

<b>Institution:</b> University of Reading		
<b>Unit of Assessment:</b> 6 (Agriculture, Veterinary and Food Science)		
<b>Title of case study:</b> Reducing and replacing saturated fats in milk: evidence of the benefits to human health and the environment shapes government and food industry policy and practice.		
<b>Period when the underpinning research was undertaken:</b> Between January 2008 and December 2019		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b>	<b>Role(s) (e.g. job title):</b>	<b>Period(s) employed by submitting HEI:</b>
Julie Lovegrove	Professor of Human Nutrition, Director, Hugh Sinclair Unit of Human Nutrition, Reader, Senior Research Fellow	January 1996 - present
Ian Givens	Professor of Food Chain Nutrition, Director, Institute for Food, Nutrition and Health, Head of Food Production and Quality	April 2004 - present
<b>Period when the claimed impact occurred:</b> Between August 2013 and December 2020		
<p><b>Is this case study continued from a case study submitted in 2014?</b> Yes: The 2014 case study focussed on research findings demonstrating that the saturated fat content of milk could be reduced by modifying the diet of dairy cows with an oleic acid-rich diet. This work led directly to the implementation of a new policy by M&amp;S, which continued in the current REF period. Subsequent studies by the team have underpinned collaboration with a major EU milk processor to develop healthier dairy products with a smaller environmental footprint. The current case study also describes evidence of the health benefits of these dairy products and the appointment of Lovegrove to the UK government's Scientific Advisory Committee on Nutrition (SACN), Lovegrove's expertise, has informed policy on saturated fats and health, based on her body of research.</p>		
<p><b>1. Summary of the impact</b></p> <p>University of Reading research has shown how cardiovascular disease (CVD) risk factors can be reduced by replacing dietary saturated fat with unsaturated fat. The team's unique whole food chain approach enabled UK retailer Marks and Spencer (M&amp;S) to reduce saturated fat and palm oils across its milk supply chain, with approximately 380,000,000 litres of this milk sold to 1,500,000 consumers within the current REF period. Likewise, Valio, a major EU milk processor, has updated their carbon reduction policy and is encouraging their 4,500 milk producers, producing 1,800,000,000 litres of milk per year, to reduce methane emissions because of the team's findings. Valio has also heavily invested in developing new butter and cheese products. This body of research has also informed UK government policy, with Professor Lovegrove's expertise making a major contribution to SACN's 2019 <i>Saturated Fats and Health</i> report, and to its public health advice to reduce dietary saturated fat and replace them with unsaturated fats.</p>		
<p><b>2. Underpinning research</b></p> <p>Cardiovascular diseases (CVD) cause 3,900,000 deaths annually in Europe (45% of all deaths). A key dietary recommendation for CVD reduction is the lowering of saturated fatty acid (SFA) intake to be below 10% of total energy (%TE) and this target has been part of UK public health policy since 1994. However, contradictory scientific evidence on the role of SFA in CVD risk (including Chowdhury <i>et al.</i> 2014) has led to public confusion, and the National Diet and Nutrition Survey (NDNS) data show that average intakes of SFA continue to exceed the government's recommendation (<a href="#">NDNS results from years one to nine</a>, published 2018). Lovegrove and Givens founded their lipids and health research group in 2008 to research the most suitable fats to replace SFA in foods, to reduce CVD risk, and ways in which this could be achieved in dairy foods – the largest dietary source of SFA. Their approach has been to</p>		

identify strategies that avoid the need for consumers having to change dietary habits, and to measure the effects of dietary SFA replacement on health.

University of Reading research has demonstrated the importance of SFA replacement with unsaturated fats. In a large human dietary intervention study (n=195) on dietary fats and CVD risk (DIVAS), replacement of dietary SFA (approximately 9.5%TE) with monounsaturated fatty acids (MUFA) lowered key CVD risk factors including low density lipoprotein cholesterol (LDL-C; -11.3%), total cholesterol to high density lipoprotein cholesterol ratio (-5.6%) and moderated a rise in blood pressure<sup>1</sup> supporting data from their earlier RISCK study (n=545), also investigating SFA replacement with MUFA<sup>2</sup>. The finding that replacing SFA with MUFA was beneficial was novel and extremely important for dairy foods, where Lovegrove and Givens' earlier work showed replacing dairy SFA with MUFA was more achievable than replacing with polyunsaturated fats<sup>3</sup>.

With MRC funding, the RESET study<sup>4</sup> (2013-2017) fed high-oleic acid sunflower oil-containing diets to dairy cows resulting in milk fat with lower (-25%) SFA and higher (+44%) MUFA, consistent over several production periods suggesting the possibility of commercial adoption<sup>5</sup>. UHT milk, cheese and butter were made from the modified milk and from normal milk. The research team carried out a double-blind, randomised, controlled crossover, 12-week human intervention which showed that the modified dairy was linked with lower fasting LDL-C, and improved vascular function and related plasma nitrite, compared with conventional dairy products. This indicated fatty acid modification of dairy products as a potential public health strategy aimed at CVD reduction<sup>4</sup>.

Subsequently, an EIT Food-funded study, carried out in collaboration with the University of Helsinki and Valio, fed dairy cows diets containing rapeseeds (the oil of which is high in MUFA) resulting in milk fat with lower (-17%) SFA and higher (+58%) MUFA<sup>6</sup>. Moreover, the 10- to 16-carbon SFA, regarded as the biggest generator of raised blood cholesterol, were 36% lower in modified milk than in conventional milk. Processing of the rapeseeds was completed with normal on-farm equipment, suggesting the approach could be adopted on commercial dairy farms.

Importantly, the oleic-acid-rich diets fed to the cows resulted in up to 18-20% lower methane emission than was seen with traditional feed regimes.<sup>6</sup> Methane is a potent greenhouse gas and thus the results show the potential to provide dairy foods with additional health benefits and lower environmental impact.

### 3. References to the research

The research outlined in this case study was supported by competitive research awards, including from UKRI (e.g. BB/I006087/1 and MR/K020218/1), the UK FSA and Department of Health Policy Research Programme (024/0036), and through the EU Horizon 2020 funded EIT Food Initiative (project reference 1001967). Human trials were registered with ClinicalTrials.gov, including NCT02089035 and NCT01478958, and have led to outputs in notable peer-reviewed journals, such as the *American Journal of Clinical Nutrition*.

1. **Vafeiadou K, Weech M, Altowajiri H, Todd S, Yaqoob P, Jackson K.G., Lovegrove J.A.** (2015). 'Replacement of saturated with unsaturated fats had no impact on vascular function but beneficial effects on lipid biomarkers, E-selectin, and blood pressure: results from the randomized, controlled Dietary Intervention and VAScular function (DIVAS) study'. *Am J Clin Nutr.* **102**, 40-48. DOI: <https://doi.org/10.3945/ajcn.114.097089>
2. **Jebb S.A., Lovegrove J.A., Griffin B.A., Frost G.S., Moore C.S., Chatfield M.D., Bluck L.J., Williams C.M., Sanders T.A.** (2010). 'RISCK Study Group. Effect of changing the amount and type of fat and carbohydrate on insulin sensitivity and cardiovascular risk: the RISCK (Reading, Imperial, Surrey, Cambridge, and Kings) trial'. *Am J Clin Nutr.* **92**, 748-758. DOI: <https://doi.org/10.3945/ajcn.2009.29096>
3. **Givens D. I., Kliem K. E., Humphries D. J., Shingfield K. J. and Morgan R.** (2009) 'Effect of replacing calcium salts of palm oil distillate with rapeseed oil, milled or whole rapeseeds on milk fatty-acid composition in cows fed maize silage-based diets'. *Animal*, **3** (7), 1067–1074. DOI: <https://doi.org/10.1017/S175173110900442X>
4. **Vasilopoulou D., Markey O., Kliem K.E., Fagan C.C., Grandison A.S., Humphries D.J., Todd S., Jackson K.G., Givens D.I. and Lovegrove J.A.** (2020). 'Reformulation

initiative for partial replacement of saturated with unsaturated fats in dairy foods attenuates the increase in LDL cholesterol and improves flow-mediated dilation compared with conventional dairy: the randomized, controlled REplacement of SaturatEd fat in dairy on Total cholesterol (RESET) study'. *Am J Clin Nutr.* **111**, 739-748. DOI: <https://doi.org/10.1093/ajcn/nqz344>

5. Kliem K., Humphries D., Markey O., Vasilopoulou D., Fagan C., Grandison A., Jackson K., Todd S., Givens D.I. and Lovegrove J. (2019). 'Food chain approach to lowering the saturated fat of milk and dairy products'. *Intern J Dairy Technol.* **72**, 100-109. DOI: <https://doi.org/10.1111/1471-0307.12564>
6. Halmemies-Beauchet-Filleau A., Jaakkola S., Kokkonen T., Turpeinen A.M., Givens, D.I. and Vanhatalo A. (2019). 'Rapeseed lipids to decrease saturated fatty acids in milk and ruminal methane emissions of dairy cows'. *Proceedings of the 10<sup>th</sup> Nordic Feed Science Conference*, Rapport Sveriges lantbruksuniversitet Institutionen för husdjurens utfodring och vård, no. 302, Swedish University of Agricultural Sciences (SLU), 69-73, Nordic Feed Science Conference, Uppsala, Sweden, 11 June 2019.
7. Guo, J., Astrup, A., Lovegrove, J.A., Gijssbers, L., Givens, D.I. and Soedamah-Muthu S.S. (2017). 'Milk and dairy consumption and risk of cardiovascular diseases and all-cause mortality: dose–response meta-analysis of prospective cohort studies'. *Eur J Epidemiol.* **32**, 269–287. DOI: <https://doi.org/10.1007/s10654-017-0243-1>

#### 4. Details of the impact

As a direct result of the research outlined in this case study, key players across the food industry now have a greater understanding of how saturated fatty acids (SFA), particularly from dairy products, affect both human health and greenhouse gas emissions from dairy farming. What is more, the research has provided ways to mitigate these negative effects by changing farming practices. The team's studies have provided evidence of the importance for our cardiovascular health of reducing SFA and replacing them with unsaturated fats. This knowledge has informed UK Government and WHO dietary policy on SFA and clarified for the public how dietary SFA intake affects their health.

##### **Impact on the dairy industry – from production to retail**

The team's early finding – that the SFA content of milk fat could be reduced from approximately 70 to 60% of total fatty acids (TFA) by replacing palm oil with oleic acid-rich rapeseed in the diet of dairy cows – formed the basis of a 2014 REF impact case study. That case study reported the introduction of a new policy by M&S in October 2011 requiring its milk producers (38 dairy farms) to reduce the SFA content in their milk by at least 6% for an extra payment [E1, E2]. This policy, continued in the current REF period, resulting in further sales of approximately 380,000,000 litres of milk and led directly to the removal of approximately 4,750 tonnes of palm oil (1,000 tonnes per year) from the diets of cows across the M&S milk supply pool, and 400 tonnes of SFA (84 tonnes per year) from their supply chain under this practice [E1]. M&S is one of the UK's leading food retailers and sells 80,000,000 litres of milk to around 1,500,000 customers each year [E2]. Assuming two people per household, **the highlighted evidence on the M&S activity represents an estimated 3,000,000 people per year in the UK who have benefited from reduced SFA/increased MUFA in their diet over the current REF period.**

Later studies by the Reading team, which demonstrated a health benefit from the consumption of milk with reduced SFA and increased MUFA, have led the Finnish company Valio to invest in the co-development of new dairy products (butter and cheese) from milk with a saturated fat content of approximately 60% TFA. Valio processes 1,800,000,000 litres of milk from 4,500 farms per year and is a major supplier to the international dairy ingredients market, with subsidiaries in Russia, Sweden, the Baltics, USA and China. Since January 2018, over EUR 400,000 has been co-invested in product development and consumer acceptance studies supported by EIT Food (an EU Horizon 2020 initiative). Between 2018 and 2019, Valio and academic partners at the Universities of Reading and Helsinki undertook extensive consumer testing on UHT milk, cheese and butter made from the modified milk. In acceptance tests, subjects were very positive about the products containing less SFA compared with standard products [E3]. Valio has stated that work at Reading, demonstrating the substantial reductions in methane obtained from feeding oilseeds (including rapeseeds) to dairy cows, has "helped

*the development of our policy on carbon reduction” as well as stating that they have been “encouraging our milk producers to adopt approaches to reduce the production of methane” [E4]. Furthermore, feeding strategies developed through the EIT Food project, and based on earlier work at Reading, have been incorporated into a book for Finnish farmers, called ‘Climate-Wise Farm Enterprise’. The book was distributed to subscribers of the leading Finnish farmers magazine Käytännön Maamies (print run 17,000) in 2019 [E5].*

### ***Influence on Government dietary policy***

Lovegrove’s more than 250 scientific papers have made a significant contribution to understanding the importance of dietary fats in relation to CVD risk. This expertise has underpinned her appointment to a number of senior advisory roles that shape government policy and industry policy and practice, and, in turn, impact upon public health. Notably, she has been a member of the UK Government’s Scientific Advisory Committee on Nutrition (SACN) since October 2009 and SACN Deputy Chair since June 2020.

In June 2014, SACN agreed to undertake a priority review of the evidence on the role of SFA on health. This decision followed a request for specific advice by the then Food Standards Agency (Scotland) and was based on Lovegrove’s advice, underpinned by her own research findings that there was convincing evidence to warrant updating the 1994 guidelines on SFA [E6]. SACN convened a working group in October 2015 with Lovegrove a key expert on fats and CVD. She drafted the review’s chapter on cardiovascular disease and subsequently contributed to the whole report and development of recommendations arising from the evidence review. The ‘Saturated Fats and Health’ report was published in August 2019 [E7]. It was based primarily on the committee’s expert assessment and grading of evidence from systematic reviews and meta-analyses of randomised controlled trials and prospective cohort studies [E6].

The report reinforced existing public health policy by recommending that the population average contribution of saturated fatty acids to total dietary energy should be reduced to no more than 10%. However, **SACN made an important clarification, advising for the first time that SFA should be replaced with unsaturated fats**. This explicit recommendation followed the conclusion in Lovegrove’s cardiovascular diseases chapter, that there was more evidence for polyunsaturated fats, but insufficient evidence to support substitution of SFA with either carbohydrates or protein for improved cardiovascular disease health outcomes. It has since been incorporated into Government policy and public health advice, for example as part of the NHS live well, eat well guidance [E6, E8]. Respected societies and organisations welcomed these clarifications. Speaking on the day that the report was published, The Head of Nutrition Science at Public Health England, said: *“SACN’s review supports and strengthens current advice. We recommend eating foods high in saturated fat less often and in smaller amounts and swapping to unsaturated fats to help achieve a healthy, balanced diet.”* In addition, a statement from the British Nutrition Foundation (BNF) said: *“The effect of saturated fat on health has been hotly debated in recent years and the relationship between saturated fat and cardiovascular disease (CVD) has been called into question. As the SACN report highlights, we have evidence from clinical trials that replacing saturated fat with unsaturated fats (especially polyunsaturated fats) can have a beneficial effect on blood cholesterol levels and CVD risk.”* The Director General of the BNF added: *“What is really important when it comes to reducing saturated fat is what you eat instead.”* [E9]

Since its publication, the SACN report on Saturated Fats and Health and updated public health guidelines has helped to support the food industry to take action on high saturated fat containing food products. For example, a Food Standards Agency report (September 2020) on a survey of the nutritional content of cheesecake sold by food businesses across Northern Ireland (NI), found that some cheesecake portions sold in restaurants exceeded the advised daily recommended intake for saturated fat. As a result, the report made recommendations for a number of targeted interventions to support food businesses across NI to reduce the saturated fat content of cheesecakes and other desserts [E10].

Furthermore, the team’s research has informed the development of the World Health Organisation’s (WHO) draft guidelines on SFA intake target, which were published for consultation in May 2018. This document cited a meta-analysis on dairy and CVD risk, co-authored by Givens and Lovegrove, as ‘emerging evidence’ that different SFA-containing

foods, such as dairy, may have different effects on CVD risk [7]. As a result, the draft WHO guidelines recommended that further research comparing the effects of SFA from different food sources on CVD and mortality was needed [E11].

**Summary:** Evidence from the University of Reading has steered the policies of a major milk processor and retailer, influencing practice change by dairy farmers across the UK and EU. UK retailer M&S has provided evidence that this policy led directly to the removal of significant amounts of SFA and palm oil from their supply chain. Over 1,500,000 M&S customers have benefited from consuming this healthier milk over the REF period and the removal of an estimated 1,000 t/year of imported palm oil and reduction in methane emissions from the M&S supply chain has played an important role in meeting the company's corporate and social responsibility targets. Methane reduction in dairy cattle is also a key target for Valio, and their suppliers are being encouraged to change practice based on Reading research as part of the company's carbon reduction policy. UK and international health guidelines have also been shaped by the research, providing clarity to UK public health advice and with the WHO recommending that further research comparing the effects of dietary SFA on CVD and mortality be carried out as a result of the team's evidence.

### 5. Sources to corroborate the impact

- [E1] Testimonial from M&S Head of Agriculture & Fisheries Sourcing on the impact of Milk Pool Diet, November 2020.
- [E2] [M&S online statement on sourcing milk](#).
- [E3] EIT Food report, produced by Valio in November 2018. Dairy products with reduced saturated fatty acids – sensory analyses of butter and cheese.
- [E4] Testimonial from Nutrition Research Manager at Valio on the development of saturated fat reduced milk and dairy products, November 2020.
- [E5] Vanhatalo, A., Halmemies-Beauchet-Filleau, A., Jaakkola, S., & Juga, J. (2019). 'The role of ruminants in the food system'. In: S. Peltonen, K. Aalto, I. Hennola, & S. Anttila (Eds.), 'Climate-wise farm enterprise' (49-56). (Knowledge to Produce; No. 145). Association of ProAgria Centers. ISBN 978-951-808-279-1. [Translation of publisher's webpage with description of the book](#) provided as a PDF, along with page 53 of the book which relates to results from the University of Reading.
- [E6] Testimonial from Chief Nutritionist, PHE on Lovegrove's contribution to SACN.
- [E7] [SACN report on Saturated fats and health](#), August 2019.
- [E8] [National Health Service live well, eat well, eat less saturated fat advice](#), March 2020
- [E9] Expert reaction to the publication of the SACN report on saturated fats and health, August 2019.
- [E10] [Nutritional content of cheesecake, report by Food Standards Agency](#), September 2020.
- [E11] World Health Organization [Draft guidelines on saturated fatty acid and trans-fatty acid intake for adults and children](#), public consultation May to June 2018.