Sustainability appraisal: a combination of economic, environmental and social benefits

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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.

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"

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.


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

The three pillars of sustainability

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.

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).

Perceived usefulness of general indicator groups

Indicator group	Mean score
Economic	4.51
Environmental	4.09
Social	3.75

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

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

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

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]

Components of the Sustainability Index

Economic

- Profits
- Costs

Environmental

- Energy Consumption
- Climate change
- Acidification
- Land utilisation

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.

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.

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.

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).

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.

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

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.

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.