



The following response to the Consultation on Food Security from the British Society of Soil Science (BSSS) covers only those questions that fall within the Society's remit.

General Comments

The British Society of Soil Science is in agreement with many of the points raised in the consultation. The Society feels that in the UK agricultural and associated land research is undervalued compared with other disciplines and consequently funding for research in this field is poor. This is reflected in the UK's capacity in soils research to deliver support improved food security. Soil is the base resource for all terrestrial ecosystem services including food production whether arable or livestock based and there are severe issues concerning the maintenance of the current knowledge base in the future (5 – 10 years). Many experts in land resources are approaching retirement age and there is a real concern over the ability to fill these niche areas of expertise. This area of soils research has suffered in the past as a result of separating soils from their role in food production. Soils research within the ecological / environmental fields has thrived in recent years while there has been little research investment in relation to agriculture / food security. It is now time for fully integrated approaches to be adopted to ensure that these contrasting roles of soil are fully appreciated not only within the agricultural context but also in delivering the range of ecosystem services that humans require for health, wealth and well-being. The British Society of Soil Science is wholly supportive of initiatives that promote integration-learning, knowledge transfer, research and public understanding. There is a need to ensure funding of long term experimental and monitoring programmes which will help decision-making processes in terms of land use and changing climatic and population pressures on food security.

Q1. Are the challenges outlined in paragraphs 8 to 20 the most important drivers and wider considerations as the background to food security? What other considerations or drivers should be taken into account?

This is a very good and generally comprehensive summary of the drivers and wider considerations. The Society welcomes a wide vision research portfolio that serves to address food security within the context of climate change and optimised management of natural resources to support the range of human needs and demands. We agree that there are significant opportunities for UK agriculture in the near future and would like to see an emphasis on identifying the win-win opportunities regarding production alongside the delivery of other ecosystem services.

A major challenge in tackling these drivers and considerations will be the development and fostering of effective multi- / inter-disciplinary research teams which will require the skills and expertise of social, economic and environmental researchers. Soil scientists will have an important role within these teams, given the central role of soils in delivering ecosystem services.

The focus of Defra on the environmental impacts of agriculture and of BBSRC on biomedical sciences over recent decades has resulted in a loss of key expertise in strategic and applied research into soil science and, particularly, of those staff able to communicate their research



effectively with farmers and advisers. Succession has been almost non-existent, and key staff at institutes are still under threat of redundancy because of financial pressures.

The major research challenges offered by a more integrated approach to agricultural research would encourage and foster a new generation of scientists to fill the existing gaps in the UK's research capacity. Early-career scientists from research fields which have been better supported in recent years should be encouraged to migrate to these important research issues and thus help to address the current imbalance in soils research and knowledge transfer. This would also support the transfer and exploitation of novel tools and approaches which, in recent years, the UK's soils research community has successfully developed and applied to issues of environmental protection, biodiversity and climate change.

Within the international context, the degraded state of agricultural land will continue to be a severe limitation to increasing food security in many regions of the world.

Q2. What, if any, additional overarching issues need to be taken into account when formulating priorities for research relating to food security?

The British Society of Soil Science welcomes the point made in paragraph 26 that integrated, systems-based approaches are needed. Such research is difficult to fund through responsive mode grants and mechanisms for funding need to be reviewed, the Society understands fully the cost and long term commitment that is required but believes that this is an essential way forward. Paragraph 27 refers to synergies and conflicts and finding an optimal balance. It is clear that there are unavoidable trade-offs between various ecosystem services: sustainable agricultural production might not deliver the biodiversity and landscapes that that public appear to want or, *vice versa*, farming for biodiversity might not deliver all the food that is needed.

The soils community has proved itself able to deliver coordinated research across funders (Paragraph 28). BBSRC's own Cross-Institute Programme for Sustainable Soil Function (SoilCIP: <http://www.sustainablesoilcip.org.uk/>) has done this, linking research at BBSRC institutes with Scottish MRPs and UK universities, and funded by BBSRC, Defra, RERAD, the EU and others. Effective coordination (paragraph 29) is possible but requires considerable effort and management, with associated costs. The competitive nature of responsive mode funding, especially at current levels of success, mitigates against coordinated, cooperative multi-disciplinary research. Given the implications of future food security, it is imperative that there is adequate consideration of appropriate funding mechanisms to ensure that both the required research and technology transfer can be delivered. The Society considers that this will require funding mechanisms that can support both multi- and interdisciplinary research for social, economic and environmental scientists and research that can consider farming within its local to global contexts.

The Society believes there is a real need to address land evaluation issues in relation to land use and land use change. Increases in food production are likely to be achieved by a combination of



increased efficiency and changes of land use, with the potential expansion of farmed land. Any change to land use needs to be done with as much knowledge as possible and therefore understand the implications for the range of ecosystem services over time. To provide this we need to implement and secure funding for longer-term monitoring and assessment programmes to inform future decision making. Information from these schemes will be essential in guiding the development of appropriate land use changes and management options and will also provide essential UK relevant data to appropriate scenario modelling initiatives.

The Society agrees that translation is critical, which raises the problem of the demise of a UK extension/advisory service. Existing advisers are good but coverage in some areas and disciplines is poor. However, public-private partnerships are not necessarily the solution, nor are they easy to establish, especially in agriculture where private industry is not financially strong. Funding for public, non-IP protected research from the fertiliser industry has been weak to say the least for many years.

Urgency (Paragraph 31) is desperately needed. There have been many workshops, meetings and reviews. **Action, not discourse, is needed now before key research expertise is lost and the UK loses its ability to respond.**

Q3. Please comment on the research targets for crop production – which are the most important and/or most urgent priorities, and what other important topics should be added (including wider social and economic considerations)? For the top priorities, please indicate time scales if possible.

Paragraph 31. “There is a need to instil a sense of urgency among policy makers but also among the research community, given the long lead-time for some research (for example, development of new crop varieties can typically take around 10 years). To meet the scale and pace of the rising demand for food, major programmes of focused research must be put in place without delay.”

We support the need for a sense of urgency but wish to reinforce the point that the research community cannot respond if there are insufficient funding opportunities. We fully support the implementation of major research programmes that would encourage an integrated evaluation of the economic, social and environmental costs/benefits of management options to increase food production and maintain food security

We support the need to research new crop varieties which can deliver multiple goals. However, there is a clear, and fairly fast, opportunity to evaluate the potential in the novel use of existing crop varieties and types to increase crop productivity across UK. For example, existing crop suitability models require revision to reflect recent and future impacts of climate change on soils and current farming practice.

Paragraphs 32 d and e. The recent arrival of diseases, such as sudden oak death, is a timely reminder that research into plant diseases is as important as that into animal diseases. It is too simplistic to suggest that the incidence of plant pathogens will be altered because of the development of resistance. Abiotic stresses, particularly those associated with climate change



(i.e. rainfall patterns and temperature) have the potential to alter the seasonal prevalence of disease and thus new combinations of particularly soil-borne cereal diseases could emerge.

Regarding soil science/microbiology Paragraph 32(o), the physical structure of the soil interacts with its chemistry and biology and should not be overlooked. The recent RASE report 'The Current Status of Soil and Water Management in England' (see Q10) should be used as an essential input to this review.

Paragraph 32 p). There is a pressing shortage of skills and expertise in soil science. There are issues generally at undergraduate level in all areas of science but the Society feels that more could be done at postgraduate level by reinstatement of funding from Defra. This is critical for producing people with the skills to lead knowledge transfer of research into practice. There are also issues of retaining such knowledge as post-doctoral employment is far from attractive because of its scarcity and predominantly contract-based nature in both academic and industrial sectors.

Q4. Please comment on the research targets for livestock and fish production – which are the most important and/or most urgent priorities, and what other important topics should be added (including wider social and economic considerations)? For the top priorities, please indicate time scales if possible.

There is a need to consider research in pasture management with an aim of keeping livestock out at grass for as much of the year as possible. Such systems operate successfully in New Zealand and for effective adoption in the UK; research into the effect of stocking rates on soil physical and chemical properties is needed.

Targets should consider the role of land / soil management practices to mitigate greenhouse gas emissions from the livestock sector and what practices would be effective and realistic within farming systems within the UK and elsewhere. It would be timely to consider the cost-effectiveness of the various options. The question remains, what are the implications to global food security by reducing GHGs from agricultural land? Is there a balance to be achieved within the farming sector or between farming and other sectors?

Q5. Please comment on the research targets for agricultural practice – which are the most important and/or most urgent priorities, and what other important topics should be added (including wider social and economic considerations)? For the top priorities, please indicate time scales if possible.

All of those listed are critical, as are translation into practice by effective communication with farmers.

It is questionable whether the conservation of biodiversity should be of first priority. It remains to be determined to what extent biodiversity, especially in soil, is a key to sustainability. However, it is important to adopt the precautionary principle here to ensure that decisions are based on sound science. Research to date suggests much functional redundancy in soil



biodiversity, and large yields of wheat can be grown on what is essentially chalk on down-land from which soil has been eroded. Good soil and land management should enable us to produce enough food for ourselves and others and maintain a biodiverse environment. The Game Conservancy's work at Loddington and LEAF (Linking Environment And Farming) farms generally provide excellent examples that both can be achieved.

Minimum or zero tillage is beneficial in some circumstances but recent research suggests that claimed benefits for carbon sequestration are incorrect (e.g. Defra report SP0561, 'The effects of reduced tillage practices and organic material additions on the carbon content of arable soils', 2008).

Research is needed into optimum tillage practices for food production, quality, protection of water resources, biodiversity and energy use (i.e. climate change). It is important that we get a clear picture of how these practices change in their ability to meeting these objectives over the course of time in conjunction with changes in the climate by adopting an ecosystem approach. Regular monitoring of our land resources are needed to best meet the needs of decision makers into the future and to provide data to underpin models.

Looking to the future, research should be exploring the risks and opportunities associated with farming systems that are less dependent on inputs from fossil fuel sources. With this comes the need to look at how soil systems could be managed to improve resource use efficiency, pest and disease control, environmental impacts and reduction of waste.

Q6. Please comment on the research targets for food safety – which are the most important and/or most urgent priorities, and what other important topics should be added (including wider social and economic considerations)? For the top priorities, please indicate time scales if possible.

There is the need to maintain careful consideration of the risks to human health from soil management with corresponding development of appropriate risk assessment methodologies that address novel crops and management practices.

Q7. Please comment on the research targets for nutrition, food quality, processing and manufacture – which are the most important and/or most urgent priorities, and what other important topics should be added (including wider social and economic considerations)? For the top priorities, please indicate time scales if possible.

There is increasing pressure for food to be produced locally both to help reduce the environmental impact of food production and transport and also to help sustain agriculture as a viable rural industry with the associated economic and social benefits that accrue. More research is required on the links between food quality in terms of the nutrient and essential elements contained within locally sourced food and the local soil resource. A number of soils are naturally deficient in such elements.

Q8. Overall priorities for research Considering all the research targets outlined:



(a) Which should be the most important overall priorities?

For soil science, priorities should be an integrated systems-based approach that will support evaluation of the economic, social and environmental costs/benefits of farming, the functional importance of soil biodiversity in contrasting farming systems, soil management practices that improve resource use efficiency, pest / disease control and minimise environmental impact (nitrate and phosphate leaching, greenhouse gas emissions, sediment runoff, reduce waste, carbon sequestration).

The development of crops that can capture resources more effectively, tolerate drought or severe storms, and produce yields requires input from soil science. Too often the approaches used by geneticists and plant breeders ignore processes that occur out of sight in the soil environment.

There have been numerous significant advances on food security that have been led by soil scientists in the UK. Rice varieties that can penetrate compacted soils were identified in novel research between Rothamsted and the University of Aberdeen. Soil management practices were developed at the now closed Silsoe Research Institute to preserve water in agricultural production in southern Africa. These skills, however, have been severely eroded. Closures of national research facilities mean that both geographical and agricultural coverage and hence research relevance has been reduced. Therefore research regarding future challenges has been equally reduced.

(b) What (if any) additional research targets would make a real difference?

No comment.

(c) Does the UK have sufficient facilities/ infrastructure to deliver the research, and if not, what are the additional needs? (for example, see para 35 and 38)

Soil science at key centres has been severely eroded. Many key soil scientists, especially soil surveyors, have reached or are about to reach retirement. Succession must be ensured. The soil science community require intellectual and physical resources to be effectively coordinated and supported over realistic time periods to ensure maintenance of expertise.

The Society would support the establishment of farming systems facilities that would act as integrating platforms for multi- and interdisciplinary research and technology transfer. This platform model has been successfully applied within UK and elsewhere (e.g. Rothamsted, SG RERAD programme, INRA France, etc)

(d) In which topics could UK research make the greatest impact in improving food security for developing countries?

The UK is an internationally acclaimed centre for soil science research. It already makes a major impact through its contribution to relevant research but more could be achieved. Research linking soil science to climate change models, specifically the Roth-C carbon cycling model, has



greatly improved predictions of the impacts of climate change on soil and feedback mechanisms and thus our ability to maintain food production.

As recognised by the Bill & Melinda Gates Foundation and the World Bank, very simple changes in soil management, such as the provision of fertiliser and better water management, can have far greater impact in developing countries than plant genetics. We also need to establish what management practices are needed to restore degraded land to the extent that it can support viable agricultural production and evaluate these in relation to the social, economic and environmental cost and benefits at local to global scales.

The UK is an international leader in rhizosphere research, which is a sub discipline of soil science. For instance, links between plant biologists and soil scientists have identified root traits that could ease root proliferation to deeper soil horizons, which is essential for drought resistance. Basic processes involved in the uptake of nutrients and water by roots are also being investigated by soil scientists in the UK.

Q9. Knowledge transfer

- (a) How should the translation of research into practical application for food security be best supported? (you may wish to consider separately the needs of the UK and those of developing countries)**

This is a strategic issue that requires strategic research, and such research is difficult if not impossible to achieve through responsive mode grants from individual research councils. As noted elsewhere, many scientists capable of translational research, both for the UK and overseas, have retired or left research. A major shift in emphasis will be needed if these skills and resources are to be retained/regained. The training of scientists from developing countries will have the greatest impact on improving food security. Obtaining PhD funding for promising students from these countries, however, is extremely challenging

- (b) What new funding mechanisms for knowledge transfer and translational research would be beneficial?**

Long-term, i.e. 10 years plus. BBSRC could consider a KT/translational ISPG.

- (c) How can relevant industries be encouraged to invest more in R&D?**

The Levy Boards have been very effective at directing funds from the primary industry into soils-related research. Currently the Bill and Melinda Gates Foundation is supporting soils research for Africa and developing countries. The fertiliser industry has rarely put significant sums of money into institutes and universities, preferring to set up its own research capability when it needs it or can afford it. The Society doubts that this could easily be changed.

Q10. Training, skills and career paths



(a) What important areas of expertise and what levels of skills related to food security are in short supply (please provide evidence if possible), what are the causes of the shortages and how best should these needs be met?

The RASE recently published a report 'The Current Status of Soil and Water management in England', which focused on what is essentially soil physics. Members of the Soil Science Department at Rothamsted were interviewed in the course of the preparation of this report and so it reflects some of their views. However, the generic problems reported extend to all areas of soil science, despite the view within the report that basic research is adequate. The report contains some useful data to chart the decline in key areas of soils research relevant to food security. It states a decline in Government science investment in soil and water management of 45% between 1986 and 1998, a decline in Defra funding of BBSRC institutes by £19M in 2007 from the real terms equivalent of £129M in 1997 and an expected further decline in Defra funding of 20% by 2010-11. In summary, most areas of practical soil (and other food production/agricultural) research have been neglected and need urgent support for succession.

Soils research, especially the applied aspects, has centred on environmental aspects of agricultural production. It is now timely to take a more rounded view and once again link soils the need to produce food. There needs to be longer-term and lateral understanding of soils and this will need continual and enhanced input into basic fundamental research.

(b) What areas are most urgent to address, and on what basis should investment in training and skills be prioritised?

There is need to address investment in soil science, in particular in the realms of soil chemistry and physics. There is also urgent need to prevent the loss of current existing soil knowledge by investing time and training into younger generations and preventing the loss of knowledge through the lack of on-going employment. It would be best to invest in existing centres of excellence promoting integration and multidisciplinary approaches to encourage knowledge transfer. A new breed of scientist able to cross existing boundaries between plant breeding/genetics and soil science is required to address the threats posed by food security. Very simplistic approaches are often used to examine plant responses to stress because of a lack of knowledge or consideration about processes in soil.

Q11. Coordination across funders

(a) How should coordination of research related to food security be improved (in the UK and internationally)?

Defra and the Research Councils need to agree responsibilities and to establish better coordination of their research funding. The integration of former research institutes or some of their components with others has in some cases eroded the soil science base along with its integration into wider agricultural and other research areas – this ought to have provided an opportunity for further integration however the Society is not convinced that this is occurring. This must include all Research Councils as this challenge demands interdisciplinary research. The



recent LWEC umbrella may be suitable mechanism for this integration but it must be a trans-UK initiative and not exclusive to RC organisations since a great deal of the UK soils research capacity now exists outwith the Research Councils standard terms of funding eligibility. Internationally there is much discussion and support from funders for workshops and exchange visits. Securing funding for research projects is much more difficult, however. International research coordination will require some international research funding.

(b) What overseas models for funding and coordination should the UK consider adopting?

The model used in Scotland is improving integration across disciplines and the development of longer term research platforms.

(c) What will be the most important opportunities to maximise the effectiveness of UK research spending through coordination with activities overseas?

The newly developed link with EMBRAPA Brazil will be very important. Brazil has an excellent research infrastructure that seeks to reconcile bioenergy and food security. The UK soil science community has strong links with Europe - Wageningen/Alterra, INRA, - Australia and New Zealand; the Society is discussing exchange of visits with New Zealand and Australia. Links are also strong with China, with some funded collaborations. However, funders have tended to support exchange visits and workshops but effective research coordination needs funding for research.

Q12. Regulatory framework In what ways does the regulatory framework in relation to food production and supply present barriers to improving food security, and how best might any such barriers be overcome?

The most common complaint from farmers and advisers is that their prime role in food production is over-regulated but indirectly through environmental concerns. Any measures that reduce the complexity of regulation and the bureaucracy associated with food production would be well-received.

Q13. Public engagement

How can we best capture the views, aspirations and concerns of stakeholders, including different interest groups across society, and ensure that these contribute to developing a food security strategy?

There has been much research into capturing views, aspirations, etc. The RELU programme has linked the natural with the economic and social sciences. Lessons can be learned from RELU projects. More problematical is the failure to realise aspirations. Many are contradictory and socioeconomic research can lead to disappointment when views and aspirations are not realised. Expectations can be unrealistically raised through the consultation process, but that is not say that it is not worthwhile; it is a research area in its own right.



There is scope to extend the RELU programme into an ongoing cross RC/ Defra theme which would ensure knowledge transfer across all interested parties.

Q14. What additional barriers (beyond those outlined) may prevent the successful implementation of a strategy for research to improve food security, and how might such additional barriers be overcome?

The RAE and IAE focus on high-impact publications and do not encourage strategic and applied research. The need to provide evidence of economic and social impact should help but this is sometimes hard to quantify in agriculture. Some mechanism needs to be found for giving value to strategic and applied research and outcomes not quantifiable in financial terms.

Q15. Please provide any further comments on any issues that are relevant to this consultation.

See above.