

Strategically Important and Vulnerable Capabilities in UK Bioscience

Report from the BBSRC Bioscience Skills and Careers Strategy Panel

October 2009

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Strategically Important and Vulnerable Capabilities in UK Bioscience

Executive Summary

In May 2009, BBSRC and the Biosciences Federation ran a public consultation on niche areas of research expertise in bioscience that were strategically important for the UK, but were already vulnerable or were likely to become so.

This report summarises the responses to the consultation and outlines the recommendations for further action made by the BBSRC Bioscience Skills and Careers Strategy Panel.

A total of 42 responses were received, with some describing multiple 'niche' research skills. Responses were received both from individuals and professional bodies, the latter often providing a combined view of members.

Responses to the consultation were received in the following broad research areas:

1. Chemistry and Biochemistry (4 responses)
2. Animal Physiology (7 responses)
3. Biotechnology and Biosciences for Industry (9 responses)
4. Plant and Agricultural Sciences (32 responses)
5. Systematics and Taxonomy (14 responses)
6. Other areas (6 responses)

(Note that some responses to the consultation covered more than one area.)

The responses to the consultation were considered by the BBSRC Biosciences Skills and Careers Strategy Panel (BSC) in July 2009. Following discussion, the following four areas were agreed by BSC as priorities for further action by BBSRC:

- Whole Animal Physiology
- Industrial Biotechnologies
- Plant and Agricultural sciences
- Systematics and Taxonomy

BBSRC will be looking in detail at the recommendations from BSC in order to decide how best to address the concerns that have been identified.

BBSRC welcomes feedback from the wider research base on the recommendations that have been made, and the evidence of strategic importance and vulnerability that has been presented. Comments should be sent to skills.unit@bbsrc.ac.uk

Strategically Important and Vulnerable Capabilities in UK Bioscience

1. Introduction

Background to the 'Niche Skills' Consultation

- 1.1. In May 2009, the Biotechnology and Biological Sciences Research Council (BBSRC) and the Biosciences Federation (BSF) held a public consultation to identify areas of bioscience research expertise that are strategically important for the UK, but that are already vulnerable or were likely to become so.
- 1.2. The consultation was established on the advice of the BBSRC Bioscience Skills and Careers (BSC) strategy panel, chaired by Professor Ottoline Leyser CBE FRS (University of York).¹ This is one of seven strategy panels that BBSRC uses to advise on various aspects of its strategic work. The work of the seven strategy panels feeds into the Strategy Advisory Board, BBSRC's high-level advisory board, which reports directly to BBSRC Council itself.
- 1.3. BSC was established in 2008 and met for the first time in January 2009. One of its first recommendations to BBSRC was that a full consultation be held to help identify areas of bioscience expertise that are strategically important, but in a vulnerable position.
- 1.4. A consultation questionnaire was developed jointly with BSF – see **Annex 1**. The questions were designed to ask respondents to provide concrete evidence to support the contention that an area of research expertise was (or was becoming) vulnerable, and also to explain the strategic importance of the UK retaining this expertise. In other words, why is it important, who needs the expertise, and why does the UK need to retain its own expertise, compared, for example, with recruiting in specialists from abroad? The questionnaire also sought to ask about any action that was already being taken to address the difficulties, and what action BBSRC should take to help.
- 1.5. The term 'niche skills' was used to indicate that the focus of the consultation was on the problems faced by specialist areas of expertise where the numbers of experts needed may be relatively small, but where they provide a vital contribution to the UK's ongoing available expertise.
- 1.6. With niche areas, the low numbers of individuals that are needed can itself mean that there are few employment opportunities for new researchers who, understandably, may choose to specialise in areas where the job prospects are clearer. Other broad factors which can lead to a niche area becoming vulnerable are explored in section 2 below.
- 1.7. In launching the consultation, BSC was very concerned to move beyond merely anecdotal reports of skills shortages, or the normal dissatisfaction that an individual principal investigator may have about the lack of PhD funding for their lab and the lower standard of applicants to postdoctoral positions compared to when they were setting out on their careers. In order to advise BBSRC on priorities for action, it was felt to be essential that BSC could base its recommendations on a solid evidence base.

¹ Further information, including the membership of BSC, is available on the BBSRC website at: http://www.bbsrc.ac.uk/organisation/structures/panels/skills_careers/index.html

- 1.8. The consultation was launched simultaneously on the websites of BBSRC and BSF on 7 May 2009, and it ran until 3 July 2009. 42 responses were received both from concerned individual academics and scientists, as well as professional societies and charities representing broader subject areas.

Consideration of the Responses

- 1.9. The responses from the consultation were discussed by BSC at its meeting in July 2009, along with data obtained from the British Library² on the classification of PhD theses in biosciences in the period 2005 to 2008. Since it is standard for every awarded PhD thesis to be lodged with the British Library, this dataset provides an important insight into postgraduate research training in UK universities at a level of detail unavailable from HESA statistics.
- 1.10. In general the Panel felt that the consultation had worked well and had enabled a clear short-list of areas of concern to be identified. It felt that the questions had been effective in probing the reasons behind the emergence of vulnerability in the supply of expertise, but that the quality of evidence provided in the responses was mixed. Many responses had provided little hard data to demonstrate the vulnerability of a particular niche area of expertise, and some respondents had not demonstrated the wider impact and strategic relevance of a skill's vulnerability beyond their own research.
- 1.11. In some niche areas, it appeared that organisations were not taking simple steps to undertake 'succession planning' for key areas of expertise that they were at risk of losing through the retirement of current experts.
- 1.12. A number of responses raised concerns around undergraduate degrees and the robustness of training that was currently provided. Proposals made in the *OLS Life Sciences Blueprint (2009)*³ for an accreditation programme for biology degrees, emphasising high levels of mathematics and practical skills were noted by BSC. However, the Panel also expressed concern over whether funding for teaching in universities had kept pace with the high cost of modern bioscience training, and whether the current funding model would make it possible for universities to run such courses.

The aims of this report

- 1.13. This report is based on the discussions at BSC and seeks to put information from the consultation into the public domain, where it may be of use to research organisations, research funders and policy makers.
- 1.14. Section 2 below identifies some of the broader issues that were cited by respondents as causing vulnerabilities in expertise to emerge. The processes by which an individual niche area of expertise can become vulnerable are complex. They are often the result of interconnected interactions within the wider system of funding for teaching and research, high-level skills provision in Higher Education, and the availability of employment opportunities for individuals with specialist expertise.
- 1.15. Section 3 seeks to discuss the main areas of expertise where BSC felt evidence had been provided that supported the conclusion that the areas were both strategically important to UK bioscience and vulnerable.

² Or more accurately, from 'Index-to-Theses' which provides electronic access to the British Library's thesis records. See: www.theses.com

³ Office of Life Sciences *Life Sciences Blueprint*: <http://www.dius.gov.uk/~media/publications/O/ols-blueprint>

- 1.16. The following four niche areas were agreed by the Panel as priorities for further action by BBSRC:
- Whole animal physiology
 - Industrial Biotechnologies
 - Plant and Agricultural sciences
 - Systematics and Taxonomy
- 1.17. The recommendations to BBSRC from BSC are given, and these will now be considered by BBSRC alongside its current strategic priorities, and will help to inform future plans.

2. What Causes Skills Shortages to Arise?

- 2.1. This section seeks to explore a number of the generic issues that emerged from the consultation in terms of explaining the causes of a skills vulnerability.
- 2.2. The responses often demonstrated how complex and interconnected the issues are that give rise to a vulnerability in the supply of expertise. For example:
- A 'skills shortage' may seem to concern a shortage of individuals being trained in a specialist area, i.e. a 'supply side' difficulty.
 - However, on further investigation, the issue may relate to a shortage of employment opportunities for individuals with the expertise in question.
 - Universities, research institutes and commercial employers may have a very low turnover of staff in certain specialist areas, or posts may be declining because of changes in external funding or commercial priorities.
 - This in turn can send messages back up the skills 'supply chain' and influence the decisions that students make about specialising in particular areas.
- 2.3. The mix of factors that are causing a particular vulnerability in an area of expertise are individual to that area, but a number of common themes emerged:

Career structures for specialists

- 2.4. The absence of a clear career path into a specialist career in a particular area may make study in the area at degree or PhD level less attractive as a choice for students. Equally, if the number of posts coming up in an area is very small, it may be unrealistic to expect students to take the risk of investing their time and money in training for a job that may not materialise. Lichenology and mycology were mentioned by respondents in this respect.

Employment opportunities in the research base

- 2.5. Changes in employment opportunities for individuals with specialist expertise, such as reductions in research posts being funded through project grants, will have a greater impact in niche areas than in more generic areas of bioscience research. If an area is only attracting low levels of research funding, individuals who have developed key expertise may simply decide to move out of science and pursue a more stable career path in an entirely different area.

Changes in public funding for research

- 2.6. A number of respondents argued that changes in Defra funding for research projects in the agri-food area had had a significant impact on the availability of postdoctoral positions. Postdoctoral research positions in universities and research institutes form a key stage in the development of very highly skilled individuals who then move

- 2.7. Reductions in research funding can, therefore, have significant negative external impact beyond the immediate research, and on the skills supply chain itself for a wide range of specialist areas expertise.

Public and science community perceptions

- 2.8. Perceptions of a science area by the science community itself and the wider public will have a significant impact on whether students and early-career scientists see the area as offering attractive and exciting opportunities. Soil science, for example, was mentioned as an area where the strategic and scientific importance was not always obvious to students choosing module options at university.

Student interest and demand

- 2.9. Changes in student demand for modules and courses at HE level will have a direct impact on whether a university or college continues to employ an individual with particular teaching expertise. Universities and colleges will respond, understandably, to changes in demand from students.
- 2.10. Where departments have merged to form larger schools of bioscience, this can make it easier for a university to respond – for example, by replacing a lecturer in agronomy with one in a more popular area of molecular biology. The downside to this increased responsiveness is that strategically important niche skills can be lost from the HE sector with considerable rapidity.
- 2.11. A number of respondents also felt that undergraduate teaching in some areas had not progressed, and courses were taught in ways that were now perceived to be old-fashioned. Taxonomy was mentioned by one respondent as an area that needed to be taught and presented in a different way if it is to appeal to a modern student audience; for example, linked to subjects with broader appeal, such as conservation.
- 2.12. The lack of interest in, and negative portrayal of, some of these subjects (such as plant science and taxonomy) in schools, is a contributing factor to the drop off in the number of students entering HE choosing to study these subjects. A number of respondents noted that with this decreased demand, many undergraduate courses are closing or being made peripheral parts of other degree courses. A lack of informed and accurate information on science careers reaching young people is an associated issue. Interest needs to be generated at an early age and then sustained throughout the school years to have optimum impact.

Employer demand

- 2.13. Some respondents were vague about the level of demand from employers for particular high-level skills, and also about who the ultimate end-users of niche skills outside of academia may be.
- 2.14. Equally, some responses from employers did not demonstrate knowledge of existing mechanisms, such as CASE PhD studentships, by which they could influence the availability of opportunities for students to undertake high-level training in niche areas.

High-cost of training

- 2.15. Where there is clear evidence of demand from organisations needing high-level skills, there may be factors that prevent a university or college responding to that need. One factor mentioned by respondents was the high-cost of training, either in staff time or direct costs, in some specialist areas, which may make it uneconomic

Research Assessment Exercise

- 2.16. A number of responses argued that the continued employment of specialists within HE in some niche areas had also been made difficult by the successive rounds of the Research Assessment Exercise.
- 2.17. Universities have become increasingly aware of the need to maximise the publication output of their research staff in high-impact journals. Specialist journals covering niche areas will tend to have lower impact factors. Respondents argued that this in itself makes it difficult for applicants to lectureships to compete if they are working in a niche area; and equally departments will be drawn to make appointments in areas that are likely to generate papers in higher impact journals.
- 2.18. The following section considers in detail the four main areas that were identified by BSC as strategically important and vulnerable on the basis of evidence submitted in the consultation.

3. Strategically Important and Vulnerable Areas of UK Bioscience Expertise

- This section illustrates the range of views brought to the attention of BSC, citing the concerns of respondents and the actions that they suggested. As such, the views should not necessarily be taken to represent the recommendations reached by BSC, which are summarised at the end of each sub-section.

3.1. Whole Animal Physiology

What the area covers

- Areas mentioned in the consultation included whole animal physiology (*in vivo* skills including the handling of both laboratory and large animals), pathology and toxicology.
- A lack of skills was reported at the undergraduate and postgraduate levels.

Strategic importance

- Respondents cited:
 - Animal physiology skills are needed for maintaining the UK position as a world leader in biomedical research and drug development; relevant expertise is relatively high in the UK and harder to find abroad.
 - Such skills are also required for high quality *in vivo* research in academia, including for research on disease and disease pathways, mechanistic understanding of brain-behaviour relations, pre-clinical research (of relevance to both humans and animals), integrative approaches to systems biology, and placing biological research in the context of the whole animal.
 - Whole animal skills are also important for the development of advances in alternatives to the use of animals in research.

Evidence of Vulnerability

- Respondents cited:
 - Employer surveys showing difficulty in recruiting appropriately trained staff; this requires them to invest heavily in in-house training, which can have a negative effect on productivity.
 - There is a lack of trained graduates and postgraduates:
 - Only around 2% of life sciences undergraduates have exposure to whole animal studies, due to limited funding.
 - There is a similar trend for postgraduates, more of whom are using molecular biology techniques instead of whole animal studies.
 - Pathology is an area that is growing rapidly but where many of the skilled people are reaching retirement. This area requires a lengthy training programme and companies have found it difficult to recruit in this area.

Causes of Vulnerability

- Respondents cited:
 - High financial and administrative burden associated with *in vivo* training.
 - Tight regulations on animal experimentation.
 - Around 25% of experts who are able to train others properly are reaching retirement age.
 - Whole animal work being seen as a riskier career – most researchers prefer to use cells or tissues and are not trained in anatomy. Research involving whole animals is (seen to be) less successful than that involving molecular biology.
 - Training in the use of *in vivo* techniques requiring more supervision time; HE curricula have changed and there has been an increase in student:staff ratios at HEIs.
 - Despite this there is no shortage in the number of undergraduate students wishing to carry out training in whole animal work.

Existing action being taken

- The following actions were described:
 - The Integrative Mammalian Biology initiative by Funding Councils, BBSRC, MRC, Wellcome Trust, and industry.
 - MRC Integrative Toxicology Training Partnership.
 - MRC Centre for Drug Safety Science at Liverpool University.
 - Summer schools and intern schemes from the British Association of Psychopharmacology, British Physiological Society and British Pharmacological Society.
 - The Institute of Animal Technology (IAT) has outreach programmes to provide information on countering activities of anti-vivisection groups.
 - The American Physiological Society creates workshops and summer training sessions in order to retain skills.

- The Biosciences Federation have developed an 'ideal curriculum' for a masters course in safety pharmacology.
- The following further actions were suggested by respondents:
 - Provide additional ring-fenced funding for training and research: change the strategic direction of funding to support the area; provide funding for masters courses and increased support for PhD training.
 - Develop a national agreement that full economic costs are not routinely charged for training.
 - Hold seminars and discussions on the ethical concerns of animal experimentation in the curriculum of physiology courses.
 - Provide a wider range of options – more analysis of the problem and a targeted approach to supporting key areas.
 - Continue to encourage academia-industry partnerships.

Recommendations from the BSC panel:

- There is a clear need to promote the role and importance of researchers with whole animal expertise.
- In particular, BBSRC should explore how to drive the systems biology agenda further into whole animal contexts in responsive mode. The proper costing of whole animal work is essential to ensure that posts for individuals with this expertise are sustainable.
- BBSRC should ensure that opportunities for joint working with industry are fully maximised, including the expectation that industry meets more of the cost of research training in strategically important areas for their long-term success.
- BBSRC should investigate ways of encouraging increased collaboration between biology, veterinary and medical departments in universities and institutes regarding the development and maintenance of whole animal expertise and training.

Further information

- BBSRC spend for research funding involving the use of animals is estimated as around £63M in 2007/08 – around 20% of the total BBSRC research spend in that year. Estimated research spend on the 3R's (reduction, replacement and refinement of animals in research) and animal welfare was £4.9M in 2007/08, increasing to £6.8M in 2008/09. These figures include research through grants and core funding to institutes; detailed figures on studentships involving the use of animals are not currently available.
- BSC agreed at its meeting in January 2009 that BBSRC should use funding from its targeted training budget to provide a higher level of funding to cover the costs of *in vivo* training in PhD studentships. BBSRC has subsequently been in discussion with MRC and the British Pharmacological Society about operating a joint approach to funding the high costs of training in this area, and it is hoped that further details will be available by the end of 2009.
- The BBSRC Masters Training Grant call in 2009 listed Masters Degrees providing *in vivo* skills as a priority.

3.2. Industrial Biotechnologies

What the area covers

- Areas include bioprocessing, pharmaceuticals and drug development (including *in vivo* work), fermentation and flavour science. This covers all aspects of production from lab-based R&D to larger-scale manufacturing, formulation and delivery.
- Generally the shortages were reported at the masters and PhD postgraduate levels, with some areas also reporting a need for more training at the undergraduate and postdoctoral levels.

Strategic importance

- Respondents cited:
 - The importance of the life sciences industry for the UK is well recognised, as demonstrated in the *Government Response to the Review and Refresh of Bioscience 2015 Report*⁴ and establishment of the Office of Life Sciences.
 - The pharmaceutical industry is the UK's top research sector, accounting for 28% of all business investment in R&D in the UK. The industry employs around 67,000 people, around half of whom are skilled staff working in R&D. Pharmaceutical exports in 2008 were £17.2bn, bringing a trade surplus for the UK of £6bn; the pharmaceutical industry adds more value per employee than any other major industrial sector. It has strong collaborations with academia, totalling around £60-80m in 2005. In 2007, pharmaceutical companies provided work experience for over 850 school students, 514 year long placements for science undergraduates and 606 PhD students.
 - Changes in US policy relating to embryonic stem cells will increase overseas demand for researchers with expertise in cellular-based therapies; in this changing and developing area, the UK needs skilled people to maintain its skills base for international competition.
 - It was noted that this field of research increasingly requires skilled engineers and bioscientists able to work in a multidisciplinary environment.

Evidence of Vulnerability

- Respondents cited:
 - A difficulty in recruiting suitably qualified staff with practical and/or theoretical expertise. Many of the qualified people are already in industry where they obtained their skills through in-house training. Skilled people are recruited from abroad, but tend to return to their home country, taking their skills and training with them.
 - The development of new medicines requires different skills from those needed in the past; for example translational medicine – translating scientific discoveries into real therapies and medicines – is an increasingly significant area in the pharmaceutical industry, but there are major gaps in teaching here.

⁴ *Government Response to the Review and Refresh of Bioscience 2015 Report* (May 2009)
<http://www.berr.gov.uk/files/file51169.pdf>

- Flavour science was also noted as an area with a significant lack of skilled people, with only two UK Universities providing training and experts reaching retirement age. The nature of flavour science is changing with an increased emphasis on food choice and psychology to tackle over-eating through understand flavour dependency, rather than through diet and exercise. These new research areas will move elsewhere if UK does not develop sufficient expertise.

Causes of Vulnerability

- Respondents cited:
 - Few institutions have the breadth of teaching capability to provide adequate training; for example, specialist equipment may be required for practical work, with expertise in both biology and engineering.
 - Too few bioscientists and engineers are being attracted onto existing courses, which are not delivering the right content to increase graduate employability and meet industrial needs.
 - There is a lack of awareness of drug metabolism and pharmacokinetics amongst undergraduates, combined with a lack of practical experience and not enough teaching modules in mathematics.
 - It was noted that there is a trend away from applied research in bioscience departments, possibly due to RAE metrics. For example, this has resulted in some applied bioscientists moving to biochemical engineering departments.

Existing action being taken

- Respondents described the following:
 - Proposals from OLS as part of the Skills Activism agenda⁵ will hopefully help overcome a lack of relevant skills in undergraduate bioscience degrees.
 - The Society of Biology could have a role in setting criteria for bioscience degrees, which could be accredited by the new organisation.
 - BBSRC have a number of relevant schemes, including: Bioprocessing Research Industry Club (BRIC); Industrial Partnership Awards; Industrial Impact Fellowships; and the Industry Interchange programme.
- The following further actions were suggested by respondents:
 - BBSRC should provide continued support to help promote areas to engage with industry and other partners.
 - Strengthen postgraduate training through the interchange of staff with industry, for example through expansion of CASE studentship and placement schemes.
 - Develop undergraduate and masters curricula in areas linked with engineering, and provide additional funding for specific masters training.
 - Provide greater marketing of existing schemes.

⁵ See, for example, the speech by Rt. Hon. Lord Mandelson, First Secretary of State, to The Royal Society for the encouragement of Arts, Manufactures and Commerce, London, 17 December 2008: <http://www.berr.gov.uk/aboutus/ministerialteam/Speeches/page49416.html>

- Create a centre of excellence in the area of bioprocessing research to generate jobs and raise standards and status of the area in the UK.

Recommendations from the BSC panel:

- BBSRC should investigate the changes to university research provision in this area between RAE2001 and 2008, and whether there is evidence that the RAE process has driven a change in the pattern of research activity in this area. An understanding of whether there has been a change, and whether this has been beneficial or not for the supply of trained people, will be important to inform future policy by funders and other bodies.
- BSC noted that the Industrial Biotechnology Innovation and Growth Team (IB-IGT) report⁶ had been published in June 2009 and welcomed ongoing work to take forward its recommendations. A meeting of key partners chaired by Dr David Brown (CE of IChemE), and involving the research councils, had been held in July 2009 to discuss skills provision in this area.
- BBSRC should seek to maximise the new opportunities to foster collaborative training made possible by the new Knowledge Transfer Network directed by BSC member, Dr Chris Warkup.

Further information

- BBSRC estimated spend on industrial biotechnology research is £23.9M in 2008/09.
- In its 2009 studentship competitions, BBSRC is seeking to fund studentships in the following areas of relevance to biotechnology and biosciences for industry:
 - BBSRC Targeted Priority Studentships in Bioprocessing.
 - BBSRC Masters Training Grants (MTGs) - Masters Degrees providing strategically important training for industry, particularly Industrial Biotechnology and Bioprocessing, were specified as a priority.
 - BBSRC Industrial CASE Studentships – BBSRC’s annual competition that allows companies as well as academics with a commercial partner to submit PhD studentship proposals.
- BBSRC has identified the strategic importance of research on next generation bioenergy and biorenewables (the use of biofuels and industrial materials from novel sources) in its public consultation of the new BBSRC Strategic Plan for 2010-2015.

3.3. Plant and Agricultural Sciences

What the area covers

- A number of distinct areas were identified under this heading, and they are considered separately below. Recommendations from the BSC panel, covering all of the sub-disciplines, are shown at the end of the section.

⁶ *IB2025: Maximising UK Opportunities from Industrial Biotechnology in a Low Carbon Economy*, available at <http://www.berr.gov.uk/whatwedo/sectors/chemicals/IBIGT/page44395.html>

Plant physiology

Strategic importance

- Respondents cited:
 - To assess the performance of improved crops and responses of plants to climate change.
 - To assist in moving agricultural production into marginal and degraded lands, to help understand plant adaptation strategies, for example for the production of bioenergy crops.
 - To maintain a supply of good technicians and research leaders, supporting the ability of the UK to respond to the need for elevated and sustainable food production at home and globally.

Evidence of Vulnerability

- Respondents cited:
 - The average age of plant physiologists is increasing, with many nearing retirement.
 - There is a reduction in the number of trained people with specialist skills, making recruitment to posts difficult.
 - There is an increasing reliance on the specialist skills and knowledge of hobbyists.
 - The industrial sector is relying on in-house training due to difficulties in recruiting people with the required skills and experience.

Causes of Vulnerability

- Respondents cited:
 - The rapid increase in high throughput 'omic' technologies has eclipsed the more traditional disciplines, resulting in a perceived decrease in funding opportunities for applied research and whole plant physiology compared to more fundamental molecular level plant science.
 - Plant physiology is a difficult field in which to recruit undergraduate and postgraduate students: student demand for plant science courses has reduced and there has been significant restructuring or closing of specialist departments in recent years.
 - Other related areas, such as the study of lichens and fungi, are also decreasing in popularity, both within the teaching and research communities.

Existing action being taken

- The following actions were described:
 - The Gatsby Charitable Foundation provides a number of schemes relevant to all aspects of plant sciences. Such schemes include: grants; development of a new plant science laboratory in Cambridge; summer schools, bursaries and studentship schemes. The Foundation also supports the Science and Plants

- The following actions were suggested by respondents:
 - Fund more summer studentships, targeted masters courses and provide support for teaching staff.
 - Encourage the employment of staff with specialist interests / expertise by liaising with HEFCE to reward Universities that do this.
 - Work with other organisations to strengthen school and college curricula, particularly opportunities to undertake fieldwork and lab-based plant growth experiments.

Plant breeding

Strategic importance

- Respondents cited:
 - To face the challenges of climate change, food security and policy drivers. The challenge for 21st century agriculture is to double food production over the next 40 years, in a sustainable way, on a finite amount of land and using increasingly scarce and costly resources.
 - To develop crops with increased quality and yield, greater resistance to pests and pathogens, and higher tolerance to environmental stresses.
 - To maintain scientific coherence to deliver new cultivars from scientific progress.
 - To match the current emphasis on genomic information with equally good phenotypic data.
 - To develop a pool of skilled people needed by plant breeding companies.
 - The UK cannot depend on expertise from abroad as they are not trained to address UK-specific problems and retention of skills within the UK after training can be difficult.

Evidence of Vulnerability

- Respondents cited:
 - The current shortage in the UK of qualified plant breeders represents both a present and future need. Much of the relevant research on basic plant science is in model crop species without being transferred to staple crops.

Causes of Vulnerability

- Respondents cited:
 - There is an ageing population of plant breeders with several senior breeders due for retirement; recruitment is difficult with a general lack of interest from students and researchers moving to train and specialise in the area. This is partly due to the emerging molecular disciplines and the peer review system rewarding publications in high ranking journals, which do not always favour practical applications that are more difficult and qualitative to assess.

- There are very few places that train plant breeders, and plant breeders are increasingly concentrated in the private sector, with a relatively minor role in the university and research community. There is a difference in attitude over the responsibility for plant breeding between public and private sectors.

Existing action being taken

- The following actions were described:
 - SCRI has initiated a proactive succession management policy; it was suggested that more action like this was needed nationally.
- The following further actions were suggested by respondents:
 - Provide targeted funding for specific opportunities.
 - Provide strategic support for Masters courses and PhD studentships.
 - Encourage greater transfer of skills and knowledge between sectors and institutions in the UK.
 - Provide strategic support through PhD studentships linked to industry via the Crop Improvement Research and Technology Club.⁷

Plant pathology and pest management

Strategic importance

- Respondents cited:
 - To develop and maintain the ability to respond to novel pests and diseases relevant to the agricultural and horticultural industries, including accurately detecting and identifying quarantine organisms and developing control strategies for new problems; if exotic diseases remain undetected, control measures become more difficult to apply and the costs increase.
 - To enhance understanding for food security; to work in crop protection and nature conservation; and to study the loss of biodiversity.
 - To ensure that the general public is able to distinguish between beneficial species and pests and to prevent the eradication of beneficial species.
 - To address the world-wide shortage of skilled people in this area, including plant health inspectors, and to train the indigenous population to appreciate the issues.
 - To maintain a pool of trained researchers to work with practical plant breeders to develop diverse control strategies, including in response to climate change.
 - A developed taxonomic knowledge of insects, fungi and other pathogens is essential for the effective control of plant pests and diseases (see further details in the Systematics and Taxonomy section).
 - As an example of potential losses to crops caused by uncontrolled diseases, it was reported that fungi are the cause of the majority of plant diseases and comprise nearly 70% of non-native pathogens introduced to the UK. For disease control in wheat, losses where current expertise is lacking to provide

⁷ For more information on BBSRC's Crop Improvement Research and Technology Club, see: http://www.bbsrc.ac.uk/business/collaborative_research/industry_clubs/crop/index.html

Evidence of Vulnerability

- Respondents cited:
 - There is a limited number of specialist research groups in the areas of plant pathology and entomology, with a significant reduction in the number of experts due to retirement or moving to other fields.
 - There is difficulty in recruiting into these areas as most applicants have little relevant experience, and some research groups have few or no specialists.

Causes of Vulnerability

- Respondents cited:
 - The lack of a significant cohort of researchers in the area means that very few universities offer relevant courses, with little postgraduate training and a lack of career opportunities.
 - A reduction in funding for strategic research and training, with the loss of the former MAFF studentship scheme and the RAE rewarding basic rather than applied research.
 - A shift in strategic direction by BBSRC towards molecular biology was also cited as a cause of the current vulnerability of this area.
 - The British Society for Plant Pathology carried out a skills audit in 2006, showing a decline in plant pathology skills.⁸

Existing action being taken

- The following actions were described:
 - The British Mycological Society and British Society for Plant Pathology are developing strategies and action plans to maintain interest at schools, Universities and with the public, funding summer bursaries and PhDs and setting up a research group network.
 - Rothamsted Research is initiating a pilot programme in 2009 to encourage more interaction between academic scientists and the agricultural industry. This is aimed at raising awareness amongst agricultural advisers of recent research findings, and improving the applied understanding of research scientists.
 - The Gatsby Charitable Foundation has developed a new plant science laboratory in Cambridge.
- The following further actions were suggested by respondents:
 - Provide funding for undergraduate and postgraduate studentships, including targeted masters training.
 - Provide funding for fellowships or sabbaticals to enhance research and teaching expertise, and networking grants to help coordinate research.

⁸ BSPP Skills Audit: http://www.bspp.org.uk/society/skills_audit_results.php

- Target funding into special priority areas, such as agro-ecology, entomology and practical plant pathology.
- Co-fund with others to promote skills in applied and strategic research, for example through LINK.
- Talk to farmers and growers and encourage close working with industry.

Soil science

Strategic importance

- Respondents cited:
 - To ensure the UK's ability to respond to global issues in food security.
 - To assess the impacts of environmental change on agricultural production, including the response of plants to abiotic stresses such as drought; to understand how soil structure affects greenhouse gas emissions.
 - To deliver strategic research for improving nutrient use efficiency in crops.
 - To deliver research on the bioavailability of pollutants in soils and the transfer of these pollutants to the food chain.
 - To prevent soil loss and pollution through erosion.
 - To ensure that the UK has a pool of trained specialists who have an understanding of UK climatic and other conditions relating to agricultural production.

Evidence of Vulnerability

- Respondents cited:
 - There has been a decline in the amount of fundamental soil science research in the UK, although it remains strong abroad. There are few jobs available in the commercial sector and these tend to be filled from abroad, with extra in-house training being provided.

Causes of Vulnerability

- Respondents cited:
 - Reduced funding from Defra was given as a key reason for the reduction in the number of specialist soil scientists in the UK, and it is now seen as a poor career choice.
 - There are some links with the agricultural industry, but companies cannot afford to undertake the basic soil science research (such as soil physics) that is necessary.

Existing action being taken

- The following actions were suggested by respondents:
 - Provide continued funding through the SoilCIP programme and work with RASE on a gap analysis for soil science.

- Hold discussions with Defra and NERC to agree responsibilities for research provision and ensure funding is not further reduced.
- Provide targeted funding in soil biophysics and in collaboration with key institutions working in the area, such as SCRI.

Horticulture

Strategic importance

- Research and training in horticulture is needed:
 - To develop skilled people to maintain and enhance the UK's horticulture industry, which employs around 300,000 people and is worth around £9 billion each year. Skilled people are essential to retain the UK's global competitiveness in this sector and to meet new challenges to produce high quality, safe, nutritious food in a sustainable way.
 - To address challenges of sustainable crop production in a changing environment.
 - To retain skilled people within the UK to develop experience and for succession planning.

Evidence of Vulnerability

- Respondents cited:
 - Many of the UK's specialists are approaching retirement age.

Causes of Vulnerability

- Respondents cited:
 - Horticultural research has a poor public perception and is not seen as an attractive career choice.
 - There are very few UK postgraduate students in horticulture, and of these, few are retained within the UK after training.

Existing action being taken

- The following actions were described:
 - The *GrowCareers* website⁹ which gives advice on careers in the horticultural industry.
 - The Horticultural Development Company (the levy body for the sector) carries out a number of activities promoting careers in horticulture and provides funding for research through initiatives.
 - NFU Why Science Matters campaign.
 - *Horticulture Week* campaign.
- The following further actions were suggested by respondents:

⁹ *Grow your own career in horticulture:* <http://www.growcareers.info/>

- BBSRC should encourage more interaction with industry and levy bodies;
- Develop a higher profile for relevant careers;
- Provide funding for a practical horticulture training scheme.

Recommendations from the BSC panel (covering all the above sub-disciplines):

- The wide range of specialist expertise needed to sustain a strong agricultural research base is increasingly recognised. BSC, at its meeting in January 2009, had agreed that concerns in this area be addressed through the development of Advanced Training Partnerships (ATPs), and it noted that BBSRC was calling a Town Meeting in October 2009 to discuss this new funding initiative with key partners.
- BBSRC should also investigate the potential disadvantage that plant scientists face in submitting grant proposals, in comparison to other areas of bioscience, given the role of BBSRC as the single funder in this area.
- BBSRC should explore opportunities to work with the Gatsby Foundation to promote further plant sciences in schools, given evidence that children and young people perceive the area as less exciting than other areas of biology.

Further information

- An analysis of postgraduate theses submitted to the British Library between 2005 and 2008¹⁰ indicated that the numbers of theses in several areas relating to plant and agricultural sciences were low relative to other subjects. In particular, within the Agriculture classification area, there were a consistently low number of theses (less than 20 per year) classified as either field crops or horticulture between 2005 and 2008. In addition, within the Biology and Biochemistry classification area, there were less than 20 theses submitted per year in different areas of Botany, including: algology; general botany; mycology; plant cytology and histology; vegetational history; crop physiology and herbicides; and systematic botany.
- BBSRC total estimated spend on plant, crop and soil science is £78M in 2008/09, comprising: £44M on crop science (of which £4.5M is on pests and pathogens outside the plant host – note this does not include all spend on research relating to plant pests and pathogens); £31M on other plant science; and £3M on soil science. Total spend (2008/09) on horticulture research is £7M.
- BBSRC is planning to hold a 'Town Meeting' with representatives of a wide range of partners in October 2009 to discuss the launch of a new training initiative: Advanced Training Partnerships (ATPs). These partnerships will aim to link up universities, institutes, agricultural colleges, levy bodies, and agri-food industries in order to help them work together to address high-level skill needs in strategically important areas of research expertise.
- In its 2009 studentship competitions, BBSRC is seeking to fund studentships in the following areas of relevance to plant sciences and agriculture:
 - BBSRC Masters Training Grants (MTGs) - Masters Degrees providing strategically important training for industry, particularly high-level skills to address concerns around food security, were specified as a priority.

¹⁰ Data from Index-to-Theses (ITT): see www.theses.com. Theses are submitted to the British Library on a regular basis from participating Universities (including all BBSRC funded Universities) and are assigned to one of over 300 classifications based on the thesis title.

- BBSRC Industrial CASE Studentships: BBSRC's annual competition aims to enable SMEs as well as individual academics to propose collaborative PhD training programmes.
- Food Security is an area of key strategic importance to BBSRC, as outlined in the public consultation of the new BBSRC Strategic Plan for 2010-2015, providing skills and research on bioscience underpinning an adequate, affordable, sustainable, nutritious and safe food supply in a changing world.

3.4. Systematics and Taxonomy

What the area covers

- This area covers systematics and taxonomy for all groups, but particularly microbes (including fungi), algae and plants.

Strategic importance

- Respondents cited:
 - For monitoring global biodiversity and environmental conservation, including in adaption to climate change.
 - To ensure that the UK retains a pool of trained professionals able to provide taxonomic identifications.
 - To interpret the outputs from various 'omic' based approaches.
 - For the search and discovery of bioactive compounds of commercial potential therapeutic importance.

Evidence of Vulnerability

- Respondents cited:
 - Global shortages of taxonomists, which mean that the UK cannot rely on recruiting skilled people from abroad.
 - There has been a significant decline in the numbers of taxonomists over the past 10-20 years, with specialists not being replaced when they retire. Of those remaining, many are retired or reaching retirement age.
 - There are very few algal taxonomists and of these, most work outside of the university sector and therefore are not involved in teaching.

Causes of Vulnerability

- Respondents cited:
 - There is an inadequate representation of taxonomy in degree courses and a lack of teaching provision in Universities.
 - There is poor national and international organisation of taxonomic coverage.
 - There is a lack of funding available for PhD studentships despite adequate numbers of students being interested in the area.

- The emphasis of the RAE on high impact journals and low weighting to other areas of impact has discouraged universities from recruiting systematists.

Existing action being taken

- The following actions were described:
 - NERC has awarded a contract to work with the Natural History Museum to manage a review of the current status and trends in the UK taxonomy and systematics sector and assess strategic needs for the outputs from taxonomy and systematics.
 - Funding is available from NERC, especially for masters courses.
 - The Linnean Society of London is currently surveying the major taxonomic societies and local museums that hold natural history collections with the aim of producing accurate and up-to-date data, which will help identify the gaps in provision and opportunities for remedying them. The Society also hosts an annual systematics debate series to stimulate interest in the field and distributes a small number of grants.
 - The Natural History Museum supports a masters course with Imperial College, and several other MSc courses are available in related areas such as evolutionary biology, at Institutions including the Universities of Reading, Exeter and Glasgow.
- The following further actions were suggested by respondents:
 - Encourage the Quality Assurance Agency for Higher Education (QAA) to strengthening organism identification as a Bioscience benchmark
 - Provide greater support to organisations like the Natural History Museum, NIAB, Botanic Gardens and other private providers.
 - Co-fund a small number of career posts at suitable institutions (such as Kew or CABI) for individuals to characterise and identify organisms, providing a service to the UK community.
 - Provide incentives for young scientists to undertake careers in taxonomy, including increased support for undergraduate teaching.
 - Provide increased support for taxonomy research where it intersects with new technologies and other areas of bioscience research.
 - Work with NERC to close the gap in research funding.

Recommendations from the BSC panel:

- An approach emphasising 'centres of excellence' may be most appropriate to sustain research training across the wide variety of fields in this area. There may also be an untapped pool of resources in university museums/collections that could be utilised better in this model.
- Investigation is needed into whether research organisations are charging market rates from industry for use of their taxonomic expertise, or costing their activities on a sustainable basis.
- Proper consideration should be given to the funding of training at overseas facilities and to fostering further collaborative arrangements;

- BSC agreed that these recommendations should be passed on to the consultants who are appointed to undertake the review of taxonomy research being led by NERC, and BSC looked forward to seeing the outcomes from this review.

Further information

- Further analysis of postgraduate theses submitted to the British Library (see footnote 10) indicated that the numbers of theses classified as systematics or taxonomy were consistently low between 2005 and 2008 (less than 20 per year) for systematic botany, systematic microbiology and zoological taxonomy.
- BBSRC estimated spend on systematics and taxonomy research was £15.3M in 2007/08; less than 1% of this was taxonomy-based research, with the majority being systematics based.
- The research councils, including BBSRC, are launching a new funding scheme for research in systematics and taxonomy. The Systematics and Taxonomy (SynTax) scheme is designed to provide short-term funding for preliminary research that will form the basis of novel responsive mode proposals with a substantial systematics/taxonomy component¹¹.
- BBSRC, in conjunction with the systematics community, is developing an e-Taxonomy roadmap.

3.5. Other Areas Mentioned in the Consultation

- A number of other areas were mentioned in the consultation, but were not given as high a priority by BSC as those mentioned above.
- In some cases the evidence provided for the strategic importance or the vulnerability of an area was less strong. Some areas were mentioned which concerned broader areas of expertise, but which did not appear to suffer from the same difficulties as 'niche' areas.
- Areas included epidemiology; mathematical skills, data management and informatics; and science communication.
- Concerns were also raised about glycobiology, quantitative biochemistry and analytical chemistry.

Further Information

- BSC and BBSRC will keep these areas under consideration.

4. Next Steps

- 4.1. BSC will monitor progress against its recommendations at its subsequent meetings, and information will be made available via the BBSRC website:

http://www.bbsrc.ac.uk/organisation/structures/panels/skills_careers/index.html

¹¹ http://www.bbsrc.ac.uk/media/events/091109_syntax_research_scheme_launch.html

- 4.2. BSC is keen that a report on the niche skills consultation is made widely available in order to reflect back to the science community, and the wider base of organisations using specialist bioscience expertise, what it has been told. The advice given by respondents was sometimes in conflict, and with limited resources available, difficult decisions need to be made about priorities for public funding support. It is hoped, however, that the publication of this report will help promote further discussion around these important issues.
- 4.3. BSC, BSF and BBSRC would like to thank all the individuals and organisations that took the time and effort to respond to the niche skills consultation.
- 4.4. BBSRC welcomes feedback from the wider research base on the recommendations that have been made and the evidence of strategic importance and vulnerability that has been presented. Comments should be sent to skills.unit@bbsrc.ac.uk

Strategically Important and Vulnerable Niche Bioscience Research Skills - Consultation

The Biotechnology and Biological Sciences Research Council (BBSRC), with the support of the Biosciences Federation (BSF), is holding a consultation with the UK bioscience research community regarding concerns over potential shortages in *strategically important and vulnerable* 'niche' research skill areas.

Niche research skills are areas of specialist research expertise where the number of expert individuals need not necessarily be large, but where there may be an important requirement for the UK to retain some expertise in the area concerned. Areas of niche research expertise can be particularly vulnerable due to a number of factors – for example, limited training or career opportunities for individuals, or the retirement of existing specialists over time, etc.

BBSRC invites individuals and organisations from the academic, commercial and institute research sectors to provide information and evidence regarding concerns over specific niche areas of research expertise.

The BSF will be encouraging its Member Organisations to submit responses to the consultation, and will be holding a Task Force meeting in early June.

Please return your responses to clare.nixon@bbsrc.ac.uk by 3 July 2009

This information will be used by BBSRC and its advisory panel, the *Bioscience Skills and Careers* panel, to consider whether BBSRC action may be needed to address concerns, and if so, what interventions would have maximum benefit.

If you have any queries regarding this consultation please contact the BBSRC on [specific BBSRC email address]

Contact Name:	
Contact Email:	

If you are responding on behalf of a society or organisation, please provide details here.	
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Areas of Niche Research Expertise

Q1) Please list here the area(s) about which you are providing information.

Q2) For the area(s) listed in Q1, please indicate whether the concerns are confined to potential shortages at research degree level, or if there are related skills shortages at lower levels (e.g. undergraduate or taught postgraduate).

Strategic Importance

Q3) Please provide evidence for the strategic importance of the area(s) listed, referring to the main 'end-users' or beneficiaries of the research expertise in the UK

Q4) For the area(s) listed, please explain whether and why it is strategically important for the UK to maintain a supply of trained individuals, rather than seek to recruit from abroad.

Q5) For the area(s) listed, please provide evidence of the impacts that could result from losing UK expertise, including the ultimate economic or social impacts resulting from the loss of active research and/or training in the area concerned.

Please be as specific as possible and provide quantitative information if available.

Vulnerability

Q6) For the area(s) listed, please provide evidence of their vulnerability.

Hard evidence is crucial to help with the prioritisation of BBSRC action, and to indicate the scale of the problems. For example, evidence of vulnerability may relate to the age profile and numbers of existing specialists; trends in the numbers of research students being trained; numbers of unfilled vacancies for skilled individuals; etc.

Q7) For the area(s) listed, please provide details of what the ultimate causes of the problem seem to be.

Please provide as much information about underlying causes, rather than 'symptoms' of the problem. For example, if postgraduate numbers in an area are declining, is this due to a lack of career opportunities within or outside academia?

Actions

Q8) Please provide information on any actions of which you are aware *by institutions, companies, or professional societies* to address the vulnerabilities in supply of expertise in the areas listed.

Q9) Please describe what actions could be taken forward *by BBSRC* (in partnership with others, where appropriate) to support the efforts identified in Q8.

Thank you for providing your views.