Institution: Royal Veterinary College
Unit of Assessment: A 6 Agriculture, Veterinary and Food Science
Title of case study: **Better Management of Young stock: Addressing Calf Mortality and Suboptimal Growth**

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

In the UK, one in seven dairy calves dies annually during rearing. Herd profitability is reduced further by calfhood disease and suboptimal growth rates, delaying age at first calving and reducing milk output. Professor Claire Wathes's longstanding scientific interests in dairy cattle reproduction and development have led to a broader farming industry appreciation of this issue, and to new approaches that address the economic loss and welfare issue it represents. Her results are now incorporated into professional and practical advice from DairyCo (industry levy board); Defra; farm veterinarians; commercial feed companies; opinion leaders in dairy farming; and the specialist farming media.

2. Underpinning research (indicative maximum 500 words)

Following recruitment to the RVC in 1994, Claire Wathes, Professor of Veterinary Reproduction, established a programme on the basic science underpinning perinatal and postnatal nutritional effects on reproductive performance. Her work has centred on farmed livestock (mainly dairy cattle and sheep) and complemented that of Neil Stickland, (Senior Lecturer in Anatomy from 1984 and Professor of Veterinary Anatomy from 1994 until his retirement in 2011) who researched fetal programming of muscle growth. Through collaboration with RVC clinical experts (Michael McGowan – Professor of Farm Animal Medicine and Surgery 2000 – 2005) and epidemiologists (Dirk Pfeiffer - Professor of Veterinary Epidemiology from 1999) she has conducted research from the molecular to whole animal and population levels. She has produced data from both experimental and commercially reared cattle and thus translated her findings into practical recommendations for industry, to improve guidelines for the rearing of replacement dairy heifers to promote their welfare and improve longevity and productivity. Her research has highlighted the scale of the wastage problem in the dairy industry – in terms of both economic loss and welfare concerns of calf illness and poor growth - pinpointing reasons for the wastage at different stages.

Wathes first demonstrated that the level of maternal nutrition can influence both the endocrine system (somatotrophic axis) and organ development in fetal lambs [1]. Her research then showed that some fertility problems due to ovarian dysfunction in the first lactation of cows could be predicted based on measurements of the somatotrophic axis made in the same animals at only 6 months of age [2]. This supported her hypothesis that early life events were important in determining subsequent performance but did not at this stage differentiate genetic from environmental factors.

As dairy cattle are still growing during their first pregnancy, Wathes hypothesised this would lead to undernutrition of the fetus with preferential partitioning of nutrients for maternal growth, influencing calf development. This proved correct but she also showed that the offspring of heifers catch up within 3 months and fertility was generally better in offspring of primiparous than multiparous dams [3]. She next took an epidemiological approach to investigate the effect of growth parameters and metabolic indices during the rearing period on subsequent fertility and milk production, recruiting Holstein-Friesian heifers from 19 UK farms. Increased growth rates in the first 3 months of life were indeed associated with a reduced age at first calving (AFC) [4]. This paper concluded that heifer management should be improved by systematic growth monitoring during rearing. In subsequent related work using DNA samples from the same animals, Wathes' group identified associations between growth rate and fertility of heifers and single nucleotide polymorphisms in genes including leptin, opening the possibility that genotyping could assist in selection of herd replacements [5]. This work led to a major collaboration with China, which has a rapidly expanding dairy industry, which showed that similar issues over heifer management, exacerbated by environmental conditions, was also limiting the survival and profitability of Chinese Holstein cows [6]. In a seminal

review Wathes and her colleagues placed their published (or, at the time, soon to be published) data in the context of that of others and drew conclusions as to how this research could be used to inform the dairy industry as to how to reduce losses and improve welfare by maximising the number of replacement heifers reaching productivity within 2 years [7].

Other Quality and Relevance Indicators

The quality of the science and its relevance to industry is indicated by funding received for this work: with BBSRC, Wellcome Trust, Defra, Milk Development Council (now DairyCo) and Innovation China UK all providing major grants, and CASE awards with Merial, Volac and DairyCo. Claire Wathes was awarded the Royal Agricultural Society of England (RASE) Research Medal in 2006 for her work on dairy cow fertility and elected a RASE fellow in 2009.

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

1. Osgerby, JC, Wathes, DC, Howard, D, Gadd, TS. 2002 The effect of maternal undernutrition on ovine fetal growth. Journal of Endocrinology; 173(1):131-41 DOI: 10.1677/joe.0.1730131
2. Taylor, VJ, Beever, DE, Bryant, MJ, Wathes, DC. 2004 First lactation ovarian function in dairy heifers in relation to prepubertal metabolic profiles. Journal of Endocrinology; 180(1):63-75 DOI: 10.1677/joe.0.1800063
3. Swali, A, Wathes, DC. 2007 Influence of primiparity on size at birth, growth, the somatotrophic axis and fertility in dairy heifers. Animal Reproduction Science;102(1-2):122-36 DOI: org/10.1016/j.anireprosci.2006.10.012
4. Brickell, JS, Bourne, N, McGowan, MM, Wathes, DC. 2009 Effect of growth and development during the rearing period on the subsequent fertility of nulliparous Holstein-Friesian heifers. Theriogenology;72(3):408-16 DOI: org/10.1016/j.theriogenology.2009.03.015
5. Clempson, AM, Pollott, GE, Brickell, JS, Bourne, NE, Munce, N, Wathes, DC. 2011 Evidence that leptin genotype is associated with fertility, growth, and milk production in Holstein cows. Journal of Dairy Science; 94(7):3618-28 DOI: org/10.3168/jds.2010-3626
6. Wu, J, Brickell, JS, Yang, LG, Cheng, Z, Zhao, HQ, Wathes, DC, Zhang, SJ. 2012 Reproductive performances and survival of Chinese Holstein dairy cows. Animal Production Science; 52: 11-19 DOI: org/10.1071/AN11146
7. Wathes, DC, Brickell, JS, Bourne, NE, Swali, A, Cheng, Z. 2008 Factors influencing heifer survival and fertility on commercial dairy farms. Animal; 2(8):1135-43 DOI: org/10.1017/S1751731108002322

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

8% of dairy calves are born dead and 15% of live-born heifers are lost during rearing, in the UK, with similar figures overseas. The US Department of Agriculture reports 7.9% heifer mortality. All perinatal and rearing losses have an economic impact, but dairy heifers only become profitable half way through their 2nd lactation, recouping the average £1,300 it costs to rear them (circa 20% of dairy farm costs). Hence it is critically important to optimise rearing to ensure sufficient heifers reach adequate body size and good health – ideally for first service at 13 months - to maintain the herd. RVC's academic work in analysing the influencing factors has been translated into practical guidance, now modifying practices in the sector, to improve efficiency and reduce the welfare issues associated with wastage.

DairyCo and Defra promote key messages from RVC research regarding youngstock feeding and management [a,b]. Some advice contradicts historical practice and expectation: e.g. Wathes's work showed group housing of calves does not raise mortality from infection. It is generally recognised to have a welfare advantage, and further contributes to healthy growth by providing peer stimulation for feeding. Monitoring growth rate through as simple a means as measuring heart girth regularly, and managing feeding practices accordingly, has been shown to lead to optimal growth giving higher fertility, higher milk yield per day of life and improved longevity [c]. Feed supplier and calf-rearing specialist, Volac International, has distributed 800 – 1,000 weigh-tapes (300 in Ireland, 200 in Czech Republic and remainder in UK) to facilitate this approach. The employment of RVC post-doc, Jessica Cooke (née Brickell), as Young Animal Technical Specialist by Volac, has driven implementation of research findings [d]. HST Feeds also directly references

Wathes's research – emphasising the lifetime profitability parameters - in their 'Next Generation Heifer' feeding programme [e].

The new advice has also been promulgated via the media: the 'Stop the Loss' campaign, launched in 2011, based largely on RVC research data and championed by Tim Potter, an RVC alumnus who also completed specialist clinical training at RVC, and now a practising veterinarian, highlights this economic and welfare issue. The campaign has the support of major industry stakeholders across animal feed, health and housing, and food sectors [f]. Similarly, 'Successful Heifer Rearing to Increase Herd Profits', reporting RVC's work, is featured on The DairySite, a recognised information source for farmers internationally [g].

In parallel with economic considerations, the welfare issues from wastage identified in RVC's research have been highlighted by the Cattle Health and Welfare Group (CHAWG). The Dairy Cattle Welfare Strategy of 2010 [h] (drawing on the Farm Animal Welfare Committee's 2009 report to government, citing RVC research [reference 4]) notes: "*Further promotion of best practice methods for calf rearing and feeding to dairy farmers would also be beneficial*." Its 2012 report identified progress in this area: "*The increased publicity given by the farming press to the Stop the Loss campaign is to be welcomed whilst the National Youngstock Association is a further step in the right direction*." [i]. The Chairman of CHAWG commented further: "*RVC's research and dissemination of research findings is contributing to a significant change in the approach to management of calves, to reduce loss and ensure healthy growth, and particularly in monitoring heifers for efficient herd replacement in dairy farming*." [j]

Farm veterinary practices are also now promoting practical action to their clients, such as attention to health and diet indicated from regular weighing and measuring of youngstock. The President of the British Cattle Veterinary Association comments: "*Fundamental research at RVC is strongly linked to industry involvement … The BCVA has two principal roles: representing the views of cattle veterinary surgeons [and] signposting Lifelong Learning for cattle veterinary surgeons… New evidence based approaches to youngstock rearing, as discovered by Claire Wathes and the RVC team have been enthusiastically promoted by the BCVA and the education programme for both recent graduates and advanced practitioners includes many such concepts.*" [k]

A Clinician with Synergy Farm Health, a large practice in SW England, comments: *"… [data from the RVC's studies was used] to benchmark the pilot phase of the [heifer monitoring] service'. Some 20 farms use the service, and research results have also been incorporated into training courses for farmers (around 200 participants so far) and other veterinary practices; … and at a heifer rearing course for veterinarians in South Africa*." [l].

DairyCo notes AFC as a major factor in economic herd replacement, in its 2nd Milkbench+ report (February 2013) [m] and has indicated its intention to include AFC in its sire selection indices. The Head of Research & Development at DairyCo, comments: *"[This] work has informed much of our recent guidance on the key topics of youngstock feeding and managing herd replacements… [AFC in sire selection indices] is an additional recognition of the importance of Wathes's and Cooke's research … the availability of such data will make a decisive contribution to improving the sustainability of the British Dairy herd*." [n].

The RVC work has also impacted internationally: The US Dairy Cattle Reproduction Council has promoted RVC's findings in newsletters and flyers. A Q&A sheet highlights RVC's work on the association between a leptin gene polymorphism and perinatal mortality – which may now be used in selection of animals in breeding for herd replacements [o].

Much of the research has been undertaken on Holstein-Friesian cattle in the UK, the principal dairy breed worldwide. However, work on substantial datasets of Chinese Holsteins has led to RVC involvement in implementation of approaches to impact on the issue in China, through collaboration with Huazhong Agricultural University and the largest dairy farm (3,000 cattle) in the Hubei Province. The Director of that farm comments: "*Research results from Professor Wathes's team at the Royal Veterinary College have been highly influential in raising awareness of the level of calf mortality and how farming practices can be modified to reduce losses – both during rearing*

and in culling sub-fertile stock... This dissemination […] to opinion leaders in the Chinese dairy sector is now being implemented in our farm practice." [p].

Wathes, as a key opinion leader, has contributed more generally to the dissemination of RVC findings and consequent advice to the industry sector: she has been invited to give keynote presentations at major international conferences, including those held in Karlstad, Sweden, (2011) and Wuhan, China, (2009, 2011).

The most recent funding of Wathes by DairyCo incorporates support for a wide-reaching programme of events across the UK, (average of 1 per month) targeting UK farms, commencing in 2012 and continuing beyond the REF Impact period, to reinforce the messages to deliver economic impact [q]. A workshop focusing on calf health organised in July 2013 at RVC attracted 50 participants from stakeholders across the farming sector. Feedback indicated broad influence of the RVC research amongst delegates in different roles in industry and the public sector. (N.B. The diverse audience meant that not all questions – intended mainly for farmers and veterinarians - were relevant to all participants.) 75% (27/36) reported changed professional practice, with 81-93% (of 25) following guidance suggested by research outputs. Although 9 meeting participants reported that impact was 'too early to tell', 16 claimed improved survival rates and 18 improved calf health and economic benefit to their own or clients' business [r].

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

a. (http://www.dairyco.org.uk/library/farming-info-centre/feeding/feedingplus-section-10-managing-youngstock-feeding.aspx [accessed 4 Mar 2013]
b. http://archive.defra.gov.uk/foodfarm/farmanimal/welfare/documents/cattle-rearing10mon.pdf Esp. sections 1 and 4. [accessed 31 Jul 2013]
c. http://www.farmersguardian.com/advantages-for-early-calvers/25451.article [accessed 4 Mar 2013]
d. http://www.volac.com/news/agriculture-news/news253/feeding-for-target-growth [accessed 4 Mar 2013].
e. HST Feeds Ltd 'Next Generation Heifer' feeding programme printed flyer. Held by RVC.
f. http://www.fwi.co.uk/landing-page/livestock/youngstock/ [accessed 4 Mar 2013].
g. http://www.thedairysite.com/articles/2140/successful-heifer-rearing-to-increase-herd-profits [accessed 4 Mar 2013].
h. http://www.eblex.org.uk/wp/wp-content/uploads/2013/06/Dairy-cow-welfare-report-2010.pdf Page 14 of 36. [accessed 31 Jul 2013]
i. http://www.eblex.org.uk/wp/wp-content/uploads/2013/06/Cattle-Health-and-Welfare-Report.pdf Page 45 of 48. [accessed 31 Jul 2013]
j. Statement from the Chairman of Cattle Health and Welfare Group. Held by RVC.
k. Statement from the President of the British Cattle Veterinary Association. Held by RVC.
l. Statement from Synergy Farm Health veterinary clinician. Held by RVC.
m. http://www.dairyco.org.uk/resources-library/technical-information/milkbenchplus/milkbenchplus-report-2013/ Page 31-34 of 52. [accessed 31 Jul 2013]
n. Statement from Head of Research and Development, DairyCo. Held by RVC.
o. http://www.dcrcouncil.org/media/Public/QA%20Leptin%20Gene.pdf [accessed 31 Jul 2013]
p. Statement from Director of Wuhan JinXiu Animal Husbandary Science and Technology Development Co Ltd. Held by RVC.
q. http://www.vetsonline.com/actualites/detail/41382/rvc-dairy-cow-research-receives-major-cash-boost.html [accessed 4 Mar 2013]
r. Feedback forms from Improving Calf Health and Welfare Workshop, RVC, 23/7/13. Held by RVC.