Institution: University of Hertfordshire

Unit of Assessment: Panel A (6): Agriculture, Veterinary and Food Science

a. Context

A long track record of applied agricultural research at the University of Hertfordshire (UH), together with the arrival of a veterinary scientist as Vice-Chancellor, led to formation of the Agriculture, Veterinary and Food Sciences (AVFS) UoA in 2011.

The main types of research impact relate to aspects of **food security** in the UK, Europe and the rest of the world. Examples of impacts on components of the food chain are:

1. **Improved agricultural productivity** by increasing yield/quality through applying research to improve agronomy (Higgs), irrigation (**Crook**), control of insect pests (**Denholm**), nematodes (**Davies**), and diseases in arable (**Fitt**) and horticultural crops (Hall, awarded MBE 2012) and livestock (McKellar, awarded CBE 2011) for improving urban food security (Parham) and preventing spread of diseases by international trade (Zhang et al. 2013).
2. **Economic benefits** through UH research consultancies (AERU; Biodet) and by applying research to benefit crop breeders (improved disease resistance: **Huang**, **Stotz**) and growers (potato nematode biocontrol: **Davies**; strawberry disease forecasting: Hall), and improve control of nematodes in livestock (McKellar) and bacteria in pigs (**Baines**).
3. **Better UK and EU public policy and practice on food** (Parham), drinking water (Jenkins), bovine TB and badgers (McKellar), food eco-labelling (**Lewis** et al. 2010; **case study 2**), livestock feed additives (AERU), climate change adaptation (Butterworth et al. 2010) and climate change mitigation (**case study 1**).
4. **Improved public health and welfare** in relation to better diet for the general public (Hoffman, **Vafeiadou**) and amateur, club, elite professional athletes (Kass, Roberts), and improved public understanding of environmental issues, e.g. biodiversity (Burton, Edmonds-Brown).

The main non-academic user groups/beneficiaries of the research are:

1. **Industry in the UK, EU and overseas** that invests in and exploits the results of the research includes farmers and extension workers (**case studies 1 and 2**); agrochemical & veterinary drug companies; the water industry; food industry; farmer levy boards (e.g. HGCA, HDC, crop disease forecasting); sports nutrition companies (e.g. High 5; improved diet for athletes) and crop breeders (e.g. BBSRC LINK consortium, resistance to pathogens).
2. **Government(s) and policy makers**, who implement recommendations on policy made as a consequence of our research. These include the Chinese government quarantine agency, AQSIQ (Zhang et al. 2013), European Commission and UK national government departments and agencies (agriculture/environment policy, **case studies 1 and 2)** and UK local government in Hertfordshire and other regions.
3. **Public bodies**, such as the UK Chartered Institution for Water & Environmental Management (CIWEM) and Institute for Environmental Management & Assessment (IEMA), Climatismé Magnetisme Sismicite Lac Alpin (CLIMASILAC) France (Jones et al. 2013) and India Water Portal, also implement policy recommendations arising from the research.
4. **The general public in the UK, Europe and rest of the world**, who benefit from improved food security (e.g. subsistence farmers in China), improved diet, improved education (UK schools, Nuffield bursaries; Open Air Laboratories East England (OPAL) community groups; universities in Cyprus, Greece, Thailand, Turkey) and improved appreciation of environmental issues.

b. Approach to impact

The approach to impact involved:

1. **Engaging with users to identify pathways for impact**. For example, there were meetings with government officials in China (e.g. **Fitt**, AQSIQ, Beijing, Aug 2013), the EU (AERU, Brussels, March 2012), politicians (e.g. House of Lords, **Fitt**, Nov. 2010, 2011, Society for

General Microbiology Policy statements on climate change and food security, respectively); public bodies (e.g. CIWEM, accredits UH degrees) or industry (e.g. Defra OREGIN network funds UH work). UH staff **attended industry conferences/events**, e.g. **Fitt**, Canola Council Conference, Winnipeg Canada, April 2011; Kass, 2nd Annual World Conference of Endobolism, China 2012; Sands, CIWEM conferences.

UH staff engaged users through **personal involvement in government committees, 'popular' societies, charities and campaigns**. Examples include McKellar (Chair, government committee on Bovine TB, 2007–11; BBSRC council, 2005–11; Defra science advisory committee, 2011–); **Denholm** (President, Botanical Society of Britain & Ireland, 2013–), Edmonds-Brown (Chair, Herts Natural History Society); Zukowskyj (environmental campaigns, e.g. New Barnfield Trust, Hatfield anti-incinerator campaign, elected County Councillor 2013); Burton (Herts & Middlesex Wildlife Trust, OPAL).

2. **Developing pathways for impact**. A pathway for impact is assured by doing research that is directly funded by industry (e.g. High5 Sports Nutrition, tested in Barcelona Iron Man race, (October 2013, Roberts) or jointly funded by industry and government (e.g. BBSRC LINK, 2010–14). There are Technology Strategy Board KTPs (Knowledge Transfer Partnership, e.g. with Challs International (Naseby); and Knowledge for Society (K4S) with Business Improvement District, London (Inmidtown) (Parham)). There are publications with industry, etc (e.g. **Huang** et al. 2011). There is **joint research with collaborators to deliver impact overseas**, for example in Jordan (**Crook**, Council for British Research in the Levant); India (Indian Water Portal); China (SAIN project to build capacity for climate change adaptation in China); Cyprus (Porter, Intercollege Nicosia).

   Outputs include databases on websites and delivery by government sponsors (**case studies 1 and 2**). Others involve forming **commercial companies** (e.g. Biodet to test for airborne/ waterborne microbial contaminants) and **consultancy** to policy makers and industry (e.g. insecticide resistance, **Denholm**). There have been **workshops** to train farmers and extension workers (e.g. in China, **Huang**, Sept. 2008) or to train the UK public in ecology and biodiversity in orchards. There have been **public meetings** (e.g. Burton, OPAL, >30 public lectures, field surveys/workshops with >200 groups since 2008) and presentations at industry events (e.g. Cereals' 2013). The work is also published in trade journals (e.g. *Farmers Weekly*).

3. **Assessment of impact**. Data are collected from key users to assess the impact of the research on government policy (e.g. China, EU and UK, **case studies 1 and 2)** and industry practice (e.g. website usage tracking and statistics, sales of management packages). Impact data may be included in resulting publications; for example Zhang et al. (2013) includes data on the impact on the $1.3B trade in oilseed rape seed into China from Canada and Australia, showing implementation of our recommendations by the Chinese government to decrease the risk to food security in China from *Leptosphaeria maculans*.

4. **Support for staff**. UH supports AVFS staff to achieve impact by funding travel to attend meetings with key users (e.g. £2,000 for Hall to China in 2012) and industry conferences (e.g.£2,400 for Kass to China in 2012). It provides remission of teaching so that staff can improve impact of their research. Staff are encouraged to become members of relevant committees; Knowledge Transfer Partnership applications are supported by the UH Knowledge Partnership Office; its committee monitors the UoA's commercial activity in relation to needs of industry. The AVFS UoA is supported by UH funding to develop and obtain evidence of impact from its research (e.g., £5,000 to obtain evidence for the Zhang et al. paper from China). AVFS research features in a UH 2011 research booklet (Shaping the Future) and the UH press office issue press releases about it. The UH events management team arranges public meetings for the UoA (e.g. 20 September 2012, celebration of 40 years of crop protection at UH).

c. Strategy and plans

The strategic plan of the University of Hertfordshire and AVFS unit to significantly increase the impact of its research in agriculture and food involves:

1. **Increasing engagement with end users and beneficiaries**. Such engagement is being implemented through the External Advisory Board (>20 industry members) for new degrees in

this area. A new Agriculture pathway on the Environmental Management MSc started in January 2013 and a BSc degree course in Sustainable Agriculture and Food Security starts in October 2014, in collaboration with the Royal Veterinary College and Rothamsted Research (Memorandum signed July 2013) so that teaching is integrated with research. These degree courses, being developed in consultation with end users and beneficiaries (e.g. more than 40 UH graduates in crop protection and environment industries), will all include compulsory industry placements to increase opportunities for engagement with stakeholders by AVFS research staff.

Staff are also improving relationships with non-academic users/beneficiaries/audiences by presenting work at industry meetings (e.g. **Fitt** and **Huang** invited to present at Cereals' 2013, Crop Protection in Southern Britain, Nov. 2012), joining groups (e.g. NIAB innovation farm), seeking new industry partners (e.g. hospitals for research on magnesium in food, Kass) and maintaining an agriculture stakeholder group with local employers.

2. **Increasing research done with industry partners**. Staff seek opportunities to jointly apply for funding with industry partners (e.g. BBSRC LINK project 2010–14; three industry part-funded PhDs, 2011–16; Royal Society Industrial fellowship with water industry; Roberts' work on nutrition for high performance athletes; Naseby and Hall work with Incinerator Replacement Technology Ltd; **Baines'** TSB proposal with Procarta Biosystems). We also seek industry involvement in MSc research projects (e.g. Affinity Water for water projects) and more one-year industry placements for undergraduate students.

   Commercial enterprises related to our research are being expanded. A new laboratory completed in May 2012 costing £100,000 to complement existing Biodet/plant pathology/ microbiology laboratories increased investment in molecular biology equipment (e.g. quantitative PCR). This investment is enabling Biodet work to expand into molecular diagnostics with the aim of doubling the turnover within the next five years. The laboratories will also house a new spin-out company for biological control of nematodes.

3. **Improving delivery of results to end users and beneficiaries**. New research projects are now being required to develop impact plans. For example, for a current BBSRC LINK project, new developments are being conveyed through HGCA, NFU and breeders' open days, roadshows, workshops, trade events (e.g. at Cereals' 2013), conferences and topic sheets (HGCA, planned for 2014). To improve delivery of results, a major route for technology transfer is interlinked websites. Outputs and impact evidence from the research are being placed on the UH website and linked to other sites. There is also a developing public engagement strategy. This includes traditional methods such as lectures (e.g. Vice-Chancellor's lecture, 23 October 2013), training events (e.g. OPAL), press releases and use of social media.

d. Relationship to case studies

The two case studies selected demonstrate our approach to impact; both relate to the work of AERU, established at the university in 1994. The case studies, 'Contributing to Agricultural Climate Change Mitigation' and 'Making a Difference to Agricultural Environmental Management', both relate to the strategy of improving UK and EU government policy on food and the environment. Both case studies involved engagement with stakeholders, joint research and delivery of results to beneficiaries. They also involve engagement with local government and farmers (more than 17,000 users), 'popular' societies (e.g. UK National Trust), together with EU and UK (Defra) government officials making policy decisions. Joint research was undertaken to collect the information required for estimating greenhouse gas emissions and carbon sequestration associated with different agricultural practices and for Environmental Management for Agriculture (EMA), respectively. The outputs of the research were delivered directly by AERU (e.g. through their website or on CD-ROM (EMA)) or by stakeholders (e.g. National Trust blueprint for Carbon Land Management) and published as papers in international journals (e.g. Lewis et al. 2010). Measurements of impact demonstrate that the management tools and other outputs from the research have been extensively used (e.g. >800,000 downloads of Online Pesticides Properties Database; > 3,600 copies of EMA sold).