Institution: Aberystwyth University

Unit of Assessment: 6: Agriculture, Veterinary and Food Science

Title of case study: Reducing reliance on imported protein feed within a ruminant supply chain

Period when the underpinning research was undertaken: 2000- 2018

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Dr Christina Marley	Research Scientist; Reader	1 April 2001- present
Rhun Fychan	Scientific Officer; Research Scientist	8 September 1992- present
Dr Mariecia Fraser	Research Scientist; Senior Doctoral Research Scientist; Principal Investigator; Reader in Upland Agroecosystems	1 January 1998- present
Dr Ruth Sanderson	Statistician	1 June 1992- present
Dr Heather McCalman	Senior Extension Officer	1 April 2008- 31 Jan 2017

Period when the claimed impact occurred: 2012- 2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact (indicative maximum 100 words)

Livestock provide one third of the protein consumed by humans. Alternatives to imported soya, a key protein component of ruminant diets, are needed to provide food security. Participatory and scientific research led by Dr Christina Marley in IBERS enabled Waitrose and their producers to understand and overcome barriers to adopting home-grown protein forages as protein feed for ruminant livestock. The resulting removal of imported soya from beef, dairy and lamb production systems by a major UK food retailer has impacted on production and commerce, provided environmental benefits for the sector, and contributed to a 16.9% decrease in UK soya imports.

2. Underpinning research (indicative maximum 500 words)

The Global Challenge: Developing Sustainable Protein Sources for livestock

Competition for land to produce food, feed and biofuel is intensifying pressure on livestock systems to contribute to global protein security. Sustainable agri-food systems need to be developed to provide food security for an expected 9.7 billion people by 2050. Economically, soya is expensive and subject to price volatility, creating a lack of food security. Given increasing global competition for this resource, and reports of its detrimental environmental impacts, there is a need to reduce reliance on imported soya in livestock diets.

How the Research Developed

The defining research on the potential to reduce reliance on imported protein feed within ruminant systems first began as part of an alternative forage crops research programme [3.7] resulting in papers by Marley [3.1] in 2003. Coupled with this, the first UK research on the use of protein forages such as chicory to improve livestock performance and health, was conducted by Marley at AU [3.2]. From 2002–2007, a Defra-funded project [3.8] showed how high-protein forages, such as red clover, kale and lucerne, could be conserved as silage and used to improve productivity and nutrient use efficiency in livestock systems, making them a viable high-protein winter feed for UK livestock [3.3]. Closely aligned to this, research in plant breeding resulted in genetic improvements in forage species

that reduced the environmental impact of livestock systems [3.4]. In 2009, the Agricultural Manager at Waitrose was introduced to the protein forages and participatory research conducted by Marley's team. At that time, AHDB-funded research [3.9] undertaken in 2009-2012 overcame speculation of detrimental effects on either productivity or product quality when a protein forage was used in beef production systems [3.5]. More recently, research has improved understanding of the impact of protein forages on the environment [3.6].

Research Approach

Despite these research advances, the adoption of high protein forages by the industry was limited. Marley and her team recognised that this underpinning research would only be adopted by the industry by collaboratively involving farmers in the research process. In 2011 many UK livestock farmers, [text removed for publication], were dependent on soya to provide protein feed to livestock.

Through the Sustainable Forage Protein (SFP) project (2012-2016) [3.10], Marley and her team undertook participatory and scientific research to support the integration of protein forages into ruminant systems. In 2012, farmer workshops were arranged to determine the barriers to the uptake of home-grown protein forages and the science gaps needed to create change. Five project themes were used to overcome the barriers identified in the production cycle to fully integrate protein forages. These included their establishment, conservation, supplying out-of-season grazed forage protein, and determining their effects on product quality. Eight participatory research farmers agreed to act as case studies for the industry and supported by McCalman (AU), an extension officer in Marley's team, they changed their systems and adopted protein forages. This approach helped address some of the practical challenges and constraints experienced by the sector, with participating farmers drawing on their own experiences to the select the most suitable techniques.

3. References to the research (indicative maximum of six references)

3.1 Marley, C.L., Fychan, R., Fraser, M.D., Winters, A. and Jones, R. (2003) Effect of sowing ratio and stage of maturity at harvest on yield, persistency and chemical composition of fresh and ensiled red clover/lucerne bi-crops. Grass and Forage Science, 58(4): 397-406. 10.1111/j.1365-2494.2003.00392.x

3.2 Marley, C.L., Cook, R., Keatinge, R., Barrett, J., Lampkin, N.H. (2003). The effects of birdsfoot trefoil (*Lotus* corniculatus) and chicory (*Cichorium intybus*) on parasite intensities and performance of lambs naturally infected with helminth parasites. Veterinary Parasitology, 112, 147–155. 10.1016/j.vetpar.2006.01.029

3.3 Marley, C.L., Fychan, R., Fraser, M.D., Sanderson, R. and Jones, R. (2007). Effects of feeding different ensiled forages on the productivity and nutrient-use efficiency of finishing lambs. *Grass and Forage Science*, 62, 1-12. 10.1111/j.1365-2494.2007.00556.x

3.4 Abberton, M.T., Marshall, A.H., Humphreys, M.W., MacDuff, J.H., Collins, R.P. and Marley, C.L. (2008) Genetic improvement of forage species to reduce the environmental impact of temperate livestock grazing systems. Advances in Agronomy, 98, 311-355. 10.1016/s0065-2113(08)00206-x

3.5 Marley, C.L., Fychan, R., Davies, J.W., Scollan, N.D., Richardson, R.I., Theobald, V.J., Genever, E., Forbes, A.B., Sanderson, R. (2014) Effects of chicory / perennial ryegrass swards compared with perennial ryegrass swards on the performance and carcass quality of grazing beef steers. PLoS ONE 9(1): e86259. 10.1371/journal.pone.0086259

3.6 Crotty, F.V., Fychan, R., Sanderson, R. and Marley, C.L. (2018) Increasing legume forage productivity through slurry application–a way to intensify sustainable agriculture? *Food and Energy Security*, *7*(4), p.e00144. 10.1002/fes3.144

Research Grants

3.7 IGER Conservation of protein/energy rich alternatives to forages - LS0301; DEFRA; 1997 - 2002; GBP716,441

3.8 IGER; Optimising nutrient budgets for livestock systems based on alternative forage crops - LS3642; DEFRA; 2002 - 2007; GBP599,667

3.9 Marley, C.L; To investigate the benefits of chicory for beef cattle (72203); EBLEX (now AHDB); 01/04/2009 – 31/03/2012; GBP180,000

3.10 Marley, C.L; Efficient forage-based systems for ruminant livestock production in the UK; Innovate UK; 01/01/2012 – 31/12/2017; GBP2,041,144 (aka "Sustainable Forage Protein" project") https://gtr.ukri.org/projects?ref=101097

4. Details of the impact (indicative maximum 750 words)

Between 2012-2016, as part of the Sustainable Forage Protein (SFP) project [3.10], on-farm activities and protein forage research were disseminated across the Waitrose supply chain through nine events (eight on participatory farms; one at IBERS), each attended by 60-100 farmers [5.1.1], various producer meetings, and five annual Waitrose Farming Conferences ([text removed for publication] [5.1.1]). Attendance at these events changed understanding among farmers across the supply chain, and farming practices [5.2.1]. Knowledge exchange across the supply chain was through internal newsletters and the project website [5.5.1]. By 2016, more than a third of producers ([text removed for publication]) in the supply chains across the UK had adopted or were trying out new home-grown forage proteins [5.1.2]. Further adoption continues on participatory farms [5.2.2- 8] and across the supply chain, with Waitrose and supply chain partners continuing to monitor protein forage uptake by producers, with the results up to March 2020 shown in Table 1 [5.1.2].

"Responsible Efficient Production" (REP) Assessment March 2020	Outcome per Supply Chain (%)			Overall % supply chain
	Lamb	Dairy	Beef	Ruminants
1) Uptake of Mixed leys	80.4	52.6	63.6	69.5
2) Mixed leys used containing protein forage	65.1	33.3	54.6	57.1
3) Red or White Clover adopted	79.2	93.6	72.1	76.6
4) Uptake of bespoke WFP seed mixes sown	55.5	62.8	23.2	39.3
5) Forages reduced concentrate/feed Costs	88.4	51.3	67.1	74.4

Table 1: Uptake of protein forages determined for Waitrose Farming Partnership (WFP) by independent assessor.

Wider dissemination across the industry was achieved through articles in the media [5.5.2] and other articles in farmer literature [5.5.3], including a SFP booklet, produced in 2016 containing testimonials from participating farmers, research findings, economic analysis and carbon emissions data (Bangor University) [5.5.4]. As of July 2020, the booklet *'remains the best and most comprehensive forage protein management guide available in the industry'* [5.3.1].

Impacts on Production

Agri-food producers reported (May-June 2020): Improved resilience and feed security in:
i) Lamb: '*IBERS research allows us to use…protein forages to displace the costs of expensive fertilisers and feeds'* [5.2.2], to *'eliminate the need to import very expensive protein as concentrates'* allowing production to be *'more resilient, and able to withstand major price fluctuations in input prices'* [5.2.3] and *'cut out the use of supplement feeds to 150 ewes'* [5.2.4]; ii) Dairy: '*ceased supplementing our youngstock with concentrates'* [5.2.5];
iii) Beef: '*working with IBERS…I was able to…remove soya completely'* [5.2.6] and *'as a result of this research...the ability to reduce reliance on imported protein feed'* [5.2.7].

For many farmers across the wider supply chain soya has been 'removed entirely from the ration' [5.2.1]. Forage protein provided resilience during a drought when lucerne was *'the only green field on the farm'* [5.4.1]. The Agricultural Manager at Waitrose reported that [text removed for publication] dairy producers removed soya from diets of lactating cows, [text removed for publication] [5.1.1]. [text removed for publication].

Improved Productivity from protein forages evidenced by:
i) Lamb: *'more efficient production'* [5.2.3] and *'a 25% increase in scanning percentage'* [5.2.4];
ii) Dairy: *'volume of milk per cow, produced from grazed grass, rose from 1190 litres in 2012 to 2060 litres in 2017'* [5.2.5];
iii) Beef: *'Pushing...growth rates...from...0.8kg/day to over 1kg/day' and 'able to increase cattle numbers off the same acreage...with higher growth rates and better use of forage'* [5.2.6]. An improved quality in forage quality was also reported, with the proportion of protein by at least 4-5% [5.2.1; 5.2.3; 5.2.6].

Reduced Costs of Production were reported in: i) lamb: *'grazing ewes on kale…saved around 40% of costs' [*5.2.4]; ii) dairy: *'concentrate use per litre of milk decreased from 0.30kg per litre to 0.24kg per litre' and 'saved fuel...time and labour' [5.2.5]; and iii) beef: 'increased profitability – savings through using home grown forage versus purchased feed'* [5.2.6].

Impacts on Commerce and the Economy
The protein forage research *'conducted by Dr Marley's team has underpinned and supported a change of policy within the Waitrose ruminant supply chain, allowing for the reduction and removal of imported protein feed (soya) from feed rations in the ruminant supply chain'* [5.1.2].

i) Lamb: In 2017, Dalehead Foods established a 'forage-fed scheme' to supply Waitrose with lambs produced without concentrates. *'By 2019, Dalehead produced [text removed for publication] forage-fed lambs, an increase of 100%' since 2016. In 2020, '85% of lamb producers are using protein forages in place of feed… Without the support of the...project research team, we would not have had the knowledge needed to support our producers to achieve this change'*. Furthermore, 'business strategy, operations and workplaces practices changes as a result of the protein forages research conducted by AU', providing the option for *'a new policy to supply British lamb 365 days of the year'*. [5.4.2]

ii) Dairy: Farmers were able 'to increase the amount of forage protein grown on farm with 94% now growing forage protein crops (increased from 76% in 2016)' [5.4.1]; with Müller Milk & Ingredients and WDF (Waitrose Dairy Farmers) able to remove soya from dairy cow feed rations [5.4.1]. Organic dairy producers 'produced around [text removed for publication] more from home grown protein per cow per year', saving '[text removed for publication] purchased feed', [text removed for publication] [5.4.3].

iii) *Beef*: In 2016, the research led to a 37% increase in the use of protein forage-feed across their beef supply chain. At the corporate level, Dovecote Park was *'able to remove soya from cattle finishing rations'.* Dovecotes' records (May 2019) showed *'74% of farmers using red and white clover for increased productivity',* and 68% having a reduction in costs. In April 2020, producers continue to see the *'benefit of these changes and... to increase the acreage sown to sustainable forage protein'*. [5.4.4]

Agricultural businesses reported benefits including new products created with a catalogue of bespoke WFP seed mixtures [5.5.5] launched spring 2017, and increased sales of existing protein forage seed [5.3.1]. Although not a direct SFP partner, Pöttinger collaborated with AU on protein forage conservation research, providing in-kind contribution in 2014. Research on ensiling techniques, conducted by R.Fychan (AU), showed a rubber roller conditioner led to a '31% reduction in protein lost during harvest'; enabling Pöttinger to increase sales of this conditioner, [text removed for publication]. [5.3.2]

Impacts on Understanding, Learning and Participation
Wider benefits are seen across the farming community: *"This has filtered through to other local farmers who are also using more home-grown forages"* [5.2.6] and *"learning's' from the (SFP) project are continuing to have a wider impact on UK livestock producers"* [5.4.5].

Dr Marley's research on protein forages was highlighted on International Women's Day 2020 for *"her enthusiasm and ability to translate the science for impact with different audiences that was so infectious and impressive"* [5.4.6].

5. Sources to corroborate the impact (indicative maximum of 10 references)

Testimonials provided by retailer - Waitrose and Partners
5.1.1 Agricultural Manager (2007-2019)
5.1.2 Manager for Agriculture, Aquaculture & Fisheries & Agricultural Manager

Testimonials provided by agri-food producers within the Waitrose supply chain
5.2.1 Testimonial provided by food producer in wider retailer supply chain
5.2.2- 8 Testimonials provided by food producers directly involved in participatory research

Testimonials provided by beneficiaries across the wider agricultural industry
5.3.1 Forage seed company - Germinal GB Ltd
5.3.2 International manufacturer of specialist forage technology – Alois Pöttinger UK Ltd

Testimonials provided by Supply Chain Partners to Waitrose and Partners
5.4.1 Dairy: Müller Milk & Ingredients (MM&I) & WDF
5.4.2 Lamb: Dalehead Foods Ltd
5.4.3 Organic Dairy: Coombe Farm
5.4.4 Beef: Dovecote Park
5.4.5 Beef: Dovecote Park (2004-2019), now CIEL
5.4.6 MM&I, now CIEL CEO

Project Material
5.5.1 Project Website: http://sustainableforageprotein.org/
5.5.2 Daily Express (05/10/2016)
5.5.3 Forager magazine (Winter 2019)
5.5.4 Project Booklet - including testimonials and economic models
5.5.5 Waitrose Farming Partnership Protein Plus Forage Mixtures – Seed catalogue