

<p>Institution: University of Liverpool</p>
<p>Unit of Assessment: 6 - Agriculture, Veterinary and Food Science</p>
<p>a. Context</p> <p>Impact in UoA6 arises from research ranging from plant science, crop and animal production systems to large-scale epidemiological studies and companion and large animal clinical programmes. It takes place in the context of world-class ‘omics and fundamental systems biology facilities, clinical veterinary services (providing more than 13,000 commercial interactions each year) and two working farms which enable a wide range of partnerships, such as the Tesco Sustainable Dairy Group (TSDG) and its Centre of Excellence based at the University of Liverpool’s Leahurst campus. UoA6 impact has direct relevance to the University’s Research Strategic Plan, and is responsive to issues raised by bodies such as BIS, RCUK, Defra and relevant industries.</p> <p>Through engagement with academic, industrial, KTP, and policy partners, our research has generated wide-ranging impacts on health and welfare of animals and an enhanced societal understanding of our research. It has also yielded tangible commercial benefits, shaped national and international policy, and influenced professional and commercial practice.</p> <p>We have placed increased emphasis on the impact of research during this REF period and supported this by a strategy that provides drive, selectivity and support at all levels of our research, from PGR students to PI’s. Our determination has been evidenced by the Institute of Integrative Biology (led by UoA6 staff) receiving the runner-up award for ‘greatest cultural change’ in the 2011 BBSRC “Excellence with Impact” competition. BBSRC noted: “<i>This department impressed the judges with a culture change that was driven as much by the strong vision and commitment from senior staff as by the clear emphasis on recognising the contributions that can be made by more junior researchers.</i>” We have now entered the BBSRC 2011-2014 competition as a whole Faculty, rolling out the best practice to all staff in UoA6. This broad engagement is evidenced through a recent auditable internal questionnaire, in which, out of the 73% of UoA6 staff replying, we recorded that:</p> <ul style="list-style-type: none"> • 54 staff (81% of respondents) have research links with external companies; • 26 staff (39% of respondents) sit on policy-shaping or policy-making bodies; • 43 staff (64% of respondents) help train professionals outside the academic sector; • 51 staff (76% of respondents) work to develop the public understanding of their science; • 11 staff (16% of respondents) can demonstrate a societal impact for their research; • 28 staff (41% of respondents) can demonstrate a commercial impact for their research; • 31 staff (46% of respondents) can demonstrate an animal health/welfare impact.
<p>b. Approach to impact</p> <p>We are assisted in our focus on impact by the University’s <i>Business Gateway</i> which supports commercialisation, knowledge exchange and exploitation of intellectual property; the <i>Liverpool IP Unit</i> which oversees the initial identification and evaluation of intellectual property; and the <i>International Development Office</i> which identifies and supports development of international collaborations and institution-level partnerships. Our impact database, originally created as a resource for the BBSRC competition, has been developed to become a Faculty-wide asset to capture and report our activity (internally, to funders, to stakeholders, and to Government), increase the visibility of our efforts, and record best practice.</p> <p>B.1 Developing strategic collaborations: Many of our impact-relevant relationships are ‘bottom up’, initiated by stakeholder or academic, then supported by colleagues in Business Gateway, who manage IP protection, exchange of CDA documents, and provide pump-priming funding through a Knowledge Exchange voucher scheme. KE vouchers, funded from the HEIF allocation (up to £15K per project) have disbursed a total of £540K (plus £610K matched contributions) between 2011-2013. UoA6 has received seven of these vouchers (total £29K), together with four BBSRC <i>Sparkling Impact</i> awards (total £67K), e.g. Baylis/Brandenburg Ltd (improved traps for <i>Culicoides</i> midges), Bennett (bovine TB in badgers, with farmers, veterinary practices and the Cheshire Wildlife Trust), Hiscox/CEVA (vaccine improvement), and Jones/Nonlinear Dynamics (software development for proteomics) <i>Ad hoc</i> support is also available; UoL funded pilot research (Dawson)</p>

that led to Wellcome funding, resulting in a commercial vaccine for feline *Bordetella bronchiseptica*.

B.2 Building relationships with industry: UoA6 has a growing portfolio of industrial collaboration, with £4.5M of awards from industry during this REF period, involving 42 partners, including Pfizer (£900K), Convatec (£654K), Novartis (£459K), Mars (£374K) and Merial Animal Health (£296K). Collaboration encompasses production of licensed products, consultancies, access to research facilities and contract research, including genome sequencing. Clinical veterinary research underpins consultancies to pharmaceutical and animal nutrition industries (Boehringer-Ingelheim Vetmedica, Hill's, Merial, MSD, Novartis, Pfizer, Vetoquinol, Waltham) and collaborative clinical trials have led to additional drug label claims (**Knottenbelt, Innes, Nuttall, McEwan** with ConvaTec, Pfizer and Novartis). KTPs, an essential route to commercial impact, include commercialising equine artificial insemination (**Argo** with Twemlows), the Tesco Sustainable Dairy Group (**Smith & Argo** with Tesco), commercialising equine parasite diagnostics (**Proudman** with EPLA), and an S-KTP in the value of equine industries (**Proudman** with Cheshire West and Chester Council). Equine and canine stem cell research has resulted in commercial supply of stem cells to UK vets for therapeutic use (**Innes** with Veterinary Tissue Bank, Wrexham). Institutional support for the larger-scale veterinary focused consultancies and contract research is managed through the £11M turnover *Veterinary Business Plan*. All technical facilities operate to business plans overseen by the *Technology Directorate*.

B.3 Partnership Agreements: The Tesco Dairy Centre of Excellence (TDCE) was established in 2008 as a focus for a sustainable dairy industry, supporting research programmes and knowledge exchange. It has supported research studies on oestrus detection, digital dermatitis, cattle welfare and the carbon footprint of milk. The TDCE helped produce a DVD on the *Livestock Code of Practice* for 800 farmers and in 2012/13, more than 1,000 schoolchildren visited the Centre's teaching suite to learn about farming methods, welfare and genetics. This partnership facilitated research that alerted industry and regulators to the greater use of fluoroquinolones and 3rd/4th generation cephalosporins than previously thought. This has resulted in significant decreases in fluoroquinolone use in dairy herds.

In 2012 the University signed a Partnership Agreement with **Unilever**, creating a framework and processes to facilitate the exchange of knowledge and research between the two organisations. There are now eight different genomics, proteomics and enzymology projects established between UoA6 staff, across the breadth of Unilever research interests, including a £2M TSB project (**Hall N** with the CGR), and the Materials Innovation Factory campus.

B.4 Development of research networks: Linking basic and clinical research through Faculty restructuring has accelerated the translation of basic findings into new products and diagnostics. Staff in UoA6 are also active in University cross-Faculty Research Themes, including *Global Health* (**Christley**), *Living with Environmental Change* (**Baylis**), and *Security and Conflict* (**Bennett, Mortimer**), bringing together interdisciplinary teams and funding proof-of-concept and networking. The University's Food Security Network drives engagement with the food industry. The melding of UoA6 food security expertise with planning & governance research has created a rural forum for industry and policy makers. Recent events, which included UK Government ministerial involvement, have included debates on rural diversification, rural planning, and mega-farms. Recent collaborations include: promoting plant research (Plant Sciences Group) with UK Plant Sciences, and a KTP on cattle nutrition and welfare.

External-facing networks include **SAVSNET** (Small Animal Veterinary Surveillance Network, www.savsnet.co.uk), a £0.5M national health-surveillance scheme for pets, run by the University in collaboration with industry and the British Small Animal Veterinary Association (BSAVA). Piloted in 2008 with University and RCVS funds, health data are collected from diagnostic labs and vet practices, and disease summaries and analyses, along with publications on antimicrobial use and diarrhoeal disease are made publically available. SAVSNET, mentioned in Parliamentary Questions, was the only companion animal project invited to an EU initiative on disease surveillance (syndromicsurveillance). SAVSNET has been cited as best practice in a Dutch Government report.

B.5 Major Research Centres: A key infrastructure for impact generation within UoA6 has been the major Research Centres described in REF5. For example, the Centre for Genome Research (CGR) is a national RCUK-funded facility, and has developed close, long-term interactions with small and major commercial companies, e.g. AstraZeneca, Shell Global, GSK and Unilever (**Hall**

Impact template (REF3a)

N, Hertz-Fowler). Sequencing the wheat genome in the CGR led to collaboration with Roche and Nimblegen (**Hall N & Hall A**), and work is integrated with the UK commercial plant breeding community through the Monogram Network. CGR sequenced the *A. niger* genome for DSM, leading to the Eurofung consortium (**Caddick**, co-coordinator), funded by the industry to develop new biotechnological and pharmaceutical products.

B.6 Continuing Professional Development (CPD): Many UoA6 staff are veterinarians, and their position as researchers at the forefront of their disciplines makes them well placed to provide CPD for practitioners. We train more than 1,200 clinical and industrial clients annually (turnover £1M pa).

B.7 Policy impact: UoA6 staff participate in a broad range of policy-shaping bodies. The University encourages these activities, recognising the demands on time and providing compensatory adjustments in other roles. Our expertise is delivered to: European Food Safety Authority Schmallerberg expert group (**Baylis**); BSAVA, Advisory Committee on the Microbiological Safety of Food (ACMF), FSA's General Advisory Committee on Science, National Expert Panel on New and Emerging Infections (**O'Brien**: Chairs ACMF); Advisory Committee on Dangerous Pathogens, TSE Risk Group, Welsh Assembly's Bovine TB Science Panel (**Bennett**); BBSRC Strategic Advisory Panels (**Beynon**; **Wastling**); MRC Methodology Panel (**Diggle**); Advisory Committee on Antimicrobial Resistance and Healthcare Associated Infection (**Dawson**); Veterinary Products Committee (**Dawson, Bennett**); Scottish Government ('**Scudamore Review**'). As exemplars, our research into antimicrobial usage and resistance in wild, companion and food animals has contributed directly to a range of industry guidelines including MRSA and responsible antimicrobial use for BSAVA, and AMR for BEVA. University modelling of Schmallerberg (**Baylis**) has proved that cessation of animal movements would have negligible effects on disease spread-information now being used in current EU policy negotiations on animal exports.

B.8 Public engagement: *Corporate Communications (CC)* facilitate outreach events, marketing and media for this UoA. They produce *Realise*, a bi-annual publication that promotes successful collaborative projects with non-academic impact (circulation 3,000) and a KE prospectus for an external audience. CC hosts 'viewpoints', 'blogs', and Twitter feeds on topical issues that have included dangerous dogs, badger culls, land use and biofuels. Multidisciplinary outreach events led by UoA6 staff include the conference 'Health Challenges in a Changing World' that attracted an audience including members of the public, University staff and alumni, as well as MPs and civic leaders. Public science events addressed food safety and zoonoses through 'Big Bang' events and on plant sciences through 'Fascination of Plants' with National Museums Liverpool (>1000 attendees). Outreach events can have direct impact, e.g. research on the association of laminitis with insulin (**McGowan**) disseminated in a series of outreach lectures for charities, veterinary practitioners, and the horse industry, has resulted in new diagnostic and preventative strategies. We provide expert opinion for the media, often via the UK Science Media Centre, e.g. on the release of the wheat genome sequence, bovine TB, and food-borne *E. coli* outbreaks. We have hosted two series of *Animal Clinic* for Channel 5 (Series 1 was C5's most watched documentary series in 2012, with 1.7M viewers of the first episode).

c. Strategy and plans

In 2011, the University approved a policy for individual research planning, including impact plans at the project conception stage. Impact-related activities are now a formal part of staff development discussions that can lead to study leave to develop impact activity. Specific targets for the next REF period reflect generic developments such as improving recording of activity and clearer routes to provision of professional and funding support. An Impact Working Group (comprising senior and junior academics, PDRAs and PGRs) and an Impact Officer have been appointed to develop processes that will enhance planning, incentives, and rewards for impact activities. Some of our future priorities include:

C.1 Alignment of our activity with University aspirations: We support the University in its target (Strategic Plan 2009-14) to engage 100% of staff in KE/impact, e.g. in Jan 2014 we will hold the next of our *Research and Impact* away days that promotes the impact agenda to all research-active staff and postgraduates. Impact awareness is developed within PGR and PDRA training programmes, with incentives including prioritisation of CASE studentships. PGR students benefit from 'Professional internship for PhD students' (PIPs) within our BBSRC DTP and the RCUK 'YES'

Impact template (REF3a)

entrepreneurial competitions – leading in 2011 to a ‘Best IP Strategy’ award for a UoA6 team.

C.2 Heseltine Institute for Public Policy and Practice: We will work with the *Heseltine Institute for Public Policy and Practice*, a new University Institute (2013) that provides a platform for staff to engage in interdisciplinary policy development at local, regional and national levels. Of particular relevance to UoA6 is the ‘Rural Futures’ theme, led by **Bennett**.

C.3 Comprehensive impact database: Originally created as a resource for the BBSRC ‘Excellence with Impact’ competition, our database has been expanded and enhanced as a Faculty asset to capture and report our activity (internally, to funders, to stakeholders and to Government), and to increase the visibility of our efforts and record best practice. The database informs Professional Development Reviews, ensuring impact activity is supported, recognised and rewarded.

C.3 Materials Innovation Factory (MIF): A partnership agreement with Unilever has led to the development of MIF within an 8,300m² new build (2015) on the campus, funded via a £48M RPIF joint venture between the University, Unilever and HEFCE. For the development of consumer personal products and biologically-derived or inspired new products, MIF will require access to ‘omics technologies, provided by staff in this UoA using state-of-the-art capabilities.

C.4 An aquaculture hub: Involving potentially up to 50 academics, we will provide a portal for commercial clients with research needs in aquaculture, emphasising research, higher education, food production, animal welfare and aquaculture. In 2012-2013 we were involved in over £5M of grants and contracts, with over £1M directly coming to the University to address sustainable feedstock, biomarkers of fish health and welfare, water quality sensors and waste clean-up.

C.5 External access to analytical technologies: The *Technology Directorate* (lead **Beynon**, UoA6) is responsible for ensuring optimal access to the best science capability. Since its inception in 2010 it has focused on establishing excellent internal facilities, but from 2014 onwards, it will be open to companies and other external organisations that can benefit from the technology.

C.6 Veterinary antimicrobial stewardship: Antimicrobial resistance (AMR) is a major issue in human medicine, and the role of antimicrobial use and AMR in veterinary medicine in driving this remains controversial. One of our rapidly developing impact areas combines epidemiological analysis of resistance in animals and the environment with sociological and behavioural aspects of antimicrobial prescribing practice by veterinarians, leading to the development of prescribing guidelines and tools for the veterinary profession. We will develop work already underway in companion animals, cattle and pigs (**Williams N, Pinchbeck, Latham**) consolidating our relationship with partners such as Defra, BSAVA and BVA, and further influencing policy.

d. Relationship to case studies

The six case studies returned in UoA 6 relate to endemic and newly emerging infections (**Naylor, Williams, Proudman**); genetic markers to tackle genetic disease (**Carter**); and improving diet and health (**Shirazi-Beechey, Innes**). Each Impact Case maintained a close and on-going stakeholder relationship from concept through to development and exploitation, supported by the University’s KE strategy on commercialisation and intellectual property. Each case study has benefited from targeted University support:

- **Naylor:** One year research leave and reduced FEC costs charged for commercial exploitation activities;
- **Williams:** £60K studentship support for underpinning work;
- **Proudman:** £50K from *Liverpool IP* for commercial development;
- **Carter:** £25K of indirect support from the CGR;
- **Shirazi-Beechey:** Reduced teaching duties to support IP commercial contracts;
- **Innes:** University support to develop IP and negotiate and draft commercial contracts.

These case studies have helped to inform our future approach to impact. To achieve impact from research insights takes time and commitment, and we strive to balance this with other academic activities. We acknowledge that this effort requires recognition, support, and reward, and have included impact-related activities as a formal part of staff development discussions.