Institution: Harper Adams University
Unit of Assessment: 6 – Agriculture, Veterinary and Food Science
Title of case study: Improving water quality through providing evidence for Government policy and regulations formulation.

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

This research discovered that the time of application of animal manure to the land, for disposal and as a fertilizer nutrient source, has an important influence on the risk of water pollution. Leaching of nitrate from the manure into the soil and thence into groundwater and surface water courses (and ultimately into drinking water) was found to be greater from autumn compared with spring applications. These findings were used by the Department for Environment, Food and Rural Affairs (Defra) when writing the Nitrate Vulnerable Zones (NVZ) Regulations. Implementation of these regulations has led to reductions in the nitrate concentration of water in the UK.

2. Underpinning research (indicative maximum 500 words)

- The key research insight was to show that more nitrate leached from autumn compared with spring applications of manure. Before this research, there was no experimental evidence for the effect of manure timing on nitrate leaching in the UK.
- The research involved field experiments on both arable crops and on grassland applying manure at different times of year. Nitrate leaching into the soil was measured to quantify the pollution risk from manure application at different times of year.
- The research was conducted from 1994-1997
- The research component at Harper Adams University was led by Dr Paul Beckwith, Senior Lecturer in Soil Science (now retired) and involved Paul Lewis (current HAU staff) as a Research Assistant. The overall project was led by Dr Ken Smith (ADAS).
- The context for the research was the need to respond to the EU Nitrates Directive to avoid exceeding the EU limit for nitrate concentration, because of the possible risk to human health. The Ministry of Agriculture, Fisheries and Food (MAFF, now Defra) needed to establish the effects of time of manure application on nitrate leaching in order to contribute to a wider body of knowledge on nitrate leaching from farmland so that the NVZ Regulations could be devised to ensure compliance with the EU Nitrates Directive. The immediate aim of the Regulations was to reduce the nitrate concentration in surface and ground waters, and thereby ultimately to influence the concentration in drinking water.

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

a. Beckwith CP, Cooper J, Smith KA, Shepherd MA (1998) Nitrate leaching loss following application of organic manures to sandy soils in arable cropping. I. Effects of application time, manure type, overwinter crop cover and nitrification inhibition. *Soil Use and Management* 14 (3):123-130. DOI: 10.1111/j.1475-2743.1998.tb00135.x

b. Beckwith CP, Lewis PJ, Chalmers AG, Froment MA, Smith KA (2000) Successive annual application of organic manures for cut grass: short-term observations on utilization of manure nitrogen. *Grass and Forage Science* 57 (3): 191-202. DOI: 10.1046/j.1365-2494.2002.00317.x

c. Smith KA, Beckwith CP, Chalmers AG, Jackson DR (2002) Nitrate leaching following autumn and winter application of animal manures to grassland. *Soil Use and Management* 18 (4): 428-434. DOI: 10.1111/j.1475-2743.2002.tb00262.

Indicators of quality of the research

i. Grant awarded to Dr C.P. Beckwith
Grant title: Nitrate leaching risk from livestock manures (NT1410)
Sponsor: MAFF
Period of Grant: 1994-1997 (36 months)
Value of Grant: £172,137

ii. The above papers have received 80, 11 and 30 total citations in Google Scholar respectively (20 November 2013).

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

This research was part of the evidence used to formulate Defra policy in relation to Nitrate Vulnerable Zones (NVZ). The NVZ Regulations impose legal requirements on farmers within NVZs to aid the reduction of nitrate pollution of UK groundwater and surface waters fed by groundwater. The NVZs cover about two-thirds of UK farmland. The main impact has been to reduce the nitrate concentration in surface and ground waters, since the NVZ Regulations were introduced. The research led to the component of the regulations on timing of manure application to land, restricting the time when manure could be applied to avoid autumn application when nitrate was found in the research to be at greatest risk of leaching from manure. The impact of the research and the resulting Regulations has been demonstrated in a report by ADAS for Defra based on assessments of nitrate pollution in 2009 and 2010.

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

a. ADAS (2007) Diffuse nitrate pollution from agriculture – strategies for reducing nitrate leaching, ADAS Report to Defra. Available at: http://archive.defra.gov.uk/environment/quality/water/waterquality/diffuse/nitrate/documents/consultation-supportdocs/d3-inventory-measures.pdf

b. ADAS (2011) Nitrates Directive Consultation Document: Environmental Impact of the 2009-13 Nitrates Action Programme & of potential further measures. Available at: http://www.defra.gov.uk/consult/files/20111220nitrates-directive-consult-evid2.pdf

c. Defra (2008) Environmental Impact of Livestock Production. London: Defra. Available at: http://archive.defra.gov.uk/foodfarm/farmanimal/documents/envimpacts-livestock.pdf

d. Chambers BJ, Smith KA, Pain BF (2000) Strategies to encourage better use of nitrogen in animal manures. *Soil Use and Management* 16 (): 157-161. DOI: 10.1111/j.1475-2743.2000.tb00220.x

e. The Nitrate Pollution Prevention Regulations (2008) Statutory Instrument No. 2349: pages 9 &12. Available at: http://www.legislation.gov.uk/uksi/2008/2349/contents/made

f. Smith KA, Chambers BJ, Williams JR (2008) Towards sustainable recycling of farm manures; in search of practical solutions to technical problems. In T. Matsunaka and T. Sawamoto (Eds.) *Animal Manure – Pollutant or Resource?* Pp. 13-39. Available upon request.