FEED-A-GENE

Adapting the feed, the animal and the feeding techniques to improve the efficiency and sustainability of monogastric livestock production systems

Deliverable D6.6

Sustainability Appraisal Workshop

Due date of deliverable: M60

Actual submission date: M60

Start date of the project: March 1st, 2015 **Duration:** 60 months

Organisation name of lead contractor: UNEW

Revision: 1

Dissemination level	
Public - PU	**X**
Confidential, only for members of the consortium (including Commission Services) - CO	
Classified, as referred to in Commission Decision 2001/844/EC - Cl	

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1. Summary

Objectives

(i) To present the results of the sustainability appraisal at a workshop during the final project conference where they will be discussed, validated, and shared.

Rationale: This Deliverable disseminated the findings of the sustainability appraisal reported in Deliverable 6.5 to an audience of over 100 practitioners, academics, and civil society members. The importance of evaluating the sustainability of the innovations proposed by the Feed-a-Gene project was discussed in the light of the United Nations' Sustainable Development Goals and the design and implementation of the composite indicator was presented and illustrated with examples from the project.

Teams involved: UNEW; AFZ

Species and production systems considered: Pigs and poultry across Europe

2. Approach

The Feed-a-Gene project aims to improve and adapt monogastric livestock production systems with the objective of improving their efficiency and reducing their environmental impacts. To achieve this, the project has developed alternative feed resources and feed technologies, while at the same time identifying robust animals that are better adapted to fluctuating conditions and optimizing feeding techniques to ensure the most efficient use of feeds.

The successful achievement of these objectives has economic, environmental, and social consequences that may need to be traded off against each other in a way that reflects stakeholder preferences. Task 6.5 of the project reported on the design of a simple composite indicator that could be used to compare different feeding solutions designed by the project in terms of their overall sustainability as measured by a range of economic, environmental, or social indicators.

The final conference of the Feed-a-Gene project was held at the Hôtel de Rennes Métropole (Rennes, France) on 22 and 23 January 2020. The meeting was designed by colleagues at INRAE and AFZ to provide a range of opportunities for researchers from the project to meet with stakeholders from industry, government, non-government organizations, and civil society, to demonstrate and discuss some of the major innovations delivered by the project. These include the novel feeds developed by the program partners (e.g., protein from green biomass; finely fractionated European rapeseed meal; European soybean meals; decision support software to match the requirements and performance of monogastric animals; genetic improvements in pigs and poultry; and the precision feeding of monogastric livestock.

The final session of the conference included a workshop discussion on sustainability appraisal where all participants were able to share their vision of the sustainability and future of monogastric livestock production systems. This approach was preferred to an alternative based around smaller discussion groups as it allowed all participants in the meeting to consider the sustainability implications of making changes to livestock feeding systems.

2.1 Presentation

The presentation that framed the sustainability appraisal workshop was based around the proposition that the production of feed for livestock is an important contributor to the negative impacts that farming systems may have on the environment (Annex 5.1). It is then argued that changing animal feeding systems is an important approach to reducing these negative impacts. The challenge for the Feed-a-Gene project was to investigate the sustainability of the novel feeding systems proposed by the project to determine the extent to which they improve on the status quo.

Participants were reminded of the familiar Brundtland Commission definition of sustainable development from 1987, before being shown the simplified definition of sustainability that had been applied to livestock production in the Delphi Experiment that was conducted in the first year of the study and reported in D6.1:

“Sustainability is the long-term viability of an activity”

The contemporary context for sustainable development was then discussed within the context of the United Nations' Sustainable Development Goals (SDGs). The 17 SDGs were presented followed by a discussion of what contribution Feed-a-Gene could make towards the associated targets.

Following this, the notion of using sustainability indicators as a decision-making tool to help practitioners choose between different competing feeding solutions was discussed. The discussion was illustrated by the example of the composite sustainability index developed in Task 6.5 and reported in deliverable D6.5. The use of the Delphi method to gather data from expert stakeholders including breeders, geneticists, nutritionists, and farmers was discussed using the example from Task 6.1. It was explained that such data could be used to construct weights that would be required for the calculation of the composite sustainability index such as the one described in deliverable D6.5. The use of the composite sustainability index was illustrated through three worked examples comparing alternative feeding solutions:

- Pig feeds incorporating: (i) green protein or (ii) a fine fraction of European rapeseed meal
- Poultry feeds incorporating: (i) green protein; (ii) European soybean meal from whole beans; (iii) European soybean meal from de-hulled beans
- Feeding systems for individual pigs based on (i) an *adlibitum* feeding strategy or (ii) a restricted feeding strategy.

3. Discussion

Participants in the workshop were all aware that the livestock sector has a responsibility to address some of the areas where current activities have a negative impact on climate change and may conflict with societal aims around sustainable development (Annex 5.2**Erreur ! Source du renvoi introuvable.**). Indeed, the need to address the sustainability of monogastric livestock feeding systems by reducing our reliance on imported Brazilian soybeans and improving the feed efficiency of livestock through precision feeding and breeding solutions had been common themes in presentations and workshops across the entire final conference.

The UN SDGs (see Figure 1) were agreed to an appropriate vehicle to consider the contribution that Feed-a-Gene could make in this area. Participants were asked to suggest to which goals the project to contribute. Following some lively debate, it was agreed that Feed-a-Gene has the potential to contribute to the following five goals:

SDG2 Zero hunger – it was argued that monogastric livestock production still had an important role to play in providing a safe and nutritious source of food especially in parts of the world where animal products were still the favoured or the most accessible source of protein.

SDG9 Industry, Innovation and Infrastructure – Feed-a-Gene aims to develop innovations that both improve the efficiency of monogastric livestock production and make it more sustainable by reducing its environmental impacts. The development of these technologies into commercially-viable resources has been a concern of the project from its outset and the inclusion of industry partners both in the project team and in the final conference were examples of the efforts made to ensure that Feed-a-Gene developed solutions that took into consideration the needs of different industry stakeholders.

SDG12 Responsible Consumption and Production – by improving the sustainability of livestock production, the project is contributing towards the aim of responsible production and, based on the findings of consumer research reported in deliverable D6.4, the project also promotes a variety of practices (e.g., precision feeding, use of novel feed sources) that meet the approval of consumers. It was noted that consumers still tend to exhibit greater concern for the welfare of livestock than the environmental impacts of livestock production, therefore any feeding solutions based around the project would need to demonstrate that they produced a net welfare benefit for livestock. It was argued by one participant, that this trade-off between more sustainable livestock production practices and animal welfare issues in livestock production (e.g., indoor versus outdoor rearing for pigs) is an issue that has yet to be fully dealt with by the industry.

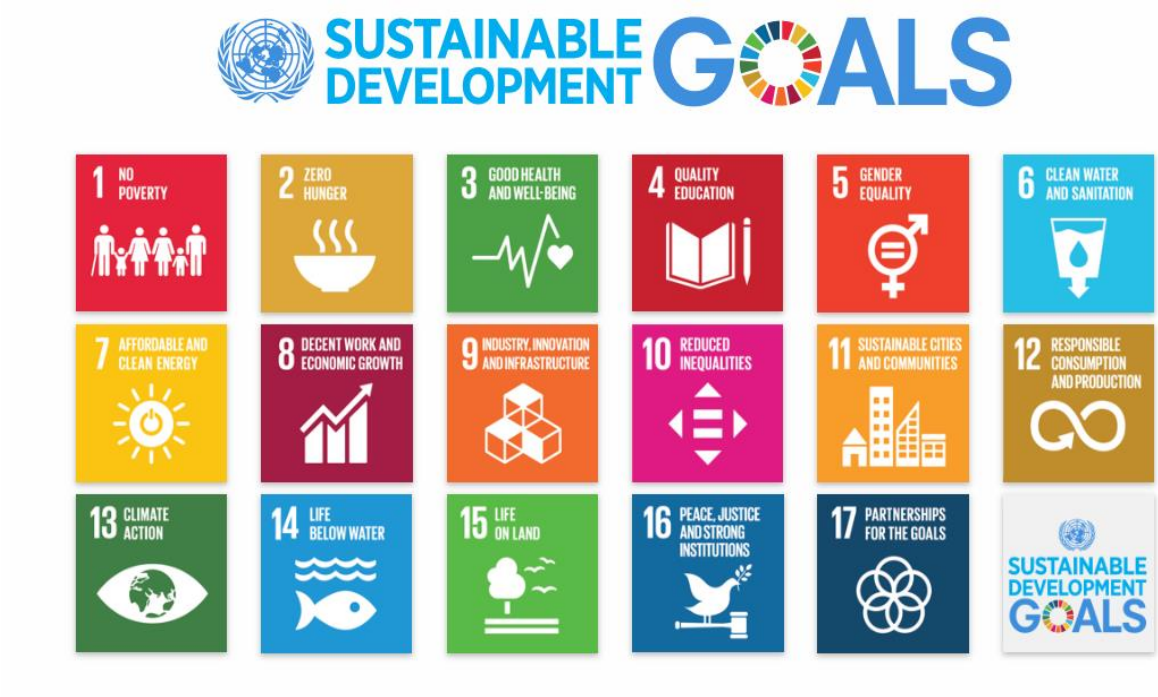


Figure 1. United Nations Sustainable Development Goals

SDG13 Climate Action – an important rationale for Feed-a-Gene is the necessity for livestock feeding systems to become more sustainable and improve the performance of the sector around its negative impacts on climate change. This can include emissions arising from the energy use in the transportation and drying of feed materials, as well as other greenhouse gas emissions. A European livestock industry that is less reliant on imported Brazilian soya beans, the cultivation of which may be associated with deforestation, is a major goal of the project.

SDG15 Life on Land – this goal includes the protection and sustainable use of terrestrial ecosystems such as forests. Again, the project's objective of reducing our reliance on Brazilian soybeans would be consistent with this goal.

Discussion during the workshop suggested that most participants were comfortable with the use of sustainability indicators as a means of assessing the relative sustainability of competing feeding systems. The potential flaws of an indicator approach were discussed, particularly around the availability and reliability of data for key component indicators. Much of the data available from Feed-a-Gene is based on preliminary results, experiments and

models and until ready-for-market versions of the technologies developed in the project are available, it is impossible to accurately measure their ultimate economic, environmental, and social impacts. What the analysis presented here demonstrates, however, is that such approaches have the potential to provide an holistic approach to sustainability appraisal, allowing indicators across the three dimensions of sustainability to be considered, alongside stakeholder judgements about the relative importance of each.

An important concern for industry stakeholders was the likelihood of data being available to implement such approaches to sustainability appraisal in the future. If, in the future, a producer wished to compare an existing production method with a novel alternative, then data would be required on the economic, environmental, and social performance of both the existing method and its potential replacement. The chances of such data being available in a suitable form, alongside appropriate indicator weights, were argued to be unlikely, unless the development of new technologies was accompanied by a similar process of data collection and analysis as that implemented in the Feed-a-Gene project.

4. Conclusions

The sustainability appraisal workshop successfully demonstrated the potential contribution of the Feed-a-Gene project on the sustainability of monogastric livestock production systems. It further demonstrated that the project could help the livestock sector in its efforts to contribute to achieving the targets set for five of 17 UN SDGs.

Crucially, the feeding solutions generated by the project offer a range of opportunities for livestock producers to be more sustainable. In particular, the replacement of Brazilian soybean meal in the feed mix with a locally-produced protein has been shown to have the potential to reduce energy costs and could have a positive impact on climate change and terrestrial ecosystems if it reduces deforestation.

It was noted that level of environmental benefits and the sustainability of novel feeds depends largely on the amount of Brazilian soybean meal being incorporated into feeds. In scenarios where the price of soybean meal is low, larger amounts are likely be used in feed. Therefore, its replacement with a more local protein alternative, such as European soybean, rapeseed meal, or green protein, can improve the sustainability of monogastric livestock feeds, though this could be offset by economic costs linked to an increase in the cost of production if the resulting weight gains are smaller or feed costs higher. A note of caution was added in the discussion where ambitious plans by China to re-invest in its pig industry, recently devastated by African Swine Fever, were argued to have the potential to provide a ready market for South American soy beans and generate the same negative environmental impacts that this project is trying to reduce.

The commercialisation of the innovations generated by Feed-a-Gene was also discussed. The sustainability appraisal demonstrated that, based on the assumptions used in the project, the adoption of many of innovations explored in the sustainability appraisal would have a negative economic impact compared to the status quo. This highlights the need for commercially available solutions based on these innovations to be able to improve production efficiency and at the same time reduce associated costs. This would need to be done without reducing the positive environmental benefits associated with these innovations.

Precision feeding solutions offer another route to more sustainable livestock production and this study provides clear evidence that the adoption of individual *ad libitum* feeding systems for pigs increases sustainability by reducing key environmental impacts and increasing profitability compared to a conventional biphase feeding alternative.

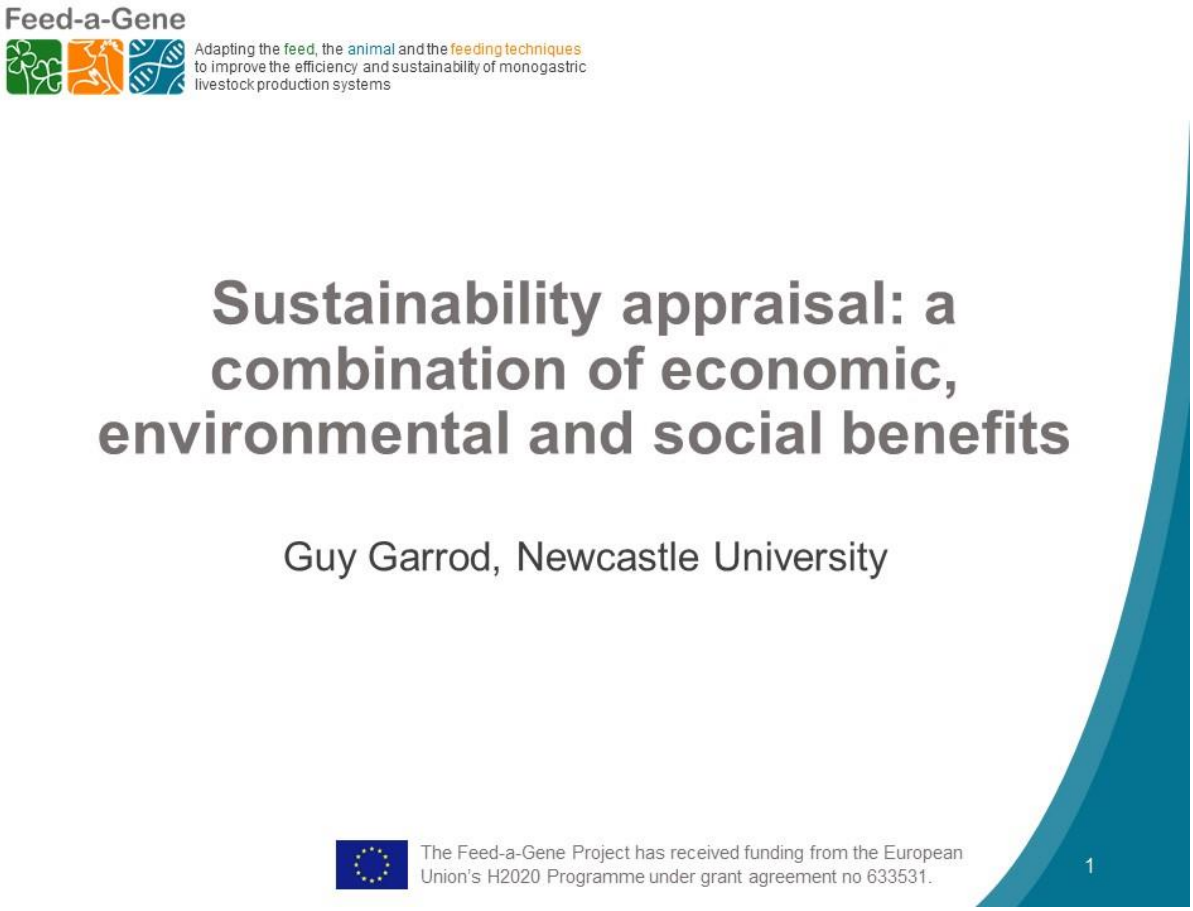
The use of an indicator-based approach to sustainability appraisal in the future will be dependent upon the availability of suitable data on the economic, environmental, and social performance of novel feeding solutions, along with information about the relative importance of these different factors in achieving sustainability. The approaches demonstrated in work package 6 provide a template to deliver such data but their use requires expertise in techniques such as life cycle assessment, cost-benefit analysis, and Delphi methods that would typically be beyond many industry stakeholders. This could lead to the adoption of ad hoc approaches to sustainability appraisal based around a small number of available variables (e.g., costs, profitability, resource use) that may not give a rounded assessment of the impacts that a given feeding solution may have in terms of its sustainability.

Therefore, if the industry is serious about adopting the most sustainable solutions possible and willing to trade-off short-term economic benefits against better environmental performance, it will need to develop partnerships with organisations that can provide the expertise and data necessary to undertake more holistic sustainability appraisals. It should also be borne in mind that, while this approach has the ability to identify approaches to livestock production that have a lower overall impact on sustainability, it may be the case that these are still less sustainable (particularly in an environmental sense) than the production of alternative proteins for human consumption. The future role of animal proteins in our diet is therefore a matter of debate, in which the industry should play an important part, supported by strong evidence of its commitment to do everything that it can to make livestock production as sustainable as possible. The work of the European Commission and the research it funds through projects like Feed-a-Gene, will be crucial in achieving this objective.

5. Annex

5.1 Presentation of the sustainability appraisal workshop

Area of expertise of the participants	External stakeholders	Feed-a-Gene participants	Total



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The problem - and the solution?

The production of feed for livestock is an important contributor to the negative impacts of farming systems on the environment, so changing animal feeding systems is one approach to reducing these impacts.

The challenge for Feed-a-Gene is to investigate the sustainability of the novel feeding systems proposed by the project to determine the extent to which they improve on the status quo.

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Defining sustainable development

In 1987 the Brundtland Commission provided the following influential definition:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

We use a simplified definition:

"Sustainability is the long term viability of an activity"

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UN Sustainable Development Goals

- The United Nation's Development Programme has set out 17 revised Sustainable Development Goals (SDGs).
- They build on the successes of the Millennium Development Goals and include new areas such as climate change, economic inequality, innovation and sustainable consumption.
- Each of the SDGs has specific targets to be achieved by 2030. Reaching the goals requires action by governments, businesses, civil society and individuals.
- The livestock industry can play its part by increasing the sustainability of livestock production through a range of measures that impact on the SDGs.

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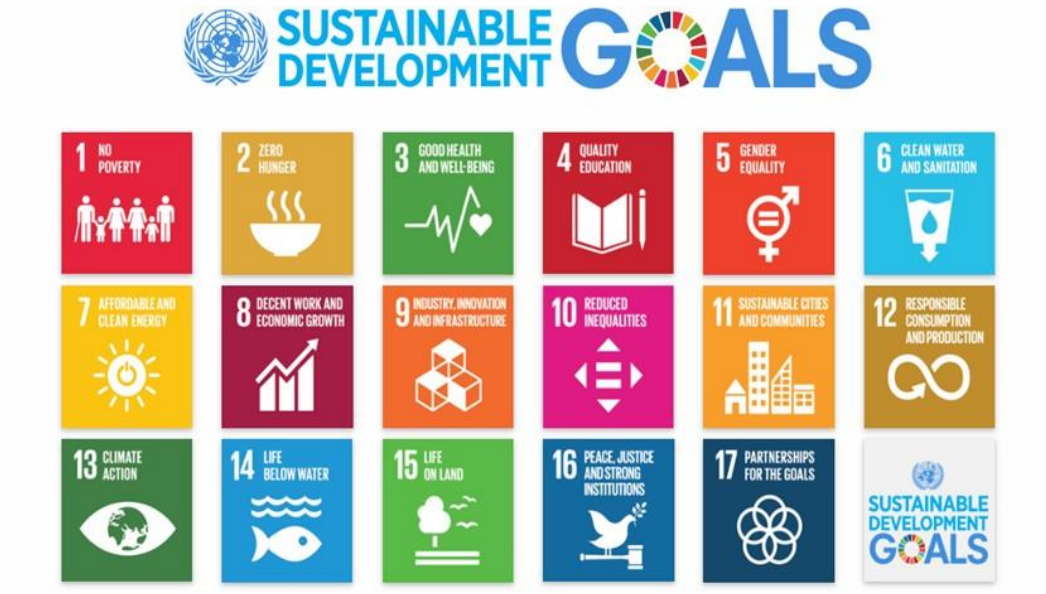

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The three pillars of sustainability

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Sustainability indicators?

- When making decisions we tend to make trade-offs between the different elements of sustainability depending on our current priorities.
- In practice, it's difficult to address these trade-offs using individual indicators across the different sustainability pillars.
- Combining key sustainability indicators into a single composite index provides a means of comparing different options across a range of relevant factors.
- Relies on the accuracy of the component measurements and sacrifices some individual detail.
- Selection of component indicators may be restricted by data availability.
- Composite indices require weightings to reflect the relative importance of different components.

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Identifying potential sustainability indicators and indicator weights

- A Delphi study in 2016 questioned 137 industry stakeholders in five EU countries to discover their opinions about the usefulness of a variety of economic, environmental and social indicators for assessing the sustainability of livestock production.
- The results of the Delphi study were used to provide weightings for the components of a composite sustainability indicator (index).

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Perceived usefulness of general indicator groups

Indicator group	Mean score
Economic	4.51
Environmental	4.09
Social	3.75

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Economic indicator scores

Indicator	Mean
Profit	4.42
Animal performance	4.35
Costs	4.32
Investment	3.84
Distribution of profits	3.81
Labour required	3.51
Robustness	3.51
Land required	3.46
Supply chain	3.23
Subsidy	2.76

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Environmental indicator scores

Indicator	Mean
Energy	3.95
Water	3.91
Climate change	3.74
Pesticide use	3.72
Nitrogen	3.71
Phosphorus	3.64
Farm waste	3.61
Acidification	3.33
Biodiversity	3.33
Land utilisation	3.28

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Social indicator scores

Indicator	Mean
Public health	4.43
Farm livelihoods	4.32
Product quality	4.08
Farm household welfare	3.82
Technological adoption	3.81
Societal preferences	3.74
Community viability	3.68
Availability to consumers	3.64
Neighbourhood impacts	3.38

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Sustainability index

$$S_i = WEC*NEC_i + WENV*NENV_i + WSOC*NSOC_i$$

Where:

- S_i = Normalised sustainability index for scenario i [-1, 1]

(S_i >0 is better than baseline and S_i < 0 is worse than baseline)

- WEC = Relative weight of economic component [0, 1]
- WENV = Relative weight of environmental component [0, 1]
- WSOC = Relative weight of social component [0, 1]
- NEC_i = Weighted index of economic components [-1, 1]
- $NENV_i$ = Weighted index of environmental components [-1, 1]
- $NSOC_i$ = Weighted index of social components [-1, 1]

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Components of the Sustainability Index

Economic

- Profits
- Costs

Environmental

- Energy Consumption
- Climate change
- Acidification
- Land utilisation

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Novel feed ingredients: Pig feeds incorporating green protein and a fine fraction of local rapeseed meal

Feed scenario	NEC_i^*	$NENV_i$	Si (2sf)
Green protein	-0.218	-0.714	-0.46
Fine fraction rapeseed meal	0.595	-0.616	-0.0032

- Due to price, current feeding solutions typically use relatively small proportions of imported soybean meal, so its replacement with an alternative protein source has only a marginal impact.
- Both scenarios have negative environmental impacts compared to the baseline, while only the rapeseed meal has a positive economic impact.

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Novel feed ingredients: Pig feeds incorporating green protein and a fine fraction of local rapeseed meal

- The feeding solution using local rapeseed meal offers a similar level of sustainability to current feeding solutions, while the use of green biomass appears to offer a relatively lower level of sustainability.
- In a scenario where Brazilian soybean meal, is cheaper and the incorporation rate could reach as high 13%, both feed scenarios are shown to be more sustainable than the baseline with S_i increasing to 0.05 for green protein and 0.50 for rapeseed meal.

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Novel feed ingredients: Poultry feeds incorporating green protein and European soybeans

Feed scenario	NEC_i*	$NENV_i$	S_i (2sf)
Green protein	-0.071	-0.244	-0.16
European soybean meal from whole beans	-0.059	0.337	0.14
European soybean meal from de-hulled beans	-0.105	0.328	0.11

- Both scenarios involving European soybeans offer positive environmental benefits for all indicators apart from land utilisation.

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Novel feed ingredients: Poultry feeds incorporating green protein and European soybeans

- All three scenarios have negative economic impacts where feed costs remain unchanged.
- Feeds incorporating green protein require the use of similar quantities Brazilian soybean meal so positive impacts on climate change & energy are relatively small.
- Using green protein increases impacts on acidification and land occupation and reduces profitability (unless feed costs are significantly reduced compared to current prices).

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Precision feeding: Comparing individual adlibitum and restricted pig feeding systems

Feed scenario	NEC_i^*	$NENV_i$	Si (2sf)
Adlibitum	0.1216	0.9049	0.51
Restricted	-0.8784	-0.1325	-0.51

- The *adlibitum* feeding system is clearly superior to the restricted system in terms of its positive impact on sustainability.
- For the *adlibitum* strategy all environmental impacts are reduced compared to the biphase baseline.
- For the restricted precision feeding strategy there is some improvement around acidification but not for the other environmental impacts.
- Similarly, while profitability improves with the adoption of the *ablib* system, it is reduced for the restricted system.

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A final word on consumer attitudes

Consumer attitudes to poultry farming (100=Most acceptable, 0=Least acceptable)	Mean
Using equipment that improves poultry feeding *(e.g. so food is always available when the hen wants it).*	74.4054
Using specially bred hens which convert more of their feed into eggs. *(This does NOT involve genetic modification).*	63.5225
Replacing part of the diet with feed made from processed plant materials such as grass or clover. *This reduces the area of good agricultural land needed.*	63.2286
Replacing part of the diet with feed made from by-products of industrial processes. *Reduces the area of good agricultural land needed.*	52.1456
Using indoor production systems that offer the hens no access to outdoor areas. *Some evidence suggests this can reduce greenhouse gas emissions and increase feed efficiency.*	29.5986
Using conventional concentrated animal feeds that contain up to 30% of grains or oil meals derived from GM plants.	25.9810
Keeping hens in large flocks. *Some evidence indicates this may reduce global warming potential.*	22.6027
Automated monitoring of animal health and feeding behaviour using sensitive remote detectors (machines). This may reduce human contact but detect some problems earlier	21.9959

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Conclusions – environmental impacts

- The feeding solutions generated by Feed-a-Gene offer a number of opportunities for livestock producers to be more sustainable.
- In particular, the replacement of Brazilian soybean meal in the feed mix with a locally-produced protein can reduce energy costs linked to transportation and the impacts on climate change associated with deforestation.
- The level of environmental benefits associated with novel feeds depends largely on the amount of Brazilian soybean meal being incorporated into feeds.
- Use of European proteins can reduce environmental impacts but could also lead to an increase in production costs if the weight gains are smaller or feed costs higher.

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Conclusions – economic impacts

- Net farm income can be improved by the adoption of novel feedstuffs, for example green protein and rapeseed meal for pigs. This result is, however, highly dependent on the costs of feedstuffs.
- In some scenarios only small price increases, or even price reductions, would be needed to ensure that production remained profitable.
- A key objective in the commercialisation of novel feedstuffs is the need to maximise production efficiency and reduce associated costs (provided that this can be done without increasing the negative environmental impacts).
- Cost reduction is not always straightforward, for example lower transportation costs from reducing the use of imported soybeans, may be offset by the increased production and processing costs of alternatives.

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5.2 Background of the participants in the sustainability appraisal workshop

Area of expertise of the participants	External stakeholders	Feed-a-Gene participants	Total
Equipment manufacturers and IT solutions providers	1	1	2
Extension services, technical advisors, consultants	4	1	5
Farmers, cooperative of farmers	3	1	4
Feed, feed ingredients, or feed additive producers	40		40
Genetics and breeding companies	6	4	10
Journalists	3		3
Networks and associations	3		3
Policy makers	2		2
Research and development organisations, academic institutions	14	62	76
Total	**76**	**69**	**145**