strongly interlinked"* (Geels 2006). That is the reason why Geels talks about "socio-technical system".

Deepening the scenarios means to take into account these required changes at value chain and territorial scales. The term "scenarios" is used in quotation marks, as these are not scenarios as understood in prospective, the methods used to define the scenarios being different.

As they are "shared" scenarios by all the countries involved in the project (see Deliverable 4.3[2]), and as grass-based systems are less in competition with food (Mosnier et al., 2021), we decided to focus on the scenarios based on "cattle fattening on pasture".

The deepening of the scenario follows the following steps:

1/ Draw the current context of the beef production: this paragraph gives a quick overview of the challenges faced by current beef production in Europe using the Multi-Level Perspective (MLP) approach (Geels 2006) ;

2/ Assess the technical and social feasibility of the implementation of the innovations: this paragraph is a synthesis of the results of the modelling and of the participative approaches;

3/ Identify the incentive measures that could support the materialisation of the scenarios.

2 Overview of the current context of the beef production in Europe

Currently, European beef production systems are dealing with several challenges. These challenges come under what the Multi-Level Perspective approach calls "external circumstances" that put pressure on the socio-technical beef production systems. Thus, the following elements threaten (or in any case put pressure on) the current European beef farming systems:

- The globalization of the market, which puts the European systems in competition with lower cost production systems (especially through trade agreements, as e.g. the MERCOSUR-EU agreement) (Collège des producteurs 2020; Chatellier, Guyomard, and Bris 2003);

[1] For more information please contact us by e-mail at s.hennart@cra.wallonie.be or visit our institution website www.cra.wallonie.be

[2] idem

- Changes in food consumption patterns for ethical, health, lifestyle, etc. reasons that lead in a decrease of red meat consumption at European scale (even if global demand remains stable) (OCDE 2020; Fostier 2019) or changes in consumers' preferences (preferences for minced meat, convenience food) (Collège des producteurs 2020; SPF Economie, PME, Classes Moyennes et Energie 2018). The most sustainable scenarios resulting from recent prospective works also point in the direction of a reduction in meat consumption (Fostier 2019);
- Changes in human-animal relationship cultural patterns that cause social demands ranging from improved animal welfare to anti-species claims (Lesage, Bidaud, and Claquin 2016; Fostier 2019; Beaufays and Giffroy 2005);
- More broadly, changes in human-environment relationship, cultural patterns that lead to environment as a social and political stake (Zin 2010). Environment is progressively integrated in policies and regulations, as evidenced by the evolution of the CAP in recent years (cross-compliance system) (Natagriwal, 2014) and national regulations (e.g. SPW Environnement 2014).
- Repeated scandals in recent years (bovine spongiform encephalopathy, foot-and-mouth disease, GMOs, meat fraud, ...) that have contributed to the deterioration of the image of the sector in society (Collège des producteurs 2020; Fostier 2019).
- The variations on the milk market that impact the beef market (e.g. end of the quotas) (Collège des producteurs 2020, Top agrar, 2019).
- The current and future population growth at global scale, which questions the ability of the whole sector to provide sufficient food at affordable price, i.e. to ensure food security (FAO 1996). The role that beef production has to play in relation to this stake is not obvious, especially given the criticisms of the low conversion efficiency of ruminants (Gerber et al. 2015).
- The climate change, which adds additional pressure on the systems (FAO, 2013).

Beside the external challenges described above, changes occur within the systems, as described in Deliverable 2.1[3] (concentration of livestock production, decrease in the EU cattle herd due to decapitalization of the dairy herd, etc.).

If all the above elements put pressure on the systems, they can lead to *"windows of opportunity to arise",* i.e. situations favourable to the emergence of innovations (Geels 2006) towards a re-design of the whole system.

3 Two scenarios developed

In this context, among others, two innovations were promoted by farmers and advisers during the participatory meetings: the based grass fattening innovation and the crossbreeding, both in terminal crossbreeding (BE and GE) and in improving the meaty potential of the breed. (FR). The barriers and levers for these two innovations and for all others innovations are presented in this appendix.

The goal of this modelling exercise is (1) to study the impact of grass fattening through fast rotational grazing (FRG) as substitute to grassland use in the baseline systems and (2) to test three systems re-designs, based on crossbreeding (SR) that could favour such practices.

[3] For more information please contact us by e-mail at s.hennart@cra.wallonie.be or visit our institution website www.cra.wallonie.be

Table 1 – Scenarios based on "cattle fattening on pasture"

Case Study	*Scenario 1 (FRG)*	*Scenario 2 (SR)*
BELGIUM: BE-CC2 + BE-F	Fast rotational grazing	• Terminal crossing using sexed semen • Fast rotational grazing • Use of local by-products
FRANCE –ITALY: FR.Cant-CC + IT-F.226	Fast rotational grazing	• Fast rotational grazing • Cross-breeding with Angus sire
Germany: GE.NRW-DF	Fast rotational grazing	• Crossbred males (Belgian Blue sire)

The Table 1 summarizes these scenarios. While the farm level results are already presented in Deliverable 3.4[4], farm combinations are needed to ensure that the observed performances are valid at the level of beef meat production system.

3.1 Wallonia

In Wallonia, the baseline is the intensive cow-calf system, which is the most representative type of suckler farm (see Deliverable 2.1[5]). In order to make a complete beef meat production system and since no Belgian Blue fattener had been defined earlier in the project, we built a Walloon fattener (BE-F) case study farm. This case study is an indoor fattening farm buying maize and concentrates to feed Belgian Blue bulls. This system has been validated by expert through a review of the feeding and the animal performances associated. Currently, Walloon beef farming systems are mainly focused on breeding and Wallonia is very dependent on other territories for the fattening and therefore for the valorisation of its beef production (Pétel et al., 2018). It is then suggested that 50 % of the suckling systems re-design in breeder-fattener systems by 2030 (Collège des producteurs 2020).

The BE-FRG scenario offers the possibility to the breeder farm to use the FRG option, while the fattener system remains unchanged. FRG is modelled (see deliverable 4.3). It leads to a yield increase of 10% and a constant "spring quality" grass. In this BE-FRG scenario, the innovation is thus applied only to the breeder farm.

The BE-SR scenario is a complete re-design in the sense that the breeder farm becomes a fattener unit that buys dairy cross-bred (Belgian Blue sire) calves to the dairy farm in which the cross-breeding and sexing innovations are applied. Bulls are bought from the dairy farm at 3 weeks old and sold at 19 month old. FRG is applied from May to September. Supplementation on pasture up to 30% of the dry matter intake is also allowed.

[4] For more information please contact us by e-mail at s.hennart@cra.wallonie.be or visit our institution website www.cra.wallonie.be

[5] *idem*

Table 2: Modelling hypothesis for the scenarios based on FRG and SR.

	Base	*Scenario 1 (FRG)*	*Scenario 2 (SR)*
Area in FRG (%)	0	From optimisation	From optimisation
Pastured Grass Productivity in FRG		+10%	+10%
Breed	= CS	= CS	BE : BB x HF FR : Angus x Salers GE: BB x SI
Carcass price	=CS	=CS	BE : 5 -> 3.40 € / kg FR : +0.40 € / kg GE : = CS
Grass QUALITY	=CS	= Spring grass quality	= Spring grass quality

3.2 France and Italy

In France, the scenarios are applied to a typical cow-calf farm located in the mountain area of Massif Central. These systems generally sell their calves to be fattened in Italy. This French farm was paired with an Italian fattening farm in order to cover the entire production cycle (FR-Base). Similar to the Belgium scenarios, FRG is modelled as a yield increase of 10% and a constant "spring quality" grass. FRG is applied only to the breeder farm. The re-design scenario (SR) tests the fattening of the calves on the breeder farm in order to produce added value and local grass-based food for the French territory. The Italian farm is thus removed from the production cycle. Calves are cross-bred with a local breed (Salers) for the cows and an early maturing breed (Angus) for the bulls in order to be able to obtain 14 month-old animals of 500 kg of liveweight, ready to be slaughtered. The market for this crossbred animals is not structured. However, the INRAe experimental farm of Laqueuille managed some years to sell this type of animals with a surplus of 0.40€/kg carc.

3.3 Germany

In Germany, the baseline (GE-base) is the intensive fattening of dairy bull calves. The only breeding farm considered in the sample at hand is the scenario GE-NRW-DF (see Deliverable 2.1[6]). The farm is an integrated farm that has Holstein dairy cows and fattens the male offspring. The fattening is done indoors using maize silage and concentrates as feed while cows are fed with grass and maize silage as well as concentrates. Besides cattle production the farm is also involved in cash crop production.

In GE-FRG fast rotational grazing is introduced. The innovation is assumed not to be suited for the fattening stage as raising group of bulls on pasture is considered as too dangerous. All other animals may be kept on pastures using fast rotational grazing. The idea is that, by reorienting the feeding of the dairy herd, other resources are freed for beef production. As before, the technical implementation is identical to the description in D4.3.

GE-SR combines FRG with the use of sexed semen and crossbreeding. The idea is that through the use of sexed semen (female) the amount of animals needed for replacement is reduced or beef semen can be selected to gain higher yielding bull calves only. Furthermore, cross breeding the Holstein dairy cows with a beef breed, i.e. Belgium Blue is possible. The resulting cross animals are not expected to get a price premium but are higher yielding meaning higher weight gains and a

[6] *idem*

higher carcass yield. Therefore the bulls reach their slaughter weight about a month earlier with a dressing percentage of 59%. For the scenario, a price per sexed semen dose of 15 Euro was assumed.

4 Modelling system combination

In case of weanling production on segregated farms both farms are modelled as individual enterprises in Farmdyn. This implicates that each farm is represented in its own optimization problem. The resulting production program is used to calculate the aforementioned indicators for each farm. However, in order to evaluate the systems performance, single indicator scores for the system as a whole are needed. Hence, all impacts are calculated per kg of beef meat carcass weight delivered at the farm gate for the whole system. In integrated dairy and beef production systems where milk, calves and old cow beef are produced alongside each other economic allocation is used to distribute impacts among products based on product prices.

The transfer of animals between the farms is considered as follows: on the delivering farm, all impacts and meat produced are calculated per kg of transferred animal. This information is then handed to the receiving farm as an impact factor per kg of imported animal. The conversion to kg of imported/exported animal is chosen as the age and weight of transferred animals on the delivering and receiving farms do not always match perfectly.

Furthermore, emissions from the transport itself are considered too. It is assumed that transport is done by lorry. The transport distance was assumed to be 800km for FR.Cant-CC + IT-F.226, 100km for BE-CC2 + BE-F and BE-D + BE-CC2.

5 Technical and social feasibility of the implementation of the innovations

Table 3: Summary of zootechnical and economical data relative to the farms of interest. (DCB F: Dairy calf breed fattener; DF: Dairy-Fattener; MC B: Mother cow Breeder; MC F: Fattener; MC-BF: Breeder-Fattener)

	BE-CC2	BE-CC2	BE-F	BE-D	BE-CC2	GE.NRW-DF	GE.NRW-DF	GE.NRW-DF	FR.Cant-CC	FR.Cant-CC	IT-F.226	Fr.Cant-CC
Innovation	Base	FRG	Base, FRG	SR	SR	Base	FRG	SR	Base	FRG	Base, FRG	SR
Type	MC B	MC B	MC F	Dairy	DCB F	DF	DF	DF	MC B	MC B	MC F	MC BF
Permanent Grasslands (ha)	64	64	0	54	64	27	27	27	72	72	0	72
Tillable Land (ha)	54	54	0	0	54	198	198	198	0	0	33	0
Suckler Cows (head)	180	180	0	0	0	0	0	0	78,99	82,47	0	77,74
Dairy Cows (head)	0	0	0	70	0	130	130	126,61	0	0	0	0
Bulls Sold (head/year)	90,67	90,67	120	0	468,87	55,64	55,64	43,68	37,11	38,74	226,8	36,52
Animal protein produced (kg P/year)	8020,2	8020,2	8280	16386,8	28132,5	36702,43	36702,43	34957,57	1925,55	2010,43	11793,6	2395,8
Revenues : Animal (k€)	233,1	233,1	289,8	172,75	526,08	436,82	436,82	442,02	68,62	71,64	292,54	88,02
Revenues : Beef (k€)	233,1	233,1	289,8	14,17	526,08	124,71	124,71	138,17	68,62	71,64	292,54	88,02
Revenues : Crop(k€)	39,81	45,49	1,5	0	103,11	255,86	262,5	261,74	0	0	0	0
Feed Cost (k€)	28,95	24,54	47,37	19,81	144,25	25,97	32,32	33,03	3,75	2,16	16,24	5,96
Variables Costs (k€)	116,61	112,63	230,68	45,04	313,97	266,44	270,47	273,34	22,57	20,59	237,61	23,48

The simulation results are summarised in Table 3 for the zootechnical and economic farm level results. More data are available in D3.4. Environmental and social results at system level are displayed in Figure 1.

5.1 FRG

The Belgian and French-Italian scenarios show positive but limited impact of FRG. The decrease in GWP, if significant, comes mainly from a reduction of feed inputs thanks to the better use of grasslands. Other effects, not taken into account in this study, such as the impact of the feed quality on methane emissions could change the conclusion. The possibility to use FRG also affects weakly but positively the net efficiency and the profit. The gain in profit, while expected, deserves further investigation in regions where droughts have become more frequent in the last years. Some participants of the French restitution workshop also mentioned that some assumptions are rather optimistic such as the maintenance of spring grass quality in summer, but some other emphasized that some potential benefits of FRG have been omitted such as the higher milk production of suckler cows that could improve the calve growth. Some French participants of the restitution workshop also mentioned that FRG might improve farm resilience to economic and climate hazards.

The working time needed to produce one kg of meat is strongly increased (compared to traditional grazing system), due to the pasture management and the feeding on pasture. This matches farmers and other stakeholders' warnings mentioned during focus groups and restitution workshops. In particular, Walloon value chain actors feared that fast rotational grazing would represent more workload linked to more frequent changes of plot and fences installation. Some French farmers noted that FRG seems to bring little additional profit for additional work and requires technical competences. However, some testimonials state that the working comfort is improved thanks to reduced time spent indoors for animals (Crochet 2016). In addition, shorter time periods in paddocks allow for better ingestion and better performance of the animals (Bessière and Barat 2014). It also improves animal health and welfare (Undersander et al. 2002), as mentioned by some participants from Italian and Walloon focus groups. Furthermore, during Walloon and Italian focus groups and restitution workshops, participants suggested marketing the meat produced on grass through short distribution channel. This would allow farmers to ask a fairer price to consumers by benefiting from a better image of their production. Therefore additional working time could be rewarded too.

In the German scenario only limited effects of FRG are observed on the beef production indicators. Only limited impact trickles down as the major impact is lost in the allocation between dairy and beef production.

5.2 BE-SR

The system redesign into crossbred fattener shows a bigger effect. As already observed in the literature, beef from dairy herd have lower impact on the climate. This is explained by the climate impact intensity of the crossbred calves coming from dairy herd. Indeed, while having similar (but generally higher) methane emission than suckler cows, dairy cows produce high quantity of milk, which dilutes the GWP of the male calves produced. Still, the obtained value is low and need to be validated. This scenario also produces very interesting results for profit and working time. Net efficiency for the meat production is increased but still under 1. This results from an optimal feeding of cereals and grass produced on farm, and by-product bought outside the farm. These results, while being promising, call for experimental validation. Furthermore, during the focus groups, actors of the value chain mentioned the risk of meat becoming a by-product of milk. This reticence must therefore be taken into consideration in case of implementation.

Among the many trials performed, only an adjustment of the herd size to the fodder resources available or a significant new by-product allowed to increase significantly the net efficiency. In focus groups, some farmers suggested to decrease the size of the herds as a mean to improve the economic sustainability of the beef systems. In general, the use of by-products was widely accepted even though farmers were afraid by the dependency on the industries providing those by-products and by the variations in quality, nutritional contents and availability.

5.3 FR-IT-SR

The system redesign requires keeping animal longer on the cow-calf farm. As each animal requires more feed, fewer cows and bulls are produced than in the baseline system. The production of protein increases for the cow calf farm since animals are sold heavier which lead to higher revenues. This offsets the increases in feed costs and variable costs and lead to higher profit for the cow-calf farms. Considering the whole production cycle with the Italian farm, this system re-design enables to reduce the global warming potential (GWP) of beef meat, increases its net human edible protein efficiency and farmer profit. Nonetheless, this system is less labour efficient. This system has been tested in the INRAe experimental farm of Laqueuille. The animals performed very well to produce tasty meat. Cross-breading Salers cows with Angus bull seems to be efficient to produce grass-fed young fattened animals. However, more harvested forages were required since young bulls were kept one additional winter. Above all, the quality of the fodder harvested and stored must always be excellent to obtain sufficiently heavy and well conformed animals. It was a handicap for the past years characterized by severe drought or low quality forages and the experimental farm was not self-sufficient in forage. Furthermore, as this type of animals is far from the standards in the beef industry, the marketing of animal products was not always favourable; in some years finished animals were sold cheaper than if these animals were sold to foreign markets. Some French stakeholders regret that an Anglo-Saxon breed was chosen instead of working on early maturing phenotypes within the Salers breed. Developing cross-bred animals will have impacts on the renewal and selection of Salers females.

5.4 GE-SR

The German scenario indicates potential drawbacks of the adoption of new technology. On the farm, the new technology of using male sexed semen of Belgium Blue bulls is used to have higher yielding animals for fattening. Although the meat of cross bulls receives no additional price premium the bulls tend to be more profitable as they have a higher weight gain and carcass yield. This gain in intensity compared to pure bred Holstein bulls rises the demand for protein feed. Due to the utilization of sexed semen, the amount of bulls fattening is increased. The additional animals fattened and the higher protein demand for fattening leads to an extension of fodder production on arable land, i.e. maize silage, and a higher import of protein rich concentrates. This leads to the observed indicator scores. The GWP is slightly increased because of the higher share of imported feed on the farm. Net efficiency declines as more forage comes from land that would otherwise be allocated directly to dairy production. Profit per kg produced is only slightly increased as the economic value of the feed is higher. Still the overall farm profit is higher as the total production of beef is increased.

These results indicate potential drawbacks of otherwise sound technologies. Although sexed semen and cross breeding can improve the sustainability of existing value chains they can also worsen them if implemented in a wrong way. Production expansions should focus on a higher utilization in grassland areas to forego potential conflicts in the production of fodder on land that is suitable for primary food production.

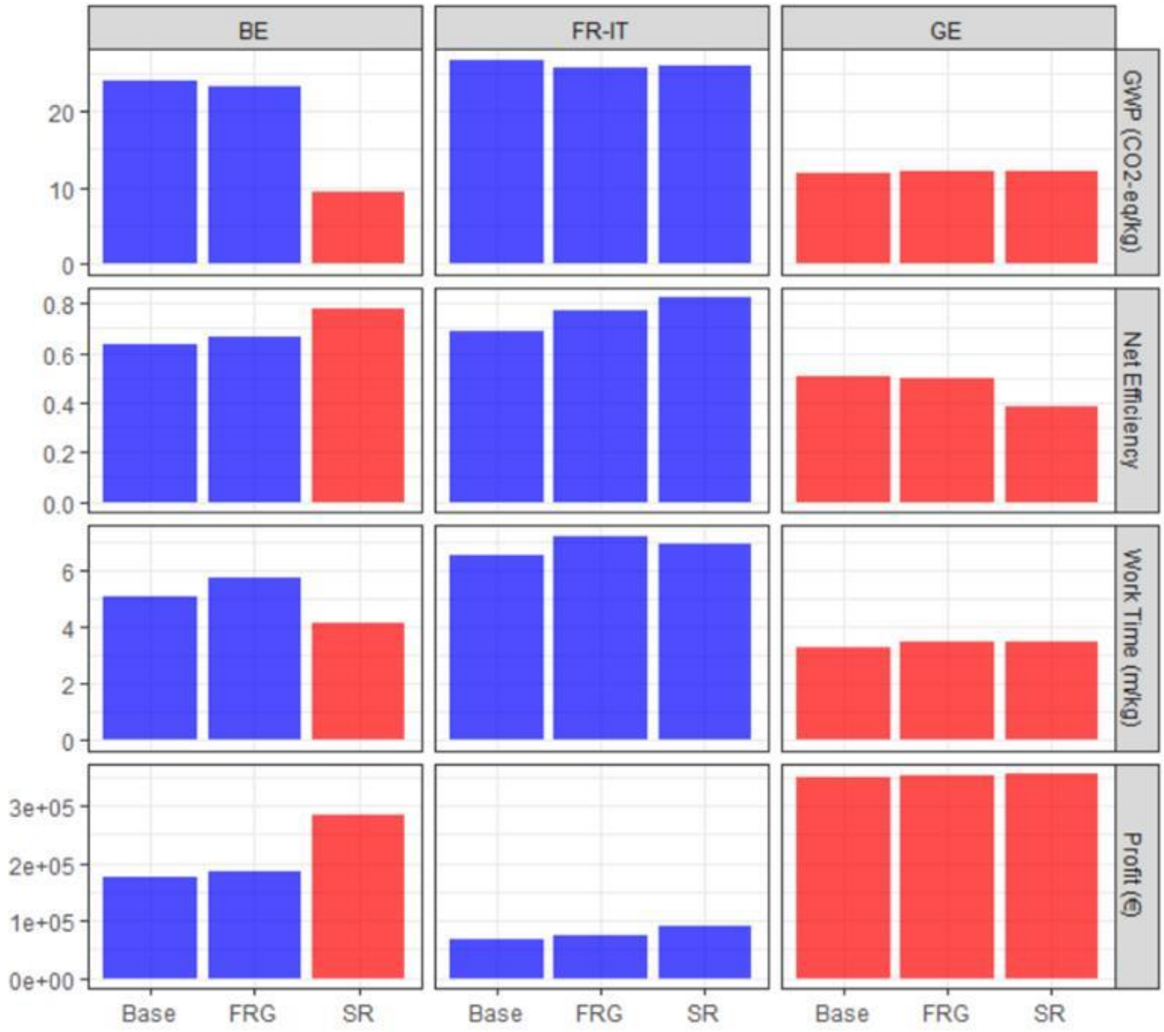

Figure 1: Values of Global warming potential (CO_2-eq/kg of carcass), net efficiency, work time (minute/kg of carcass) and profit (€) for the 9 scenarios described. The Profit shown, is the profit of the "farm of interest" in which the innovation is applied (BE-CC2, FR-CANT-CC and GE-NRW-DF). In blue: the mother cow and fattener system and in red: from dairy system to beef system.

6 Discussions and conclusions

Another aspect, that cannot be assessed by the model and which was a matter of concern for participants in the focus groups, is the quality of meat produced on such innovative systems. Recent work on the quality of animal products according to their method of production and transformation defines the quality of a product as *"all the properties that make it suitable for satisfying the needs implicit in or expressed by the players concerned* [editor's note: producers and transformers] *and by consumers"* (Prache and Santé-Loutelhier 2020). The authors consider the quality of a product through 7 dimensions or properties, as illustrated in the Figure 2.

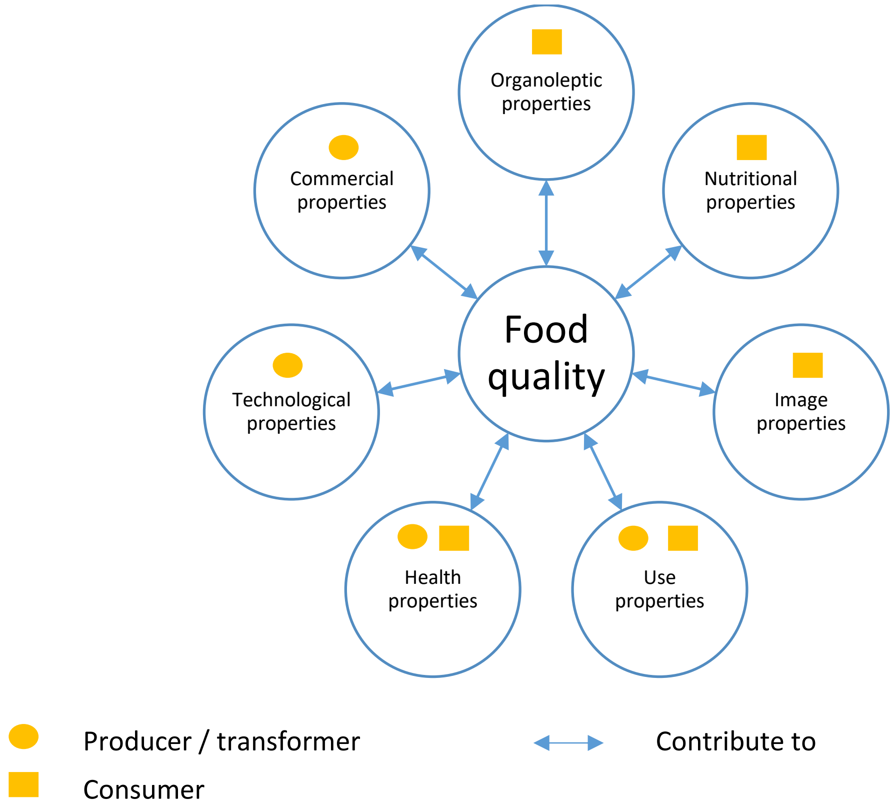

Figure 2 – The 7 properties of the quality of a food of animal origin (adapted from (Prache and Santé-Loutelhier 2020))

> *The **organoleptic properties** refer to perceptions (colour, texture, juiciness, odour and flavour).*
> *The **health properties** relate to the hazards or benefits associated with the consumption of a food.*
> *The **nutritional properties** refer to the nutrient content of foods and their bioavailability.*
> *The **commercial properties** depend on the type of product. For the meat, they are based on weight and aspect criteria (carcass conformation, fat score). They determine the price paid to farmers.*
> *The **technological properties** refer to the product's aptitude for processing and preservation.*
> *The **properties of use** refer to the practicality of the product (ease of use in terms of time and energy for the consumer).*
> *The **image properties** refer to animal welfare, access to pasture, low stocking rate, good environmental practices, the local character of the product, etc.*
>
> (Prache and Santé-Loutelhier 2020)

Seen from this angle, the scenarios based on “cattle fattening on pasture” are of interest to stakeholders, in terms of the image properties it conveys, which address with some challenges mentioned above concerning society and consumers’ expectations (ecosystem services linked to the grassland, animal welfare, concordance with cultural representations). However, they raise questions about the commercial properties (impacts on conformation of the carcass, fat score, slaughter age), the organoleptic properties (acceptance by the consumers), the technological properties (maturation period), as well as the properties of use (seasonality of the production).

As in Europe, the primacy is given to commercial properties (Prache and Santé-Loutelhier 2020), and as these properties determine the remuneration of farmers, most of the stakeholders call for a specific valorisation of such a meat – they evoked a niche market and differentiated quality – whose interest must however be investigated. Indeed, if the valorisation in short supply chain could be a lever from their viewpoint, this also raises in particular the question of the additional workload for the farmers and their accessibility to slaughter houses.

In Wallonia, the scenarios based on “cattle fattening on pasture” join partially the strategic plan of the “college of producers”, an association at the interface between producers, decision makers and value chain actors, including consumers (Collège des producteurs 2020). Indeed, this plan recommends in particular accentuating the link between beef production and grassland, which is in line with the Walloon scenarios[7].

This plan also argues for supporting of fattening in Wallonia, with 50 % of the suckling systems re-design in breeder-fattener systems by 2030 (Collège des producteurs 2020). Currently, the Walloon beef farming systems are mainly focused on breeding. Wallonia is therefore very dependent on other territories for the fattening and therefore for the valorisation of its beef production (Pétel, Antier, and Baret 2018). The re-design of breeding systems into fattening systems is an element included in the scenarios BE-SR (see Table 1), which lead to a re-design of the whole chain, and in particular, of the BE-CC2, that becomes a growing-fattening unit of crossbred males or dual-purpose males, instead of a breeding unit of BB grazers.

Concerning the impact of the grass-based scenarios on the organoleptic and nutritional properties of the meat thus produced, the acceptance of such a meat by the consumers remains a matter of concern for the Walloon stakeholders. As Pétel et al. point out, *“in Belgium, consumption is mainly oriented towards tender, lean and clear meat, which corresponds to that of BBB young bulls”,* whilst several studies tend to show that grass-fattening leads to *“a stronger colour (B-carotenes), a good tenderness and a superior juiciness of the meat. Grass-fed meat also has certain superior nutritional characteristics, i.e. higher levels of B-carotenes, vitamins A, E, B2 and B9, and polyunsaturated fatty acids (especially omega 3) »* (Pétel, Antier, and Baret 2018). However, the possibilities to valorise this kind of meat in short supply chain or in a niche market through distinctive quality could be a solution as long as it don’t become the mainstream, consumers being interested (Pétel, Antier, and Baret 2018). These two possibilities join the strategic plan of the college of producers, that recommends to valorise 10 % of the beef in short supply chain and 30 % of the beef in a niche market by 2030 (Collège des producteurs 2020). The Walloon stakeholders claim for the study of the interest of such a valorisation.

Concerning the kind of animals produced (breed, slaughter age, type) and the commercial properties (carcass conformation, fat score), the current beef production in Wallonia is mainly oriented towards the Belgian Blue breed (even if French breeds seem to be developing), and in particular the production of grazers (BE-CC1 and BE-CC2) and young bulls (BE-BF)[8]. However, given the growing consumers’ preferences for convenience food and minced meat, the characteristics of the carcass of Belgian Blue do not correspond anymore to the demand (imbalance between forequarter and hindquarter), on the contrary of cull dairy cows carcasses (Pétel, Antier, and Baret 2018). Scenarios BE-SR are of interest from this point of view, as they focus on the production of crossbred males (Holstein x BB) or dual-purpose breeds. When questioned on this subject, the Walloon stakeholders also advocated valorisation within the framework of an integrated production chain based on minced meat.

[7] At the opposite, the current main practice in Belgium (except in organic breeding-fattening systems) is the fattening in the barn (Pétel, Antier, and Baret 2018).

[8] For more information please contact us by e-mail at s.hennart@cra.wallonie.be or visit our institution website www.cra.wallonie.be

In France, in December 2018, the beef sector has proposed a strategic plan for the next 10 years. The main objectives are to increase the global quality (including the response to the societal demand as animal welfare, ect.) of the meat and a better sharing of the added value along the whole chain (from the farmer to the retailer). To do this, the French beef industry wants to significantly develop the production of labelled beef (Label Rouge: from 3% to 40% of beef production, doubling the production of organic beef in 5 years) and encourage stakeholders to contract. By improving the overall quality of the meat, beef production systems must evolve by focusing on the fattening phase (grazing access, feed/food competition) and the genotypes used (more early-maturing breed).

In Germany, additional research should aim at evaluating effects of the use of sexed semen on a higher aggregated level. Economic refluxes, like price effects of increased production, might hamper the aforementioned findings in that the total production might be decreased.

From a general point of view, the scenarios based on “cattle fattening on pasture” raise the question of the management of young bulls on pasture (scenarios FRG and SR). A solution put forward by the stakeholders would be to resort to steers. However, as highlight by the stakeholders, this could negatively affect the image properties that the scenarios convey (in opposition with animal welfare). Moreover, this would negatively affect the animal performances, and therefore animal life length. These would lead to a deterioration risk of the environmental impact of beef meat and farmer revenue.

Technically, the use of local by-products (scenarios FRG and SR), as it must be limited to a share of 30% in the diet, could affect the zootechnical performances (older slaughter age), and consequently the commercial properties.

6.1 Incentives measures supporting the scenarios

Among the incentives measures that could support the scenarios based on “cattle fattening on pasture” identified by the stakeholders in Wallonia, France and Italy, we find:

- Ease the access to land: cost and land consolidation in order to support grazing practice, and in particular fast rotational grazing;
- Support the development of technical references and guidance concerning the grasslands management and grazing practices;
- Study the interest of a specific valorisation of the meat produced in such a system, in particular the interest of a distinctive quality;
- Supporting the valorisation in short supply chain, in particular in maintaining the accessibility of local slaughter houses for farmers;
- Study the interest of the development of an integrated value chain focused on minced meat coming from crossbred animals (terminal crossing) or dual-purpose breed. This integrated supply chain also includes the development of relations of trust between dairy farmers and beef farmers in order to guarantee the health of the animals traded;
- Ensure the availability and the supply in local by-products.

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8 Appendixes

8.1 Appendix 1 – Grass fattening: barriers and levers identified by breeders, advisors and value chain actors

Barriers		Levers	
	Scale		Scale
Standards production (linked to downstream value chain) (FG6): (1) **Slaughter age**: grass fattening implies to extend the fattening phase → Incompatible with the current standards in Wallonia (young bulls production, less than 24 months old) (FG6, 7, 8) (2) **Colour of fat**: grass fattening changes the colour of the fat (whiter or greyer vs yellow if maize-fed) (FG6) (3) **Fat firmness**: carcasses of cattle fed with maize are firmer than those fed with grass (FG6) (4) **Maturation period** (FG3): some participants linked grass fattening with a longer maturation period than the one currently practiced (5) **Fattening score (FG7, 8): currently, the selling price is low, what will it be for cattle with lower fattening score? (FG7)** (6) **Meat quality and consumers acceptance**: grass fattening can impact the meat (organoleptic changes). Do the consumers like this kind of meat? (FG6, 7, 8)	VC	**Valorisation in short supply chain**: it can help to avoid standards production brakes (FG6, 7). However, the consumers' acceptance for this kind of meat still remains a concern (FG6). Short supply chain can also lead to workload increase (FG7)	VC
Over-linking beef production to grassland could lead to the elimination of suckler farming in entire regions (FG8).	T	**Ecosystemic services delivered by grassland in connection with ruminants**: it could be a response to criticisms towards beef farming (FG1, 3, 6, 7, 8).	T
Selling price: grass fattening must lead to an economic added-value, which does not exist currently (FG5, 7)	VC	**Social acceptance**: it could be an argument in terms of **image** (it corresponds to the idealized image of "a cow eating grass") (response to criticisms towards beef farming) (FG6, 7, 8)	VC
Workload: for some participants, grass fattening involves additional workload (e.g. valorisation in short supply chain). All the participants do not share this point of view. Indeed, some of them think that grass fattening can reduce workload and free up time (FG6, 7)	F	Improve **animal welfare** (FG5, 6, 7): *"Cows are made to spend time outdoor eating grass". "They will be better than locked in a barn"*. This opinion is not shared by all participants (FG7).	F, VC
Breed: grass fattening can require herd change towards specific breeds: breeds having early fattening capacity, lighter breeds (FG6, 7). All the participants do	F	**With steers:** to avoid breed issue. But extends the slaughter age and decreases animal welfare (FG7)	F

Barriers		Levers	
	Scale		Scale
not share this opinion. Indeed, some of them highlight that the barrier comes more from the value chain (standards production mentioned above) than from the breed (FG6).			
Lack of agricultural interest for grassland (in Wallonia): this poor interest for grassland can lead to a **lack of technical references and guidance related to grassland management and grazing practices** (FG6, 7)	F, T	**Improve animal health (FG6):** vitamin D supply (FG7)	F
Seasonality of products: as the production of meat is linked to grass growth, all the production come at the same time on market (FG3)	VC	**Breeder's pride** (FG6)	F
Access to land: availability and cost of land (FG6, 7)	T	Organization of exchanges between forerunners farmers (FG7)	T
Quality variability of the grass: the feed value of the grass depends on several elements: climatic conditions, management, storage and conservation conditions, … (FG6)	F, T		
Management of young bulls in plots: risk of injury (dominant/dominated competition), proximity to heifers (FG6)	F	→ **With cows rather than bulls:** participants pointed out thereupon the requirement of valorisation in short supply chain (FG6) **With steers rather than bulls:** participants again pointed out the requirement of valorisation in short supply chain. The question of animal welfare also raised (FG6)	F
Climatic conditions: e.g. risk, in case of drought period, to have to supplement the animals on pasture (the Walloon case of the year 2018 is evoked) (FG6, 8)	T	**Reduction of equipment** (manure management, barn)	F
Must remain a niche market: in order to be able to sell it at a price that will offset the cost in terms of surface area, in particular. Not all participants share this opinion (FG7)	VC		
Environmental cost: what about the impact of such a system on environment? (FG8)	T		

8.2 Appendix 2 – Dynamic rotational grazing: barriers and levers identified by breeders, advisors and value chain actors

Barriers		Levers	
	Scale		**Scale**
Increase the number of water points needed (smaller plots) (FG3)	F	**Savings:** reduction of operational and structural costs (fuel) (FG3)	F
Increase the workload: for the fences (FG3, 8), time consuming for the change of plots (FG8)	F	**Health benefit:** • **less stressful** for cows because they have enough to eat all the time (FG7) • **reduction of parasitism** (FG7, 8): this aspect could even be improved if associated with mixed species grazing system (FG8)	F
Skills: estimate the "good" stocking rate, the grazing time → need for guidance (FG3), need for skills (FG7)	F, T	**Feed intake:** increases the appetency (FG7)	F
Fragmented area (FG3, 7)	T	**Animal performance:** increases milk production if cows have a permanent access to high quality grass in quantity → benefit for calves too (FG7)	F
Equipment: adapted fences, mower for the refusals (FG7)	F	**Feed efficiency:** better valorisation thanks to constant grass feeding value (FG7)	F
Health risk: risk of enterotoxemia for the calves (FG8)	F	**Management tools:** grazing calendar (FG7)	F
Land price and inputs costs (FG8)	F, T	**Facilitate the management of refusals:** even more if it is associated with mixed species grazing system (FG8)	F
		Ecosystemic services: opens the landscape, increases biodiversity (FG8)	T
		Organization of exchanges between farmers, advisers (FG3)	T

8.3 Appendix 3 – Alfalfa and red clover as protein supplements: barriers and levers identified by breeders, advisors and value chain actors

Barriers		Levers	
	Scale		Scale
Cost and access to land: requires available areas, but the UAA is limited (FG6)	F, T	**Feed autonomy/savings:** reduces the feed purchases (FG6)	F
Climate and soils conditions: soil's PH for the alfalfa (FG6)	T	**Improve the appetency (FG6)**	F
Availability of the seeds: if everybody does it, it could be a problem (FG6)	VC	**Optimize land use**: improve the valorisation of the UAA (FG6)	F, T
Equipment required: cost of specific equipment or of the service of an agricultural work company (FG6)	F	**Improve the feed efficiency of the ration (FG6)**	F
Cost of the wrapping of the alfalfa (FG1)	F		
Globalization: this innovation must be implemented all over the world in order to reduce feed-food competition (FG2)	T		

8.4 Appendix 4 – Crossbreeding (continental breed x breed with an early maturity): barriers and levers identified by breeders, advisors and value chain actors

Barriers		Levers	
	Scale		**Scale**
Farmers/actors in genetic selection: attachment to traditional breeds. Cross Belgian Blue or French breed with one that have lower carcass yield (e.g. Angus) results in the loss of all the benefits of the Belgian Blue/French breed for some participants. Indeed, one French participant opposed "pure breeds" to "composite breeds" (FG1), while one Walloon participant speak about a "loss of the specificity of the breed and the identity linked with this specificity" (FG8)[9]. The same participants however pointed out the interest for crossing, but keeping the specificity of the breed (i.e. double-muscled type) (e.g. double-muscled Charolais x Belgian Blue) (FG1,8).	VC, T	**Avoid degeneration** (FG8)	F, VC
Consumers' acceptance: need for a validation. Not all participants share this opinion. Some of them evoked the Irish beef as an example (FG8)	VC		
Potential drift: meat as a by-product of milk (FG8)	F, VC, T		

8.5 Appendix 5 – Terminal crossbreeding (meat breed x dairy breed): barriers and levers identified by breeders, advisors and value chain actors

Barriers		Levers	
	Scale		**Scale**
Need to increase the fertility of the herd (FG4)	F	**Increase the income** (better valorisation of the calves) (FG4)	F, VC
Selling age: dairy farmers prefers to sell the calves very quickly (avoid time spent to take care of them, cost of feed), while beef farmers prefers to buy not too young calves (avoid diseases) (FG4)	F		

[9] This participant was the representative for cattle trader. However, he is also breeder and actor in the selection of Belgian Blue.

8.6 Appendix 6 – Synthesis of the Walloon stakeholders' opinion on the scenario "BE-BF x Fast rotational grazing x Use of local by-products"

Controversial elements of the scenarios	Why?	Gap compared to the outputs of the optimization	Fine-tuning of the modelling	Future work
Management of young bulls in pasture	Technically complicated (risk of injuries, dangerosity, …)	This technical difficulty cannot be taken into account by the modelling		Simulations with steers instead of bulls Study the use of castration from a technical and societal point of view. Study the interest of a specific valorisation (distinctive quality)
Use of by-products	Economic risk due to price and availability fluctuation	Risk of lower than expected incomes	Sensitivity to by-products price fluctuation to determine the impact on the scenario	Study the availability of inedible by-products in the territory
	In conflict with search for autonomy in its autarky dimension			Study the dynamic between search of autonomy and search for low feed-food competition
Limit the use of by-products to 30-40% in the finishing phase	Difficulty (or even impossibility) to produce young animals as imposed by the current standards in force	Risk of valorisation's difficulties due to older than expected slaughter age	Simulations of older slaughter ages and better carcass conformation and fat score	Study the interest of a specific valorisation (distinctive quality)
Dynamic rotational grazing technique	Implies to have plots near the farm and in one block (or in several blocks if there are access paths)	Feasibility		Study the interest of a land consolidation

Belgian Blue Breed	Is the Belgian Blue a suitable breed for a grass-based scenario given its lower feed intake capacity?	Risk of lower than expected performances		Literature review and, if needed, simulations comparing the zootechnical performance achieved with the BB compared to other meat breeds
Dynamic rotational grazing with supplementation in pasture in a mixed livestock-cropping system	Fear of an unmanageable workload			

8.7 Appendix 7 – Synthesis of the Walloon stakeholders' opinion on the scenario "combination of (BE-D x Terminal crossing using sexed semen) and (re-design of the BE-CC2 x Fast rotational grazing x Use of local by-product)"

Controversial elements of the scenarios	Why?	Gap compared to the outputs of the optimization	Fine-tuning of the modelling	Future work
Use of sexed semen	On average, 3 doses are needed in order to succeed sexed insemination (compared to 2 doses in classic insemination): does the sale of the crossbred calves at better price cover the cost of sexed semen?	Risk of lower than expected incomes for the dairy farmers	This element is currently studied by the German team	
Crossbred males purchase	Health risk for the herd	This risk cannot be taken into account by the modelling		Study the possibility to develop a "trust chain" between dairy and meat farmers OR

				Model a scenario implying the fattening on the dairy farm using dual-purpose breed
Re-design of the system	"Cultural" brake due to the attachment of the breeders in BE-CC2 case-study to the Belgian Blue breed and to their cow-calf system	This risk cannot be taken into account by the modelling		Study the acceptance of the sector, in particular the breeders, for the proposed system
Crossbred males	Greater danger of the crossbred males (for the farmer) than the BB bulls	This element cannot be taken into account by the model		Simulations with steers instead of bulls
Use of by-products	As already highlighted in the scenario 1, this use could lead to an economic risk due to the price and availability fluctuation	Economic risk that could lead to lower than expected incomes	Simulations of price fluctuation sensitivity to determine the impact on the scenario	Study the availability of inedible by-products in the territory
	In conflict with the search for autonomy			Study the dynamic between search of autonomy and search for low feed-food competition
Sale of the crops production (and feed purchase)	In conflict with the search for autonomy			Need for neutral advice
Production of food on the tillable land	The assumption that all the tillable land can be used to produce food needs to be nuanced, depending of the soil and climate conditions and the standards in force in the value chain (e.g. feed grains versus bread-making cereals).	Overestimation of the feed-food competition through the indicator "land use"		Fine-tuning of the indicator "land use"
Valorisation of the production	As already pointed out for the scenario 1, the participants wonder if this kind	Currently, the model considers a slaughter age equal to 19 month, with a		Study the interest of a specific valorisation

	of meat will be accepted by the value chain, given the standards in force.	carcass conformation equal to “U” or “R” and a fat score equal to “3”. This leads to a price of 3.40 euros/kg carcass.		(integrated production chain focus on more minced meat)