Shaping a UK strategy for agri-tech: response form

The Department may, in accordance with the Code of Practice on Access to Government Information, make available, on public request, individual responses.

All comments are welcome but we particularly encourage submission of evidence from institutions, organisations and representative bodies with an interest in this topic.

The closing date for this call for evidence is Thursday 22 November 2012 by 14.00 hours.

Please return this completed form to:

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Please describe the organisation that you represent and outline your reasons for responding to this call for evidence

Please tick the box from the below list that best describes you.

	Business representative organisation/trade body
	Central government
X	Charity or social enterprise
	Individual
	Large business (over 250 staff)
	Legal representative
	Local Government
	Medium business (50 to 250 staff)
	Micro business (up to 9 staff)
	Small business (10 to 49 staff)
	Trade union or staff association
	Other (please describe

Please write here your name/ the name of your organisation and contact details if you wish to. This would help us to contact you if we have further questions.

1. The aims and objectives of the Agri-Tech strategy are outlined above in the introduction to this call. Please give your views on:

a. The need for and potential benefits of having such a strategy.

The need for such a strategy is paramount due to increasing pressure on the world's resources for food production. The global nature of our food supply chains mean that the effects on production of food in one area of the world are felt elsewhere. Recent Defra statistics show that the UK food production to supply ratio (sometimes used as a measure of self-sufficiency) has gradually declined over the last two decades, falling from 75 % in 1991 to 63 % in 2011. Furthermore, the European Union is the world's largest net importer of food and feed.

A coherent agri-tech strategy will maximise the use of UK expertise to tackle key food security challenges both in the UK and globally. The UK scientific community is already contributing new technologies and practices that will help to raise yields globally (see response to Q2, *UK Strengths*), but the scale of the food security challenge means that there are still many areas where UK expertise could deliver solutions. This was recently acknowledged by the Foreign Office minister, Mark Simmons, in a speech to the African Investment Summit, when he stated that, '*Well over half the world's uncultivated cropland lies in Africa. And where land is being used, productivity is only a quarter of the global average. British expertise could help to improve this productivity*.'

The benefits of building a strategy in this way include being able to explore the funding landscape in parallel and to determine whether or not there is adequate provision for the underpinning research in agricultural sciences that will help to deliver new agricultural technology. Being able to identify these 'gaps' is critical to *'the effective exploitation of the science base'*.

b. The appropriateness of the objectives proposed.

The objectives proposed are broadly appropriate to the aim of '*unlocking the full economic potential of the UK's world leading research*'.

One area that is not mentioned in the objectives that ought to be considered is an appropriately flexible regulatory framework for new agricultural technologies, which is part of the process that turns research into technology that can be used for economic benefit. Current regulatory frameworks and the accompanying costs make it difficult for new products to be developed from concept to market, limiting the prospect of innovation. Of course, the rigour of such testing must be maintained. However, new knowledge and technology should be used to evaluate appropriate risks in specific contexts as part of an efficient regulatory system.

c. Desired outcomes and indicators of success of the strategy, and the role for Government in enabling delivery of these.

Desired outcomes that fulfil the strategy's objectives could include a growth in the UK SME agricultural science sector (See response to question 2 – *UK Weaknesses*) as part of the aim to '*stimulate enterprise and accelerate the translation of research into practical applications*'.

There are challenges for those in the SME sector to access and develop potential opportunities within the agricultural science area. In some cases, these SMEs operate close to the frontiers of scientific research (e.g. university spin-out companies) and so are well-placed to initiate the translation of new knowledge into applied technology. Support for these companies, via the Technology Strategy Board (TSB) and the Knowledge Transfer Networks (KTNs) could help to further develop an effective 'knowledge supply chain' for agricultural sciences. Currently, the area of agri-tech does not have its own KTN, despite agri-tech being as broad a topic as HealthTech and Medicines. The technology areas relevant to agriculture are split between the priorities of the Environmental Sciences KTN and the Biosciences KTN. Synergy between these initiatives will be important in supporting a future agri-tech strategy. Alongside this, as mentioned in 1b), the government can help to support the growth of this sector by ensuring that there is sufficient review of regulatory frameworks to take account of new developments in environmental science and technology.

Another desired outcome should be to improve the perception of agricultural sciences as a desirable career option, leading to an increase in the number of researchers who apply their skills to this area. The skills pipeline is critical to the aim of *'increased UK exports of knowledge, products, systems services and technology*'. In some areas, such as soil science, the UK is in danger of losing our leading position due to the lack of graduate researchers entering the field. The government needs to help to promote agricultural sciences as a viable and rewarding career choice. There is a need for scientists to have a good fundamental understanding of particular disciplines, but extended support to initiatives that promote interdisciplinary learning and research is needed to ensure that solutions to problems in agriculture are realised.

d. Any potential drawbacks / unintended consequences associated with these outcomes and how these could be mitigated.

In adapting the regulatory framework to be more flexible, we do not advocate a relaxation of such guidelines. The lines of communication between policymakers, regulators, academic and industrial scientists must be encouraged to ensure that any review of these guidelines incorporates appropriate scientific advice, based upon risk and not hazard alone.[1]

2. What in your view are the current strengths and weaknesses of the UK agricultural technology sector? Please provide evidence in support of your responses.

In November 2011, the RSC, the Environmental Sciences Knowledge Transfer Network and the Natural Environment Research Council (NERC) Biological Weathering consortium held a workshop examining soil science. A report from the workshop was published in October 2012.[2] One of the workshop sessions considered a '*SWOT Analysis for UK Soils and Agriculture'*. Some of the areas mentioned in this section of the report and additional evidence are outlined below.

UK Strengths

The UK is an important location for research, development and production with respect to agricultural technology. The agricultural science company, Syngenta, has its largest research centre in the UK, conducting, for example, discovery chemistry, biology, biochemistry, formulation and product safety, as well as manufacturing sites at Huddersfield and Grangemouth. Similarly, Yara, the fertiliser supplier, operates research, manufacturing and distribution sites throughout the UK, including liquid fertiliser production plants in Perth, Elvington, Immingham and Chedburgh.

The UK's research base in fundamental and applied sciences related to agriculture, such as chemistry, biosciences, soil science, plant and animal sciences is strong. Biosciences research in the UK ranks amongst the best in the world.

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1 - *Environmental Health and Safety Committee Discussion Note on Pragmatic Precaution*, Royal Society of Chemistry, August 2009

2 - *Securing Soils for Sustainable Agriculture, A Science-Led Strategy*, the Royal Society of Chemistry, the NERC Biological Weathering Consortium and the Environmental Sciences Knowledge Transfer Network, October 2012

Organic chemistry, which is a key aspect of research relating to new crop protection chemicals, was recently identified in a BIS Economics Paper as the area where the UK has the greatest revealed technological advantage. An example of the key role of organic chemistry in agriculture is the invention of azoxystrobin. Azoxystrobin is the world's best-selling fungicide, with sales of over $1 billion in 2011. The research which led to its invention involved a programme of synthetic organic chemistry that was carried out by Syngenta entirely at its International Research Centre near Bracknell, and the global supply of this important chemical is manufactured at Grangemouth in Scotland.[3]

Soil is one of the most fundamental resources in agriculture that must be maintained to ensure that agriculture is productive. In the area of soil science, the UK has a strong research community of professional soil scientists and extensive collections of data on the spatial and temporal characteristics of UK soils. The National Soil Resources Institute at Cranfield University stores the National Soils Inventory. This resource includes spatial mapping at different scales, as well as information on soil properties and agro-climatological data. The resource is web-enabled and is the largest of its kind in the whole of Europe. Information like this can provide the basis for providing solutions to sustainable intensification.

The UK has great strength in taking such fundamental research and turning it into innovative solutions through both industry and agricultural research institutions. Institutions such as Rothamsted Research, the John Innes Centre and the James Hutton Institute have a history of working on world-leading science that has led to practical solutions in agriculture. Rothamsted Research has operated a series of field experiments, continuously for more than 150 years, providing a vital resource of scientific observations at field scale. Other research at Rothamsted, in collaboration with the International Centre of Insect Physiology and Ecology in Kenya, has used the principles of chemical ecology to develop a system to reduce pest damage that can be applied on low-input farms.[4] The system comprises planting a highly attractive trap crop (Napier grass) around a maize field. The volatile chemicals from this trap crop act as a 'pull' by attracting pest insects away from the maize. In addition, an intercrop, *Desmodium uncinatum*, is grown in rows within the maize. This intercrop produces volatile chemicals that repel pest insects and therefore act as a 'push'. This pest management strategy is known as 'pushpull' technology and is currently employed by over 50,000 smallholder farmers across Africa.

Current research at the John Innes Centre on developing crops that fix nitrogen could lead to UK research inducing a step-change in agriculture globally, potentially reducing the need for fertiliser inputs. The research required to progress work in this area will need to examine plant-microbe interactions and the small molecule signals that control these, requiring interdisciplinary application of biological, chemical and genetic techniques. The strength of this research has been recognised internationally through funding from the Bill and Melinda Gates foundation, as well as recently announced funding from the BBSRC as part of government investment in synthetic biology research for future global challenges.

The UK research base in veterinary science relating to animal health, nutrition and welfare is also a UK strength, *via* research in institutions such as Harper Adams University College, but also commercially; Norbrook is a UK-based pharmaceutical company specialising in animal health that is the *largest privately owned pharmaceutical company in the world*. The livestock sector in the UK is important; in 2011, the value of outputs from the UK livestock sector was almost 40% higher than the value of outputs from the UK crop sector.

UK Weaknesses

As mentioned above, an overly precautionary regulatory framework may be detrimental in the drive to develop new innovations in the agricultural sector. This is in turn, partially linked to the high costs of developing products from idea to market, which means that much of the

[3] - *Organic Chemists Contributing to Food Production, Organic Division Council*, the Royal Society of Chemistry website

[4] - *Increasing Africa's Agricultural Productivity*, Pan Africa Chemistry Network, the Royal Society of Chemistry, September 2012

market in this area is occupied by large multinationals. The numbers of small and medium-sized businesses in the UK agricultural sciences sector are very low in comparison to sectors such as pharmaceuticals. A comparison of numbers of businesses with 249 employees or fewer using the Standard Industrial Classification (SIC) system, indicates that there are more than four times as many SMEs in the pharmaceutical sector in the UK than in agricultural sciences. Whilst larger pharmaceutical companies can explore models such as procuring advanced projects from SMEs, similar opportunities are almost entirely absent in the crop protection industry.

The 'valley of death' between research outputs and technological application in the UK is seen as a weakness that affects the agricultural technology sector amongst others. Like pharmaceuticals, the development of an agritech product can take 10 years or more, meaning that it is extremely difficult to encourage investment in potential new technology at the early stage under the current risk-averse financial climate.

There is also a perceived paucity of interaction between academia and industry across many sectors in agricultural sciences (soil science, crop nutrition and crop protection) suggesting a need to develop efforts in knowledge exchange in this area. Alongside this, the fragmentation of the scientific research base across different disciplines, institutions and research councils can lead to the perception of certain areas of research in agriculture 'falling through the gaps' with respect to sustained funding. Agriculture is a highly interdisciplinary area and it is critical that programmes in this area look to bring together researchers across disciplines, both with respect to research and the training of future researchers. Programmes such as the cross-research council Global Food Security Network and the AGRI-net initiative funded by the EPSRC and BBSRC are welcome examples of ways this is beginning to be addressed. With respect to improving interactions between industry and academia, the BBSRC initiative of research and technology clubs is helping to foster links between and provide better visibility for career development opportunities in this field. All five of the current research and technology clubs examine themes that are pertinent to agriculture, including crop improvement and animal health. However, the breadth of challenges that agricultural sciences represents means that schemes to foster such interactions must be developed further.

3. How do you think the ability of the agri-tech sector to bring growth to the UK economy could best be facilitated or supported by Government working with the industry? Please cite/suggest appropriate mechanisms and measures to attract new revenues to the agricultural technology sector, that are feasible, value for money and effective; while paying attention to UK, EU and global finance available for agricultural science.

A long-term vision for research is important to bring future growth. A commitment to growing interdisciplinary research in the area of agricultural sciences is needed. In relation to this, the government can do more to secure the skills pipeline in agricultural sciences. The government must help to promote agricultural sciences as a viable career option, whilst ensuring that appropriate programmes for training and research are available to attract talented scientists to turn their skills to this area. A number of areas in research related to agricultural sciences require similar skills as those needed for healthcare research (e.g. synthetic biology, organic chemistry and chemical biology). Whilst it is important to ensure that such skills are in supply for healthcare research, the requirement for these skills in agricultural sciences cannot be neglected.

Action to ensure that such research is commercialised and thus brings economic benefit is also critical. The UK government could assist with measures that will help to create an appropriate environment for innovation. These include broadly applicable measures such as de-risking investment in early–stage agricultural technology by promoting the use of co-financing measures more widely (e.g. R&D tax credits), as well as measures specific to agri-tech. An increase in the sophistication of regulatory measures for agrochemical and agricultural technology is an important area where the government can work with scientists to ensure that testing and monitoring procedures maintain currency with on-going developments as a result of research.

The creation of centres of excellence in the area of agricultural sciences through coordinated action across the research councils and the Technology Strategy Board could help to create a favourable environment for SMEs to be established and flourish. This could help to bridge the gap between academia and industry further by encouraging an environment where joint working as well as joint funding is facilitated, encouraging SMEs to carry out their own research and development. Creating a favourable environment that encourages the sector to innovate could then attract inward investment from overseas.

The potential value of EU-level funding for scientific research and development should not be underestimated; in the past the UK has received a generous share of money for research from European funding initiatives. In the Framework Programme 6, which ran from 2002 to 2006, the UK received 14.2 % of the total budget, second only to Germany which received 18.1 %. The Horizon 2020 programme, the successor to the EU Framework Programmes, proposes to include around €32,000 million of funding, dedicated to addressing 'grand challenges' including food security. Mechanisms need to be in place to ensure that through agencies such as the UK Research Office (UKRO) and TSB, UK researchers and businesses have the correct information and support in being able to construct consortia to bid for funding.

4. What is the potential and what should be the role of technology in addressing the needs of UK farmers, and meeting the challenges of global food security and the increasing demand for non-food bio-renewable products and resources? This would include new technologies (such as nanotechnologies, robotics, remote sensing), modern biotechnology techniques (such as genomics analysis, cloning, GM) and engineering solutions. Please provide examples where technologies may be particularly transformative in their impact, and how research skills in these may be enhanced.

The potential for new technologies is vast across all areas of the UK agricultural sector. Below are some areas where developments in technology could lead to practical tools for raising yields on-farm, both in the UK and globally. However, this list is not exhaustive. It is important for the future strategy to recognise that to develop these technologies, there must be continued investment in the fundamental scientific research that is the basis for such developments.

One critical area that must be developed is crop protection technology. It has been estimated that around 40 % of the world's crop production would not exist without crop protection agents, underlining their fundamental importance to farming. There is an urgent need to develop crop protection chemicals with new biochemical modes of activity. This is particularly pressing in light of the issue of resistance to many active ingredients used in crop protection. Glyphosate is one of the most widely used herbicides globally. However, recently, many weeds have developed a resistance to it. In Australia, the problem is widespread, prompting the formation of an industry-wide initiative to monitor the problem of resistance.

The increasing power of genomics can be coupled with biochemical techniques for assigning gene function as one of the tools in the battle against resistance. Being able to identify specific gene functions that cause resistance has the potential to allow development of new crop protection chemicals to circumvent this.

Whilst herbicides, fungicides and insecticides are an essential way to improve yield, there are opportunities to develop chemical agents that could improve crop yields directly. For example, chemicals that could alleviate plants from drought-stress or water logging as the plant grows, as opposed to the use of a remediative measure. The need for such crop enhancement chemicals will become increasingly important, due to likely future changes in climate and weather patterns.

Another key area is crop nutrition. Identifying the chemistry that controls the communication between crop species and soil organisms is important in developing ways to improve nutrient supply to plants. Understanding these mechanisms mean that sensors to monitor minute changes could be developed. Using nutrients in an efficient and sustainable way could lead to a reduction in nutrient leaching. Farmers would thus be able to use nutrient inputs more efficiently.

Phosphorus and nitrogen are essential to plant growth and are key nutrients in fertilisers. Even in livestock farming, one of the largest single synthetic inputs in bulk terms is fertiliser for application to grasslands and forages. Phosphorus is a finite resource and current production of nitrogen containing fertilisers is energy-intensive. One possible way to obtain nutrients for fertiliser more sustainably is to recycle these from waste streams. Research into developing technology to recover nutrients from e.g. human urine would need to be based upon fundamental understanding of how these elements interact with potential recovery agents to ensure that efficient and cost-effective technologies could be developed.[5]

Technology for effective monitoring and fundamental research into minimising the impacts of agricultural activity are important to ensure that natural systems can be sustained as part of the process. Research in fundamental areas such as the transport and fate of farm inputs will help to develop novel and innovative ways to assess and alleviate possible environmental impacts associated with agriculture.

As well as crop health, veterinary health is also an important issue, again with respect to developing new drugs that can combat resistance. There are also opportunities relating to niche areas of technology in relation to animal health, for example the formulation of dairy sanitizers and teat dips for cows that could present opportunities for innovative SMEs.

Development of accurate, reproducible analytical methods to measure the composition and quality of animal feed could have a real impact in terms of efficiency gains on-farm. There is an opportunity to use analytical chemistry techniques to develop ways to accurately assess nutrient content of feed mixtures. Being able to adjust quantities of feed required based on such data would help to reduce waste, particularly in farming systems where large quantities of feed are employed (e.g. poultry units).

Projects like these will not be successful without interdisciplinary collaboration. To enhance research skills that will lead to the development of new technologies, funding and research programmes to encourage scientists from different disciplines to collaborate are essential.

5. What do you think are the main barriers to the achievement of the proposed strategic objectives and how do you think they might be overcome?

Encouraging the next generation of scientists is central to many of the objectives in the strategy. The government can help here by promoting agricultural sciences as a viable career option. However, there is a role for those within the scientific community too, including learned societies in encouraging scientists to apply their skills to the area of food security. Subjects such as organic chemistry and chemical biology that have played a key role in UK pharmaceutical research are also essential to the future of agricultural sciences.

Some potential new solutions may also require behavioural changes in consumers – e.g. acceptance of food that has been produced using nutrients recycled from human waste. Communication of the urgent need for and the benefits of such technologies will require care to ensure that public concerns are fully understood and allayed. Public perception of some aspects of agricultural biotechnology, has in some cases, resulted in a negative impact on the advancement of research. Genetic modification of crops is an example of this, where public perception in Europe has led to some companies relocating important research programmes in this area. Engagement between scientists and the public to build a greater appreciation of the need for research in this area and the principles of the work behind it is important in generating correctly informed discussion. The recent work of Rothamsted Research in relation to the field trial of aphid-resistant wheat is a good example of how such engagement can help to allay concerns. Researchers at Rothamsted produced a public-facing briefing note and undertook a sustained dialogue with protest groups who wished to disrupt the trial. The planned protest passed peacefully and the sustained dialogue meant that both supporters and opponents of the field trial had an opportunity to put forward their views through the media.

Glossary

Genomics analysis

Genomic analysis involves looking for differences in the DNA that makes up the genes of different organisms. It enables the identification and selection through conventional breeding of genes that are associated with beneficial features of an organism e.g. disease resistance in crops or in an animal.

GM

GM normally involves the insertion of genes carrying a specific trait (eg pest resistance) from one organism into another. This introduction can be novel genes from the same species (cisgenics), or from another species (transgenics), individually or in small groups.

Cloning

The production of genetically identical organisms.

Remote sensing

The observation and analysis of agricultural land or livestock without the need for manual handling. For agricultural land this can be done from aircraft or satellite to assess and map features such as crop yield or diseases. Information from remote sensing can be used to increase farm management practices and animal welfare.

Nanotechnology

Nanotechnologies can be thought of as any technology which either incorporates or employs nanomaterials (e.g. carbon nanotubes) or involves processes performed at the nanometre scale. A nanometre is one billionth of a metre, around 80,000 times smaller than the diameter of a human hair.

Robotics

The engineering of machines to perform farming tasks automatically and autonomously e.g. GPS guided crop spraying, detection and mechanical removal of weeds or crop pests, automated milking of cows.

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