

<b>Institution:</b> University of Warwick
<b>Unit of Assessment:</b> UoA6 (Agriculture, Veterinary and Food Science)
<p><b>a. Context:</b> The School of Life Sciences (SLS) was established in 2010 through the merger of the former University departments of Biological Sciences and Warwick HRI. The School has broad research strengths which have been structured into six themes: Molecular and Cell Systems, Development, Infection Biology, Environment, Food Security, and Synthetic Biology and Biotechnology. Studies across a range of organisms results in our research expertise being relevant to a diverse range of audiences with applications in agriculture, veterinary science and environmental science.</p> <p><b>Industry &amp; Commercial:</b> SLS researchers have long-term collaborations with partners from the chemical, agricultural, and environmental industries. Formation of Warwick Crop Centre (WCC) has enabled a greater focus on applied research and has facilitated wider stakeholder engagement. Plant science research within SLS has led to the development of patents and generation of income by large companies, such as Syngenta.</p> <p><b>Outreach &amp; Media:</b> Engaging with the public is encouraged at all levels within SLS, with activities including a school outreach programme and attendance at public science events. Researchers give interviews to the local and national press, and are increasingly using social media to make their findings accessible to a wider audience and to stimulate public debate.</p> <p><b>Knowledge Transfer:</b> In addition to our involvement in collaborative research with industry, technical expertise is shared through courses for commercial and public sector organisations, and direct engagement with stakeholders ensures that the practical applications of our research findings and technologies are realised.</p> <p><b>Government/Policy makers:</b> Working with Government Departments has stimulated policy debate, and membership of Advisory Boards has enabled our research findings to inform guidelines in areas such as animal welfare and the use of biopesticides.</p>
<p><b>b. Approach to impact:</b> Participation in BBSRC's Excellence with Impact competition (2008 - 2011) catalysed the further development of our approach to maximising impact arising from cutting-edge science, increasing understanding of the importance of impact and enabling identification of areas of strength and weakness. When the new School was formed, a research strategy was established to facilitate the coordination of activities along the basic-applied science continuum. This applies multiple technologies to the study of a wide range of biological systems to generate fundamental knowledge. Underpinned by the six research themes, our major impact areas are: Biotechnology, Food Security, Environment, Big Data and Wellbeing. Whilst some of our endeavours align primarily with one impact area, there are also elements of overlap, and some cross-cutting activities, infrastructure and facilities. Our approach is to support all staff to apply their scientific findings, expertise and knowledge to generate broad impact beyond academia. As part of our involvement in the current Excellence with Impact competition (2013-2016) we have appointed a Director of Impact (Cameron) to provide leadership in this important area. We encourage researchers to start with small-scale projects and to engage with stakeholders at an early stage to enable relationships to develop and potential impacts to be assessed and maximised, ensuring relevance to end users. In many cases this has led to sustainable partnerships that have facilitated greater and wider impact.</p> <p><b>Industry &amp; Commercial:</b> SLS is uniquely placed to maximise collaboration with industry through WCC. Scientific expertise and facilities enable applied research, specialist services, and interaction with industry and growers. Indeed, Dow Agrosciences chose to locate its Crop Protection Unit at Wellesbourne in order to capitalise on this knowledge and resources, and the 'MORPH' crop management software developed by WCC is widely used by growers and agronomists. Between 2008 and 2012 15 PhD students graduated from SLS after completing CASE studentships, having undertaken placements with organisations including Rijk Zwaan and Speciality Produce Ltd. Further CASE studentships are underway with companies including Bayer, Unilever and Syngenta. Such activities have acted as a stepping stone towards longer-term impacts, such as the project with EBLEX to identify the causes of footrot in sheep (Green, <i>Case Study WSLSA6.1</i>). This approach has also led to patents being filed and revenue generated through exploitation of research findings, such as patenting genetic traits in plants associated with resistance to viral infection (Walsh). Additional industrial engagement comes from consultancy work undertaken by our researchers, with companies such as Pfizer (Green) and Waitrose (Chandler).</p> <p><b>Outreach &amp; Media:</b> Students and researchers take part in a wide range of public engagement</p>

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activities, and interactions with schools are a particular focus. Linking outreach activities to research helps to generate enthusiasm and spark debate, particularly among young people considering a career in science. Examples include opportunities for sixth form students to experience a university lecture, carry out lab work, and meet undergraduates, as part of the Life Sciences Summer School Programme; and engaging with local children about food security through school visits (Snitterfield Primary School and Hampton Lucy School).

The general public has a great deal of curiosity for science, particularly topical issues, and we have used our research findings to contribute to a number of public events, including:

- Leading practicals and tutorials at the Gatsby Plant Science Summer School, which brings together high-achieving first-year undergraduates with research leaders to inspire the next generation of plant scientists (Frigerio, Gifford)
- Demonstrating the role of imaging and microscopy in life science research at the Big Bang Fair (Hands-Portman, 2013)
- Involvement of one of our researchers as a panel member in the Sense About Science Plant Science public forum, who used her research findings to stimulate public debate (Gifford).

Many researchers within SLS have taken the opportunity to disseminate their research findings to a broad audience through the broadcast and print media on topics ranging from pesticide use to swine flu. Our scientists are increasingly turning to social media channels to communicate their findings. All media coverage is promoted further on the SLS website, ensuring that it is accessible to all long after its first appearance in the public domain.

**Knowledge Transfer:** Given the breadth of knowledge and expertise within SLS, knowledge transfer is a significant area of impact. Activities include short courses delivered to participants from commercial and public sector organisations, ensuring that others can capitalise on the practical applications of our basic research. Stakeholder engagement with groups such as farmers and growers ensures that our research is designed to meet the needs of end-users. For example, meetings with vets and farmers ensured that new guidelines for the management of footrot in sheep are user-friendly and implemented correctly; the lead researcher received the Royal Agricultural Society of England Research Medal in 2013 in recognition of the impact of this research (Green; *Case study WLSA6.1*). A KTP with Elsoms Seeds was one of three finalists for the Lord Stafford Award for Best KTP (Barker, 2012), which has prompted discussions on further opportunities for studentships and collaboration. SLS researchers have organised techniques workshops in areas such as biological monitoring of soil (Bending), and technologies for plant disease identification and detection (Napier); researchers have also participated in meetings to facilitate cross-sectoral knowledge sharing, including the British Society for Plant Breeders (Teakle) and the International Working Group on Legume and Vegetable Viruses (Walsh).

**Government/Policy makers:** A number of SLS researchers sit on Committees and Advisory Boards, and have influenced wide-ranging aspects of policy and management guidelines. Early and ongoing engagement by our researchers has ensured that the route to potential impact is successfully identified, assessed and monitored. Examples include: Advisor to the European Parliament on biopesticide use (Chandler; *Case Study WLSA6.2*); Advisor to the UK Government on bovine tuberculosis (Wellington); Member of the UK Government Advisory Committee on Pesticides (Bending); Member of the Farm Animal Welfare Council (Green; *Case Study WLSA6.1*); Member of the UK Insecticide Resistance Action Group (Collier).

**Institutional and School support:** The items mentioned above are a small selection of examples to illustrate the commitment within SLS towards impact-orientated research. A major factor in realising these achievements is the support, facilities and infrastructure provided by both the School and the University, including:

- Coordination and simplification of stakeholder engagement through research centres, such as WCC. WCC's Genetic Resources Unit facilitates the collection, conservation and characterisation of vegetable crops and their wild relatives, and supports collaborative research.
- Involvement in the University's *Global Research Priorities Programme* (GRP). An SLS academic (Collier) plays a major role in the GRP on *Food*, which contributes to all impact categories, particularly industrial engagement, knowledge transfer and societal benefit.
- Central roles within the University to support the advancement of impact activity, including Business Development Officers and a Knowledge Transfer Partnership Manager.
- Opportunities for dissemination of research findings beyond the academic community through the Warwick Research Archive Portal (WRAP; <http://wrap.warwick.ac.uk/>) and the University's

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Knowledge Centre (<http://www2.warwick.ac.uk/knowledge/>)

- Training in impact and dissemination through the Learning and Development Department
- Financial support in the form of Warwick Impact Fund and the BBSRC Sparking Impact Fund

**c. Strategy and plans:** We recently entered a period of review to consider how research and impact within SLS has developed, and to identify potential areas of expansion for the future. As we have recruited new members of staff and developed existing and new collaborations, the main areas of impact have evolved to Biotechnology, Food Security, Environment, Big Data and Wellbeing. Overall, our vision is to embed a culture that values impact at all levels and places it as an integral activity within the SLS research agenda. This increasing emphasis on impact will be further assisted by our participation in the current BBSRC Excellence with Impact competition, which will see the provision of impact training and resources, sharing best practice with other Departments, and improved recording, monitoring and communication of activities. The University's recent Sparking Impact award has also provided pump-priming support to several projects involving knowledge exchange and commercialisation activities led by academics in SLS and other departments. As a strategic partner of BBSRC, we expect that the increased dialogue on research planning will enable us to develop a sound approach that is in line with their priorities, placing us in a strong position to receive further funding for our impact activities.

Robust underpinning scientific research will remain the basis of all impact activity, but we will capitalise on existing relationships, such as those developed through CASE studentships, to expand current projects and networks, and reach out to new partners and stakeholders. Further development of our research themes, each driven by a Theme Leader, will give greater direction to our research, enabling opportunities to be identified and capitalised upon, and projecting a more coherent outward-facing profile to facilitate wider collaboration. Our strategy is to continue to provide support to facilitate impact activities, whilst ensuring that these activities are captured and communicated. Incorporating impact activities into recruitment, promotion criteria, and objective setting within annual reviews, will ensure that it remains at the top of everyone's agenda and that high achievers are recognised. In addition to showcasing success stories in the SLS newsletter and incorporating impact into the plans to redesign our externally facing website, we will also redevelop our intranet to provide staff with resources to help them generate impact from their research. Further support will come from the newly appointed 'Outreach Officer' (Moffat) and SLS 'Impact Director' (Cameron). Researchers can now access cutting-edge resources, in the form of a new £5m Phytobiology Facility which includes state-of-the-art glass houses and controlled environment growth rooms. This complements the field-trials infrastructure at Wellesbourne, enabling WCC to continue to develop a distinct, more industry-focussed research profile. In the longer-term we plan to move SLS to a new building on the main campus, which will provide improved research facilities, better centralised support for our researchers, and greater potential for collaboration both within Life Sciences and with neighbouring departments. We will continually monitor and assess our impact strategy, adapting our approach as necessary to ensure that the achievement of impact from research is facilitated effectively, and opportunities are maximised.

**d. Relationship to case studies:** Our research expertise is relevant to a wide number of audiences with applications in biotechnology, agriculture, environment and biomedical sciences. The SLS Research Strategy facilitates impact by bringing together scientific expertise in underpinning themes and channelling this towards our five impact areas. Researchers are encouraged and supported to contribute to at least one impact area, and to undertake a broad range of impact activities, as demonstrated by our selected case studies. A particular focus is to develop sustainable collaborations that generate a range of long-term impacts beyond academia. The two submitted case studies demonstrate how research in a specific area can lead to a variety of different impacts and they exemplify our approach of: using small-scale projects to initiate the development of sustainable impact activities; early and on-going stakeholder engagement to realise the full potential of the project; and maximising opportunities for impact through conducting high quality end-user-driven basic research. *Case study WLSA6.1* shows how initial small-scale projects with industry and stakeholders led to research driven by the end users and long-term impacts on animal welfare through changes in management guidelines. *Case study WLSA6.2* demonstrates how early and on-going interaction with policy makers stimulated debate and enabled research findings to inform policy on the use of biopesticides. These case studies reflect the research excellence within the School, the extent of our networks and interactions, and the commitment within SLS to making a difference above and beyond improving academic knowledge.