Focus Areas - Section 10

Technology / Decision Support Tools

f10

Economics of different dairy systems

Austen Ashfield, Hristina Manolova and Claire Jack

Modelling the financial resilience of dairy farms

Key Messages

- The AFBI Dairy Systems Model enables the evaluation of a range of dairy systems from both a technical and economic perspective
- The results indicated that the Medium system (8,000l/cow) is the most profitable
- Profitability within the High system (10,000l/cow) is the most sensitive to price changes; the Low system (6,000l/cow) is least sensitive

Background

Dairy farming is the largest agriculture sector in Northern Ireland in terms of output and contribution to overall GDP. The majority of milk produced in Northern Ireland is sold as internationally traded dairy products and milk price is, therefore, strongly connected to global dairy commodity prices. This export dependency can leave Northern Ireland dairy farms exposed to the high levels of volatility experienced by global dairy commodity prices. Furthermore, the recent price volatility in the main dairy farm inputs, such as fertiliser and concentrate, has created profound challenges for farmers in their farm planning decisions. However, farm simulation models can be useful to investigate the effects of variations in production, price and policy parameters on farm performance and profitability. In this context, a whole farm systems model was developed to evaluate a range of dairy systems from both a technical and economic perspective.

Research studies

The model is a whole farm, single year, static, deterministic simulation model that facilitates the technical and economic evaluation of dairy production systems. It operates with a monthly time step and was developed in Microsoft Excel. The model is empirical and uses data from production research experiments to specify coefficients and production functions (e.g. grazed grass dry matter digestibility and energy content, milk yield and the monthly proportions of grazed grass and grass silage in the diet). The user must define the farm land area owned and the production system choices. Dietary components consist of grazed grass, grass silage and concentrate (which is purchased when required). The model consists of four sub models namely; the farm system, animal nutrition, feed supply and financial.

Three different dairy systems were examined as part of this study - Low, Medium and High. In the Low system, cows calve in the Spring, produce 6,000L per cow and cows are outdoors March to October. In the Medium system cows calve in the Autumn and Spring, produce 8,000L per cow and cows are outdoors April to September. In the High system cows calve all year round, produce 10,000L per cow and lactating cows are housed all year. Farm size is assumed to be 70ha and stocking rate is set at 170kg organic N/ha.

Research findings

As shown in Table 1 the Medium system is found to have the highest net profit per farm and cow, the Low system has the smallest net profit per farm and cow. However, net profit per litre is highest for the Low system.

Potential Impact for Farming for the Future

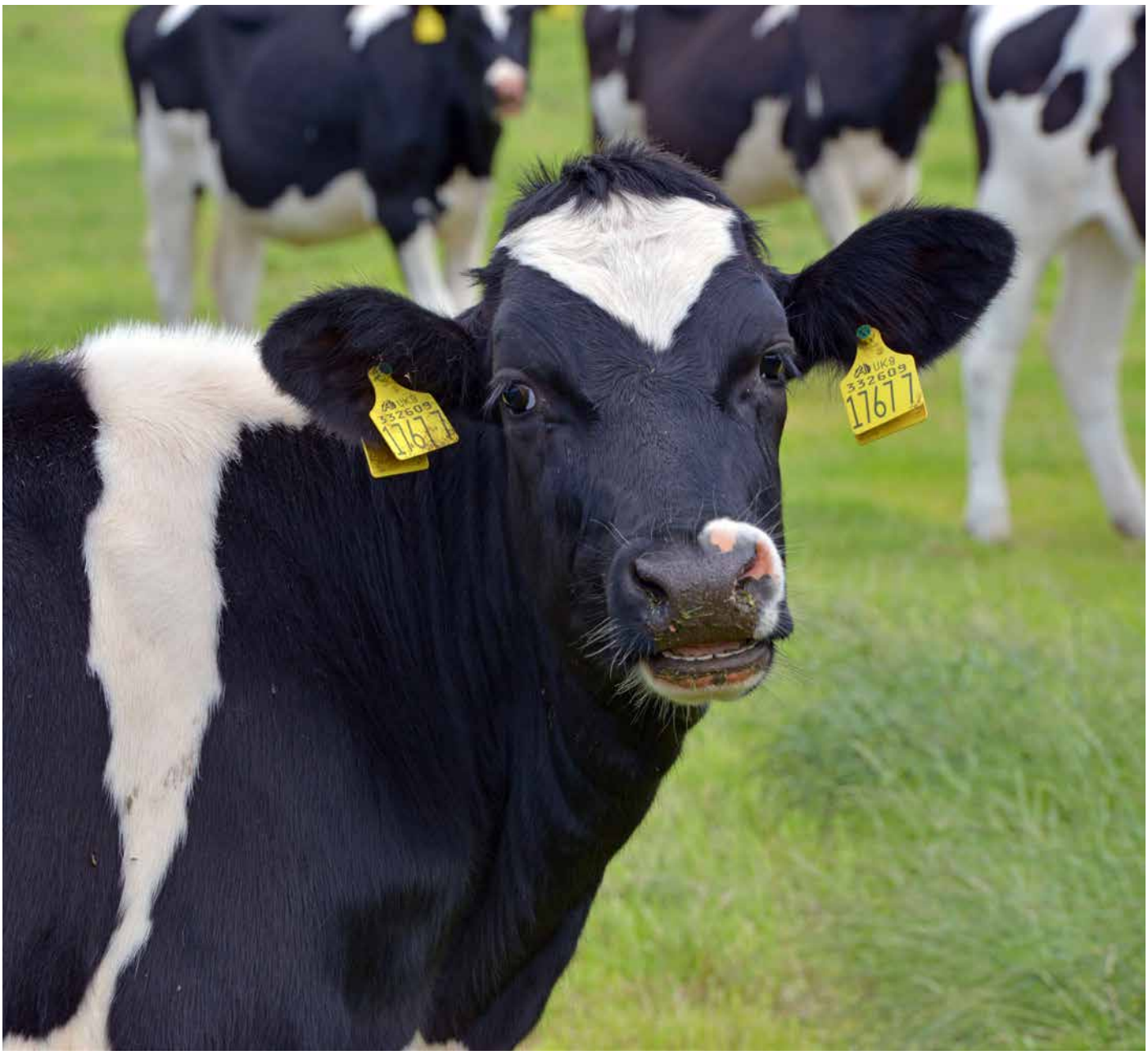
Currently, the model is being extended to develop and incorporate an environmental sub-model which will enhance the scope of the model by allowing the comparison of the different dairy systems in terms of their impact on a GHG, ammonia and water quality outcomes.

This project was funded by DAERA.

Table 1. Profitability of dairy systems using the AFBI Dairy Systems Model

	LOW	MEDIUM	HIGH
Sales (£/farm)[1]	243,602	301,793	358,616
Variable costs (£/farm)[2]	105,708	151,325	215,526
Gross margin (£/farm)	137,895	150,468	143,090
Fixed costs (£/farm)	102,881	110,956	117,397
Net profit (£/farm)	35,013	39,512	25,693
Net profit (£/cow)	347	403	270
Net profit (ppl)	6	5	3

[1] Milk price 35ppl, [2] Concentrate price £350/t, Fertiliser price £390/t



Utilising machine learning models to predict dry matter intake in dairy cattle using herd and milk production data

Dr Masoud Shirali

Precision technologies in livestock management

Key Messages:

- Routine records available on farms can be used with machine learning (ML) algorithms to predict Dry Matter Intake (DMI) in dairy cattle.
- A machine learning approach outperformed the classic models in predicting DMI.
- Predicted DMI can potentially be used to identify more feed efficient cattle which can help farmers to improve their profitability and reduce the environmental footprint of the farm.

Background:

Feed remains a major cost when rearing animals and feed use efficiency can directly influence environmental and economic sustainability. Within the dairy sector much attention has been given to the efficient use of feed resources such that resources needed for dairy production can be optimised. While dry matter intake (DMI) is a widely adopted metric to evaluate the feed efficiency of cattle, it is challenging to determine the intake of individual cows in commerical practice.

Machine learning and Artificial Intelligence is being applied to most industries and can also be applied to livestock farming.

One potential use of machine learning (ML) in livestock farming would be to apply easily obtainable data to ML algorithms to develop models to predict DMI accurately.

AFBI led a recent study aimed at exploring the use of ML methods to predict the DMI of Holstein dairy cows by utilizing routine milk production and herd information that is available on many commercial farms.

Research study:

Data from five studies conducted at the Agri-Food and Biosciences Institute in Hillsborough was used. All studies commenced at calving and involved a feed-to-yield concentrate allocation approach. All cattle were provided with a diet consisting of grass silage and concentrates, with additional concentrates given to every cow through an out-of-parlour feeding system. Data collected included milk yield, milk fat, protein and lactose content, milk fat-to-protein ratio, energy corrected milk (ECM) yield, lactation numbers (1, 2, 3, or 4 or more), weeks-in-milk, live weight, body conditioning score (BCS), and DMI measured by daily recording actual intake. A total of 4403 weekly cow records were collected. This study applied seven machine learning algorithms to predict DMI using the data collected. Model performance was then evaluated using the coefficient of determination (R2). R2 measures how well the predicted data reflects the observed data, ranging from 0 to 1 where 1 represents a highly accurate prediction.

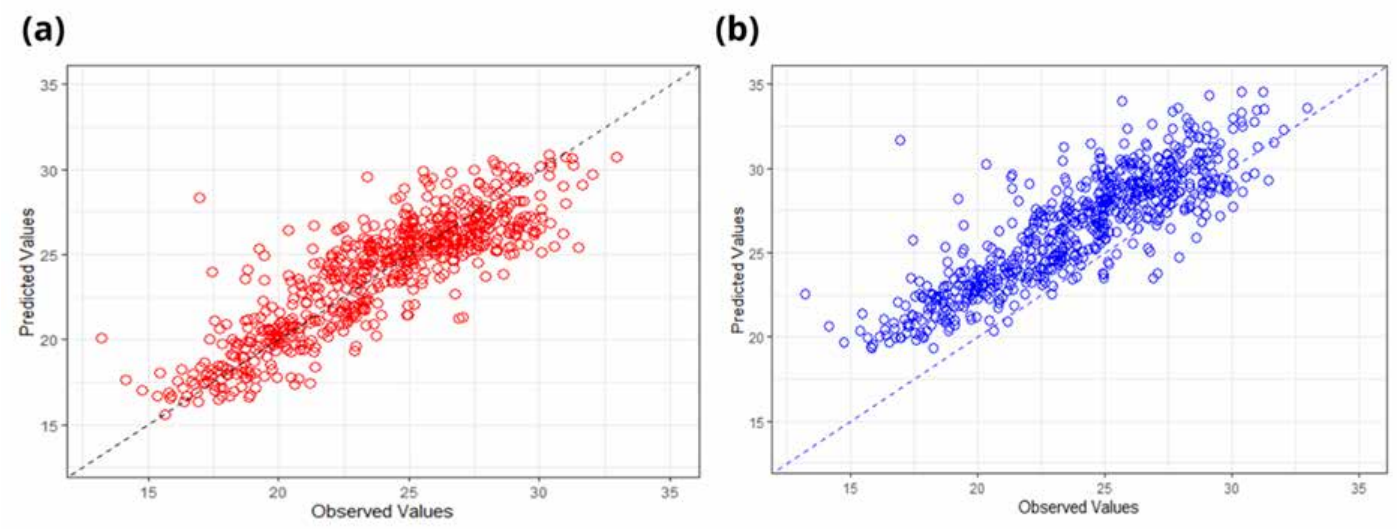


Figure 1: Predicted results against the observed results using (a) random forest (RF) model (b) linear regression model.

Research findings:

Using various machine learning methods to predict DMI, the technique known as random forest (RF) algorithm resulted in the most accurate models.

Potential Impact for Farming for the Future:

The present study demonstrated that routine records available on farms can be effectively utilised with machine learning algorithms to develop a DMI prediction model.

The information from this study has the potential to inform future breeding management tools and improve nutritional management in the dairy sector delivering reduced feed cost and greater nutrient utilisation and reduced environmental impact.

This work was funded by DAERA.

NIFAB
Northern Ireland Farm Animal Biobank

Economics of different beef production systems

Austen Ashfield, Hristina Manolova and Claire Jack

Modelling the financial resilience of beef farms

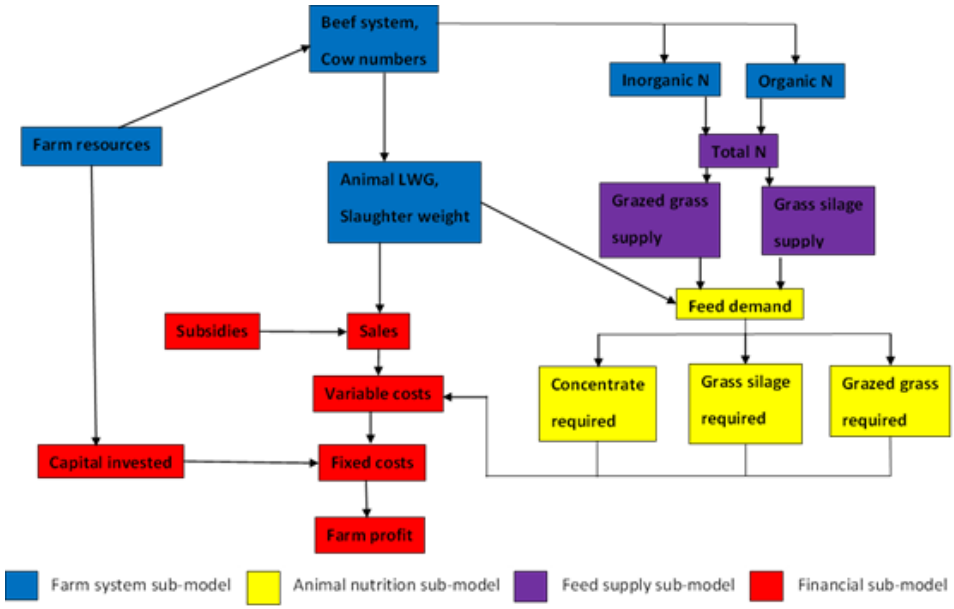


Figure 1: Schematic diagram of the AFBI Beef Systems Model

Key Messages

- The AFBI Beef Systems Model is being developed which will initially focus on the technical and economic evaluation of different beef systems

Background

Beef farming is one of the largest agriculture sectors in Northern Ireland in terms of output and contribution to overall GDP. However, as a sector it is facing many challenges over the coming years and in this context, farm businesses will be faced with decisions on which farming system to adopt and/or which new technologies to implement on the farm. Farmer decision-making is influenced by a range of factors; a farmer's own knowledge of scientific and technological issues, their attitudes to risk, capital and labour availability, environmental issues and the wider policy framework. At an industry level, it is important to have a method of assessing how such factors impact on farming systems.

This project aims to develop a whole farm beef model for Northern Ireland and will, therefore, provide an important framework to explore and guide decision making and resource-use at farm level. The results from this model will provide industry advisors and policymakers with an evidence base to examine the suitability of alternative beef farming strategies.

Research studies

While still being developed, the model is a whole farm, single year, static, deterministic simulation model that facilitates the technical and economic evaluation of suckler beef production systems (suckler to weaning, store and beef, calf to store and beef & store to beef). It operates with a monthly time step and is being developed in Microsoft Excel. The model is empirical and uses data from production research experiments to specify coefficients and production functions (e.g. grazed grass dry matter digestibility and energy content, liveweight gain and the monthly

proportions of grazed grass and grass silage in the diet). The user must define the farm land area owned and the production system choices. Dietary components consist of grazed grass, grass silage and concentrate (which is purchased when required).

Research findings

The model consists of four sub models, namely; farm system, animal nutrition, feed supply and financial. The farm system sub model defines the beef system and calculates animal sales, animal numbers, slurry production and accommodation for animals during the indoor period on a monthly basis. The animal nutrition sub model determines the energy demand and feed requirements (grazed grass, grass silage and concentrate) of the modelled herd. The feed supply sub model determines the forage production systems used to produce grazed grass and grass silage on the farm.

The financial sub model is used to calculate the costs and receipts generated from the system being modelled. It is linked with the farm system, animal nutrition and feed supply sub models to obtain quantities of the inputs used. All input prices have a default setting which can be altered by the user as required.

Potential Impact for Farming for the Future

The future plan for this model is to develop an environmental sub-model which will allow the comparison of beef systems on GHG, ammonia and water quality outcomes.

This project was funded by the DAERA.

The use of rumen temperature boluses in monitoring health of dairy origin calves

Naomi Rutherford & Francis Lively

Detecting ill health early using precision technology

Key Messages

- Early detection of disease is key in successfully treating ill health and minimising its long-term impacts
- Care is also needed to avoid the overuse of antibiotics
- Rumen temperature boluses can facilitate continuous temperature monitoring in a large number of animals and represents a tool to detect ill health early, eg in recent work at AFBI on dairy calves
- All clinical cases of pneumonia were preceded by an elevated rumen temperature in recent work at AFBI on dairy calves.

Background

Pneumonia is well known to be one of the primary causes of ill health in calves, with more than 40% of calves in the UK being affected (Royal Veterinary College). This can have a massive impact on the animals' lifetime performance, production efficiency, welfare and carbon footprint.

Fever is a key component of an animal's immune response to inflammation or infection. A fever creates suboptimal conditions for invading viruses and bacteria, while also improving the effectiveness of the animal's immunological response. Measuring rectal temperature with a thermometer is the most common method of detecting fevers. However, this is often not easily obtained, particularly when cattle are group housed or at pasture. Furthermore, rectal temperatures are often only taken once clinical signs of disease are observed. An alternative method is the use of rumen temperature boluses.

Rumen temperature boluses

These boluses are a relatively new technology that offer automatic, continuous monitoring of rumen temperature in a large number of animals, with a minimal labour requirement. When an animal experiences an elevated temperature over a prolonged period of time, a mobile phone alert is sent. The farmer can then monitor the animal and treat when needed.

Research Studies

In an observational study at AFBI Hillsborough, 77 dairy-origin beef calves of ~4 months of age had a rumen temperature bolus administered. Rumen temperature was recorded at 5-minute intervals by the bolus, and a phone alert was received if an elevated temperature was detected. Calves were monitored twice daily for clinical signs of disease.

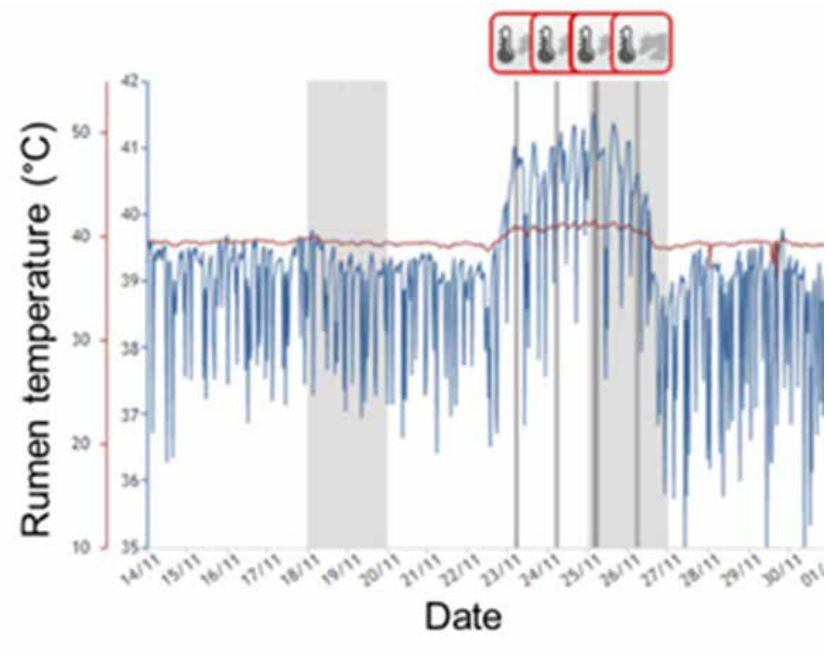


Figure 1: Rumen temperature showing a period fever

Research Findings

In this study all clinical cases of pneumonia were preceded by an elevated rumen temperature, however not all elevated temperatures were followed by clinical signs of disease. The results for the calf shown in Figure 1 had an elevated temperature for approximately three days before clinical signs of disease were observed. At this point the animal was treated and the temperature subsequently returned to a normal level. This was in agreement with research from France that found rumen temperatures were elevated for 3.5 days on average before clinical signs of pneumonia were observed in youngstock.

However, it was also the case that elevated rumen temperatures were often not followed by clinical disease. These temperatures tended to be shorter in duration and may indicate that the animal was able to overcome the disease challenge without the need for treatment. However, rumen temperature is influenced by numerous factors other than ill health including; environmental conditions, diet, acidosis, oestrus, onset of parturition, behaviour, stress and vaccination.

This demonstrates that the system is highly sensitive to elevations in temperature, and thus precaution must be taken so that antibiotics are not overused.

Potential Impact for Farming for the Future

Early detection of disease is key in successfully treating ill health and minimising its long-term impacts. With further scientific research and technical developments, there is potential for the early detection of disease using precision technology to be widely used within the industry, thus increasing production efficiency and reducing the carbon footprint of herd.

This project was funded by DAERA.

SUPER-G farm tool

Frances Titterington and Francis Lively

Supporting farmers to deliver multifunctionality from permanent grassland

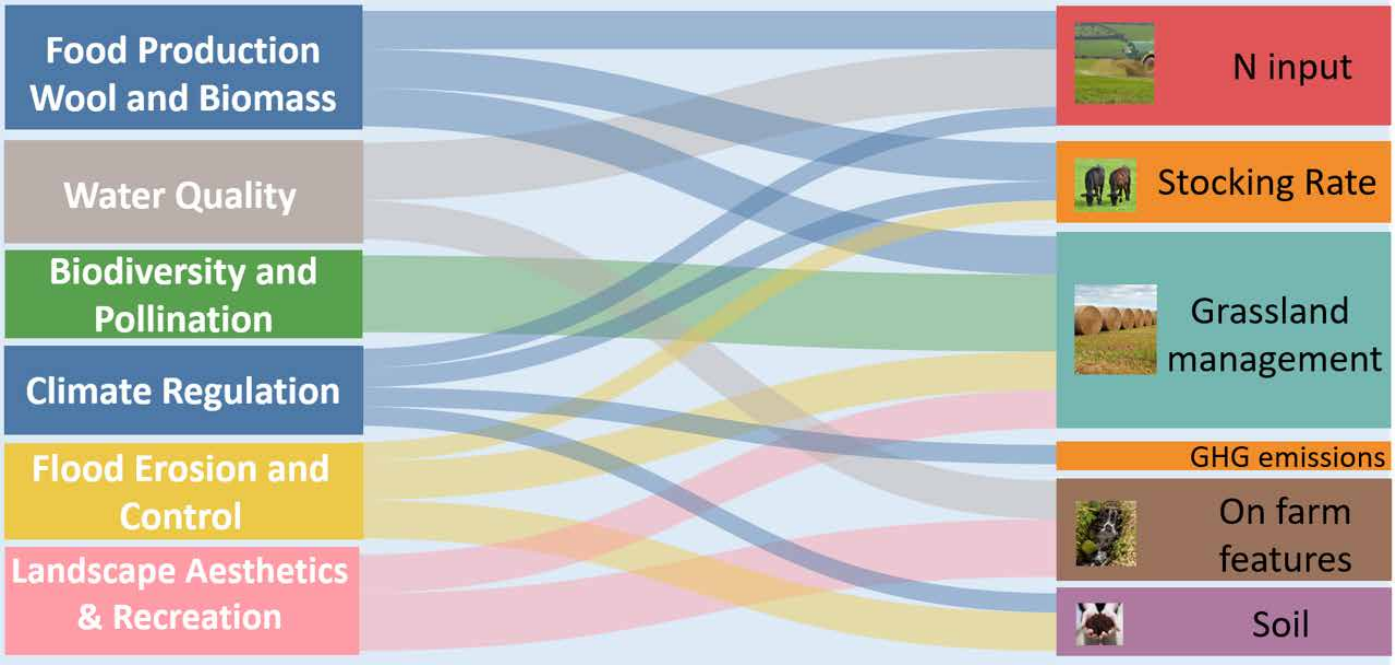


FIGURE 1- A list of the ecosystem services measured by the tool (left) and the type of information required to calculate a score (right)

Key Messages

- Permanent grassland (PG) provides a range of 'public goods' or Ecosystem Services (ES) which benefit both people and the environment
- It is difficult to improve the ES provided by grasslands because there are multiple trade-offs and synergies when managing PG
- The SUPER-G farm level decision support tool offers farmers and land managers insight into how to improve their PG and the impacts management changes could have

Background

Permanent grasslands are an important part of the landscape in Northern Ireland and across Europe. As well as provisioning ES such as fodder for our animals, it provides regulating and supporting services which provide environmental benefits such as water purification or biodiversity, and recreational benefits for visitors to the countryside. However, it can be difficult to find the balance between ES, because there are many synergies and tradeoffs, for example maximizing grass production by applying fertilizer could negatively impact water quality. The SUPER-G farm level decision support tool has been developed to help farmers understand these tradeoffs and how implementing new management can impact their production and environmental impact.

Research studies

The SUPER-G farm tool was developed with experts from across Europe. Six ES were identified which land managers could adapt their management to improve. These were: Food wool and biomass production; Climate regulation; Biodiversity; Landscape aesthetics, Flood Erosion and Control; and Water Quality. The six ES were found to be intrinsically linked, meaning that adjusting management to change one ES score would also change the other ES.

Thus, the research team made tailored advice which informed the user of management changes they can make to improve an ES score, and how these changes could unintentionally impact another ES. Farmers were involved throughout the design process to ensure that the design of the tool was intuitive, and the information provided was useful and could be easily understood.

Through answering a series of questions, the farmer will be given an ES score so they can monitor their performance. In addition to a score, advice will be given detailing how the score can be improved and if an adjustment in management will impact other ES. Each ES score is accompanied by a 'traffic light' colour code, to indicate whether the user has not entered enough information (red), the score can be improved (amber) or the score is acceptable (green). The tool is dynamic and automatically calculates scores when questions are answered, giving real time feedback, and allowing the user to model different management systems on their farm. The tool not only offers an ES score, feedback and advice but the modelling capability helps the user to learn about the synergies in ES. Users can access their data through a secure log in, allowing them to produce multiple reports covering different time periods or land parcels on their farm.

Potential Impact for Farming for the Future

The real time feedback provided by the SUPER-G farm level decision support tool helps farmers and land managers to monitor the impacts of their management but to also learn how adjusting management can intentionally and unintentionally affect ES delivered by their PG. The user can make multiple reports, allowing them to try different scenarios and predict how changing management systems can impact their production and ES delivery without risk.
By giving farmers a better understanding of the ES offered on their farm and how their management impacts them, farmers are given the power to optimise their farm system to deliver economically and environmentally.

This project was funded by Horizon 2020.

SCAN ME

BovIS – online growth monitoring tools and carcass tools

Frances Titterington and Francis Lively

Making it easier to make decisions for your cattle enterprise

FIGURE 1: The BovIS growth monitoring tool allows you to track the performance of your dairy beef or replacement heifers ensuring they are growing adequately. To help you meet the targets, enter the quality of your silage to get a breakdown of how much meal you need to feed to achieve targets.

Key Messages

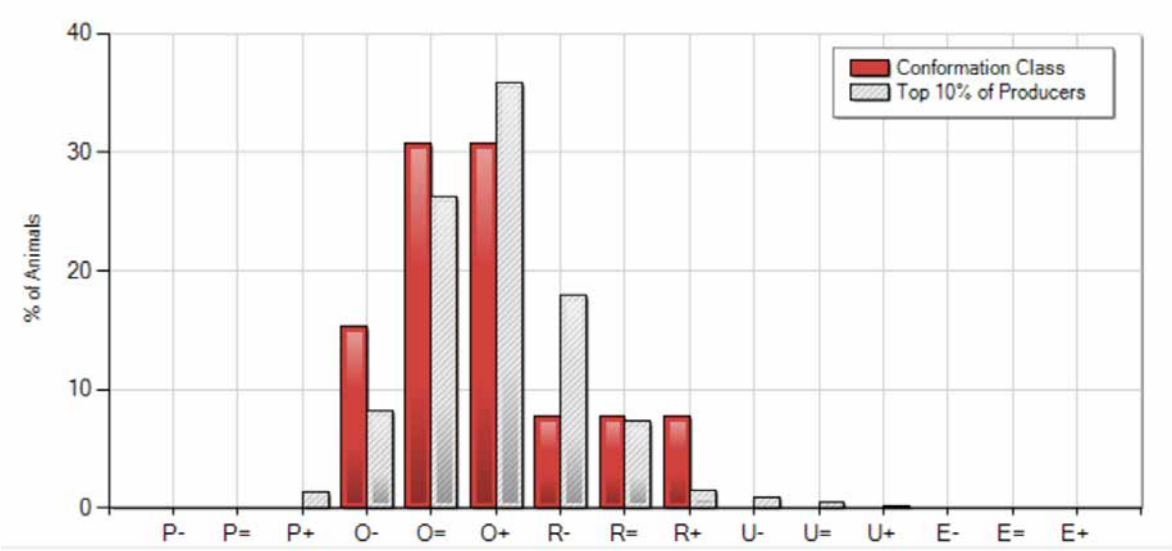
- Harness the power of data to improve your farm enterprise.
- Use target driven growth curves to ensure you are producing cattle in the most efficient way.
- Benchmark the performance of your cattle against similar cattle.
- BovIS can help farmers reach heavier slaughter weights at younger ages – hence reducing the carbon footprint of the herd.

Background

Farmers use data to help make informed decisions daily. You may not realise it, but using your knowledge of past prices or past performance to decide what action to take is essentially making a data driven decision. The Agri Food and Biosciences Institute (AFBI), with support from DAERA and AgriSearch, have developed the Bovine Information System (BovIS) which offers Northern Ireland cattle farmers exclusive access to their own cattle's slaughter data and animal information from APHIS all in one place. If you can access APHIS online you already have access to BovIS. Simply log onto your government gateway account and select the blue BovIS link from the options available in the blue boxes. This allows access to a range of free decision support tools:

Growth monitoring tool- growth targets for dairy origin beef or replacement heifers

The growth monitoring tool provides a target driven growth curve to help your cattle reach the age and weight milestones required for efficient production. The tool caters for different management systems, including breeding replacement heifers to calve at 24 months of age, or the production of dairy origin beef. Simply select the date of birth range for the cattle you



Summary of Your Performance

	Animal count	Weight (kg)	Fatness	Conformation	Age (mths)	Carcase gain (kg/day)	In spec (%)
My Steers	13	371	3=	O+	23.2	0.52	15.4
Top 10%	1,034	340	3=	O+	19.4	0.58	34.1
All Producers	20,337	337	3=	O=	25.5	0.45	20.7

(FIGURE 2: BovIS provides a breakdown of both your cattles' performance and the performance of similar cattle and the top 10% of producers in NI, allowing you to benchmark your performance and identify where improvements can be made)

want to growth monitor and the management system you wish to employ. BovIS automatically links with APHIS and presents the tag number, sex, breed, date of birth and calculates the age of the animal at the specified date of weighing. Using the ear tag to identify each animal, you can then enter the weight recorded for each animal and the program will generate an expected weight and the daily live weight gain (DLWG) required to reach a target weight in 3 months' time. This is presented in a table and an intuitive chart where it is clearly visible if cattle are within the target weight (see diagram). The tool has recently been upgraded to add new features, including dietary advice to help your cattle achieve the required DLWG, and the tool will store the animal weight allowing the growth of each individual and the group throughout their lifetime to be monitored.

Carcass benchmarking tool

The carcass benchmarking application offers the opportunity to benchmark your cattle. The benchmarking report compares your cattle's performance to the average performance of all cattle slaughtered in BovIS plants in the same period and also against the performance of the top 25 % of cattle. There are options to benchmark cattle within your own herd, comparing different breeds or cattle of the same animal type and breed that were slaughtered at a different time.

Potential Impact for Farming for the Future

The suite of BovIS tools offers an insight into the performance of your growing cattle and their performance at slaughter. By comparing your cattle performance to expected performance and the performance of other cattle, it allows you to judge whether you have the optimal management on farm and where you can make improvements towards more efficient management practices. All the information on BovIS can be downloaded to help you make your own data driven decisions to improve efficiency and reduce emissions from your cattle enterprise in the future.

This work was funded by AgriSearch and DAERA.

Food Futures: interactive dashboard to measure whole farm sustainability

Aurelie Aubry

Benefits of data to target interventions

Key Messages

- The Food Futures tool supports farmers to assess and improve sustainability (environmental, economic and social) of their farm.
- The preferred feature of the Food Futures tool was its ability to benchmark farm performance and provide targeted advice
- Keys areas identified by farmers for improvement relate to soil health (phosphorus) and slurry spreading techniques, as well as the need to reduce reliance on subsidy to be profitable and improve the ability of farmers to take time off.
- Simply asking the right questions helps to raise awareness of key drivers and impacts

Background

Quantifying and enhancing the sustainability of agri-food production is key to protecting existing markets and securing new ones. Economic, social and environmental sustainability have to be quantified, meaning a large set of varied data are required. As part of the Agri-Food Quest 'Food Futures' project, a holistic, data-driven tool was developed by AFBI and QUB to measure, verify and report whole farm sustainability.

Research studies

Scientifically robust indicators and metrics of sustainability were developed to measure economic, social, (i.e. farm family wellbeing) and environmental sustainability at farm level. Importantly, the latest research findings were incorporated in the Food Futures tool, to inform the selection and definition of more than 100 indicators and their sustainability scoring system. Specifically, responses to each indicator (eg slurry application methods, % of soils at optimum pH) are scored on a scale of 0 to 10, with 10 representing either best practice, the optimum status or the most efficient farms.

Data were then collected from 30 ambassador dairy, beef and sheep farms in NI since 2019 using a comprehensive questionnaire to inform the Food Futures tool. In 2022, an interactive dashboard was created to facilitate the use of the tool by (a) optimising data capture, (b) providing quantified feedback on the level of performance using graphics and traffic light systems and (c) providing targeted advice and practical options to improve on-farm sustainability. In 2022, Food Futures worked with the Livestock and Meat Commission (LMC) to successfully test a bolt-on tool (shorter than the full Food Futures tool) on more than 160 randomly selected Farm Quality Assured (FQA) beef and sheep farms in NI.

Research findings

Initial results indicated that there was clear potential to enhance further the sustainability at farm level. For example, among all 162 farms surveyed as part of the FQA scheme (mostly beef and sheep enterprises), less than 50% of the farms surveyed had assessed their soil health by taking regular soil samples across the farm. Using splash plates was still the most common method to apply slurry (>80%). Only 55% of the study farms had a succession plan in place and more than 35% felt that they were unable to take regular time off.

The platform developed in this project enables users to visualise key strengths and weaknesses, set up realistic targets, identify and implement actions and explore relationships among key metrics. Participating farmers highlighted the benefits of using the tool to benchmark their performance against others in their sector, which helps to identify realistic targets.

Building on the successful proof of concept developed as part of this project, there is now a need to further automate data entry requirements by establishing further links with existing dataflows and schemes.

Potential Impact for Farming for the Future

Since the initial group of 30 ambassador farms completed the full survey from the start of the programme, their active participation in both the development and use of the tool has already resulted in positive behavioural change to further improve their sustainability credentials. For example, some farms planted more trees and hedgerows which will improve carbon sequestration, while others adopted lower emission slurry spreading techniques which will reduce ammonia and GHG emissions.

This project was funded by Agri-Food Quest and industry.