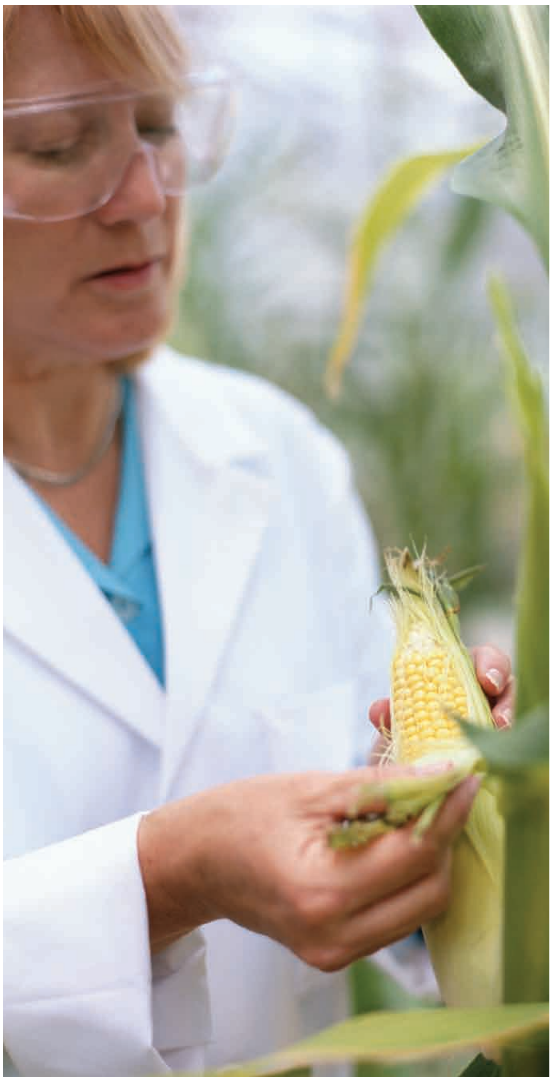
Going For Growth

Innovations in agricultural technology will help grow more food sustainably. The development of this technology, and the products that result from it, could support economic growth in the UK as part of our global trade and export network. We have been leaders in developing new crop technology but other nations are overtaking us - action is needed to realise the sector's full potential.



Contents

This paper has been prepared by the Agricultural Biotechnology Council (abc), with expert input and advice from individuals and organisations across the agricultural technology sector. The messages and calls to action are supported by leading UK plant science institutions and universities:

NFU NIAB THE SAINSBURY LABORATORY ROTHAMSTED RESEARCH

We are particularly grateful to the following for their contributions to the report: Prof Iain Gordon (James Hutton Instititue), Prof Howard Davies (James Hutton Institute), Prof Jonathan Jones (Sainsbury Laboratory), Dr Andrea Graham (NFU), Prof Tina Barsby (NIAB), Prof Andy Greenland (NIAB), Dr Lydia Smith (NIAB), Prof Sir David Baulcombe (University of Cambridge), Prof Maurice Moloney (Rothamsted), and George Freeman MP.

abc AGRICULTURAL BIOTECHNOLOGY COUNCIL

Comprising six member companies, abc works with the food chain and research community to invest in a broad range of crop technologies - including conventional and advanced breeding techniques, such as GM. These are designed to improve agricultural productivity by tackling challenges such as pests, diseases and changing climatic conditions, whilst reducing water usage, greenhouse gas emissions and other inputs. The companies are BASF, Bayer, Dow AgroSciences, Monsanto, Pioneer (DuPont) and Syngenta. Further information is available at www.abcinformation.org

Summer 2012

Executive summary

The demands of a growing global population need to be satisfied by producing more food sustainably. We need crops which make the most of limited land and resources, and we can achieve this through agricultural research and development - a process of innovation which has been going on for thousands of years and which is continued by scientists around the world today.

For too long we have lacked a strategic plan for agricultural science and technology, while countries like China and Brazil have encouraged investment and surged ahead. By failing to encourage further private sector investment, the UK is missing out on the potential economic benefits of agricultural research as academics and new investments move to those parts of the world more inclined to fostering innovation.

Britain has a strong pedigree in agricultural research, including biotechnology, and teams across the UK are at the forefront. They are developing agronomic systems and technologies that combat pests and disease, help crops to respond to a changing climate and increase agricultural productivity using fewer resources like water, fertilizer and fuel.

These innovations can deliver significant economic and environmental benefits to the UK, including the sustainable intensification of farming and in the export of high-value intellectual property from a vibrant research sector across all regions of the UK.

The sector requires stronger political support to regain its global competitive edge, to remove barriers to the commercialisation of agricultural research in the UK and to put us at the centre of global agricultural innovation and trade.

The private and public sectors want to work with the Government to achieve this by:

1. Incorporating agricultural research into Government economic policy planning, with the aim of maintaining the competitive lead of UK research institutes in the development and export of agricultural technology from Europe. Specifically, the potential of agricultural biotechnology should be included in the next Life Sciences Strategy document.

2. Setting up a dedicated cross departmental working group, involving academic institutions, research bases and industry to publish a UK strategy for growth in the agricultural technology sector. The group should be set up as a priority and deliver its initial findings by the end of the financial year 2012/13.

3. Utilising agricultural research and knowledge as a driver to increase political and economic links with emerging and established markets, including those which are leading the way on increasing food production. The Government should champion the UK's excellence in agricultural knowledge.

The private and public sectors want to work with the Government to achieve this by:

1. **Incorporating agricultural research into economic policy planning**
2. **Setting up a cross-departmental working group on agricultural technology**
3. **Championing the UK's excellence in agricultural knowledge**

The global food and farming challenge

Two of the key priorities for action by policy makers listed in the Foresight report were:

- **Invest in new knowledge**
- **Promote sustainable intensification**

Agricultural innovation can help to address these priorities.

There will be 9 billion people on the planet by 2050 and critical resources, such as land, water and energy, will become scarcer. The demands of a growing global population need to be satisfied by producing more food sustainably. We need crops which make the most of limited land and resources. We can achieve this through agricultural research and development - a process of innovation which has been going on for thousands of years and which is continued by scientists around the world today.

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In the recent Foresight report on the Future of Food and Farming, the Secretary of State for Defra recognised that:

"Concerted efforts at national, regional and global levels of government, and close partnership with the private sector and civil society, will be crucial to address the challenges we face."

Details can be found at:

http://www.bis.gov.uk/foresight

Innovation underpins the ability to increase food production

The ability to increase sustainable food production is determined by the six main areas of agricultural innovation.

Machinery
Innovations in the mechanisation of agriculture have revolutionised the ability to produce more food and reduce waste. This remains an important tool in the developing world but innovations in this area will not dramatically increase production in the developed world.

Water
Better use of water was one on the drivers of the 'green revolution' and it remains vitally important in the developing world.[1] Innovations are now focussed on reducing the amount of water required for effective crop production to safeguard this valuable resource.

Crop Protection
The ability to control pests and diseases in agriculture is fundamental to the ability to sustainably intensify food production. The opportunities to innovate in this area remain high, however the ability to discover more targeted, more effective products is being impeded by new regulations in the EU which seek to eliminate perceived hazards rather than dealing with actual risks.

Farmers
Knowledge transfer of new ideas and innovations to farmers is critical and this is an area of concern with the demise of 'extension services' sharing best practice over the last 20 years. UK farmers are recognised around the world as being open to the uptake of new innovations and they play an important role in the development of new technologies.

Fertiliser
The availability of nitrogen and other fertilisers was another key driver of the 'green revolution', and remains an important ingredient in the developing world. In Europe, legislation is limiting the use of fertilisers in many areas, driving innovation towards minimising the inputs required.

Seed
Seed provides a crop with the potential for success, given good husbandry and the right growing conditions. The opportunity to innovate in this area is very high in both conventionally bred seed and through the use of advanced breeding techniques, such as genetic modification (GM). Innovation produces higher yields and better quality crops, and has the ability to reduce greenhouse emissions, pesticide and fertiliser use. Realising the full potential of biotechnology in the EU is being impeded by a continuing inability to effectively implement EU regulations.

The UK has shown itself to be leader in developing and advancing all six of these innovation platforms, providing agronomic solutions to farmers in both the western world and in developing economies. There are many examples of UK scientific breakthroughs in plant breeding which have developed better performing crops, needing less fertilizer or delivering higher yields.

The worldwide market contribution of these innovations can be calculated in billions of dollars.

The wheat which you eat today is a direct result of research undertaken by the Plant Breeding Institute in Cambridge in the 1970s. They incorporated semi-dwarfing genes into wheat, meaning the plants produce more grain and less stalk, increasing yields by over 7%, or about half a tonne of wheat per hectare today.[3]

The Sainsbury Laboratory in Norwich have developed a method, with Japanese colleagues, of accelerating the incorporation of new traits into crops. This could enable Japanese farmers struggling to recover from the 2011 tsunami to plant new salt-resistant rice varieties in two rather than up to 10 years.[4]

The opportunity of new crop technologies

$14 billion
The net global economic benefits at the farm level added by cultivating GM rather than conventional varieties of crops have been estimated at $14 billion in 2010.[16]

17 million
In 2011, almost 17 million farmers around the world planted GM crops, up from 15 million in 2010.[15]

14 million ha
It is estimated that without GM, in 2010 additional plantings of 5.1 million hectares (ha) of soybeans, 5.6 million ha of corn, 3 million ha of cotton and 0.35 million ha of canola would have been required to maintain existing output.[14]

€443 million
European farmer margins would increase by €443 to €929 million if they were allowed to grow GM crops.[38]

The UK has traditionally been at the forefront in developing technologies that are used around the globe to grow food sustainably. Scientists from the public and private sectors have developed a range of technologies that farmers can use to meet the food and farming challenge.

This includes traditional crop protection products and, thanks to the genomics revolution and other advances in breeding technologies, contemporary plant breeder's can now use a range of genomic 'tools' to achieve germplasm improvements. These new breeding technologies, which complement approaches currently used for genetic modification, include:

Targeted mutations of a plant's own genome (Site Directed Nucleases, e.g. ZFN/ODM and oligonucleotide directed mutagenesis); transfer of genes from a different variety of the same plant (Cisgenesis); and reverse breeding of hybrid plants.[2]

Such technologies can produce crops that combat pests and disease, that reduce carbon footprints and that increase agricultural productivity using less fossil fuel and fewer natural resources such as water and non-renewable nutrients.

The global agricultural biotech research base and product development pipeline is expanding at a rapid rate in direct response to the global food security challenge. Demand for innovative solutions is high, and the UK is well-placed to build on its significant knowledge base.

However, the competition is intensifying and other countries are increasingly better-placed to turn this particular form of innovation into economic growth. Government needs to act swiftly to ensure that UK agricultural biotechnology research is at the forefront of meeting the global food security challenge.

"Trade and investment are absolutely fundamental to rebuilding and rebalancing our economy. The UK has a strong history as a trading and investing nation and continues to be one of the world's most attractive places to do business, but the world is changing and we cannot be complacent. Encouraging businesses to export more is at the very heart of our approach. We need to ensure business, especially our small businesses, have all the tools they need to flourish."
Lord Green, Trade and Investment Minister, February 2012

"We earn our way in the world if we stop being afraid to identify Britain's strengths and reinforce them, backing industries, like aerospace, energy and pharmaceuticals, creative media and science."
Rt Hon George Osborne, Chancellor of the Exchequer, March 2012

"So we are building the networks, alliances, and connections that our country needs for the future. This must include expanding trade, for sustainable growth in our economy will only come from this."
Rt Hon William Hague MP, Foreign Secretary, March 2012

What is agricultural biotechnology?

Crops grown commercially today contain improved seed traits for herbicide tolerance, insect-resistance, or both. Other GM traits aim to achieve disease resistance, drought tolerance or nutritional benefits, longer shelf life or more efficient industrial use. These have been developed for commodity crops such as soybean, cotton, maize and oilseed rape. Uptake has been dramatic - it is estimated that, for example, 88% of the cotton grown in India is now GM due to its greater resistance to pests.[5]

Work is underway at research institutes around the globe into crop traits that will help address specific challenges, such as: bio-fortifying key crops including cassava in sub-Saharan Africa; the development of heat and drought-tolerant wheat in Australia and virus-resistant rice in China.[6]

There are many more GM crops in the pipeline:

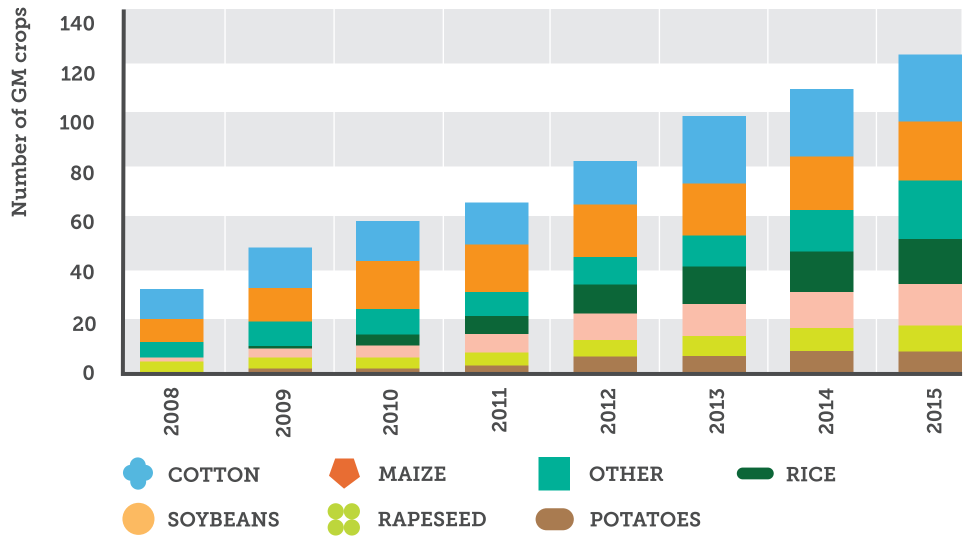
- Blight resistant potatoes will help combat a major crop disease and protect yields and are being developed in both the public and private sector.[7]
- Healthier vegetable oils, such as those with fewer trans fats, would provide benefits to consumers around the world.[8]
- Drought-tolerant GM maize will initially be commercially cultivated in the US but will be made available to farmers around the world.[9]
- Wheat research is underway to increase yields, boost nitrogen efficiency, deter pests and increase health benefits.[10]

The life-cycle for a crop technology innovation, from initial discovery through to commercialisation can take more than a decade. A variety of GM wheat currently being trialled in Australia has been in development for seven years, and it will be at least another seven before it appears in the marketplace.[11] Action to stimulate investment is needed now to deliver the tools demanded by the Government's Foresight Report for food production in 2030.

The biotech crop life-cycle [12]

Estimate of future numbers of GM crops worldwide

Current numbers and estimations of future numbers of GM crops worldwide



Source
Nature Biotechnology (2010) 28, 23-25 International trade and the global pipeline of new GM crops

Biodiversity

There is increasing evidence that the use of GM crops can reduce the impact of agriculture on biodiversity when used with sustainable crop management techniques. A recent study found that existing GM crops have reduced insecticide use and are encouraging the use of more environmentally benign herbicides and conservation tillage practices. They also increase yields which alleviates pressure to convert additional land for agricultural use.[13]

Rothamsted's aphid repellent wheat

A good example of ground-breaking UK agricultural biotechnology research is the field trial of wheat which is resistant to aphids, being undertaken at Rothamsted in Hertfordshire.

Scientists at Rothamsted have used biotechnology tools to genetically engineer a wheat plant that produces a pheromone, which aphids produce to alert one another to danger. Some plants, such as peppermint, produce this pheromone as a natural defence mechanism and it not only repels aphids but also attracts the natural predators of aphids, for example ladybirds.

This GM wheat plant works well in the lab, and is now undergoing field trials. If successful, it could open the possibility of sustainable and environmentally friendly agriculture which uses less pesticides and works with, not against, the natural enemies of pests.

Professor Maurice Maloney, Director of Rothamsted Research, said:

'This is a critical experiment to begin Rothamsted's investigation of second generation GM technologies which focus upon naturally occurring deterrents of pests and diseases. We believe that using GM as a tool to emulate natural defence mechanisms provides a unique and world-leading approach that will also benefit the environment'.

For more details, please go to:
www.rothamsted.ac.uk/aphidwheat

Europe and the UK are being left behind

Rapid growth

Globally, the biotech seed market continues to grow at a rapid rate. Over the last 10 years it has expanded by 450% - with growth of 140% in the last five years.[21]

$1.8 billion

China's spending on agricultural R&D has increased by about 10% every year since 2001, reaching almost US$1.8 billion in 2007. Private sector investment in R&D has also matured; less than 2% of total agricultural R&D was privately funded in 1999 but this increased to 22% in 2006.

Europe is being left behind by economic powerhouses around the world when it comes to investment in agricultural innovations such as advanced seed technologies. India, China, Brazil and the US lead the way.

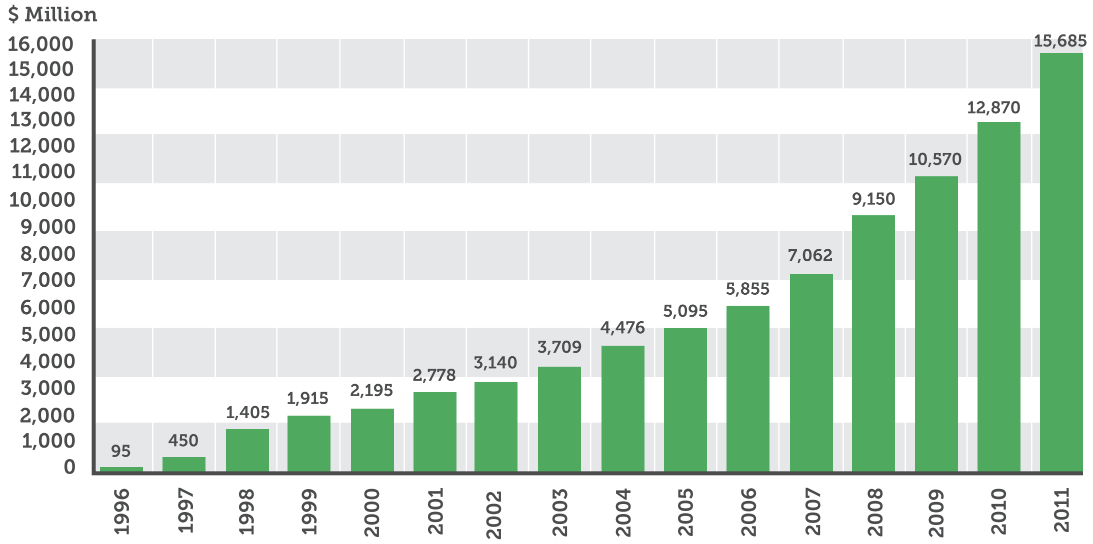
For too long the UK has lacked a strategic plan for agricultural technology, while other countries outside Europe have encouraged investment and surged ahead. India, China, the US and Brazil are investing in domestic biotech research and development capabilities and are reaping the rewards of innovations, breakthroughs, and commercialised crops.

Existing target biotech revenues for many countries are significant and the growth forecasts are remarkable; China has a target for biotech revenues of 5-8% of GDP by 2020, a significant proportion of this revenue will be driven by investment in research into agricultural biotechnology.[18] Malaysia received 2.5% of its GDP from biotech in 2010 from a standing start in 2005.[19] In Argentina, a recent study concluded that biotechnology had added over $70bn USD to the country's economy since 1996.[20]

Less than a decade ago, Brazil was officially opposed to GM technology, but now has one of the most effective regulatory approval systems in the world and is reaping the benefits of this positive approach, having recently given regulatory approval for products derived from their own research. This comes at a time of global economic rebalancing towards emerging economies, with agricultural biotechnology serving as a clear example of how knowledge transfer is benefiting such countries.

The malfunctioning process of EU approvals for cultivation and import of GM crops is one factor deterring private sector investment. However, Germany, Sweden, Spain and The Netherlands are all positioning their sectors to make the most of this situation. The UK sector must also maintain its competitive edge and prepare to be one of the first to reap the benefits of any improvement in the EU approvals process.

Growth of the biotech seed market



Source
Phillips McDougall, 2010

The largest share of the biotech crops sector is attributed to herbicide tolerant crop varieties, which represented 51.3% of the value of the sector in 2009. However, over the last few years the overall share attributable to staked trait crop varieties of maize and cotton has increased at a rate ahead of the overall market, to reach a value equivalent to 37.7% of the overall biotech seed market.

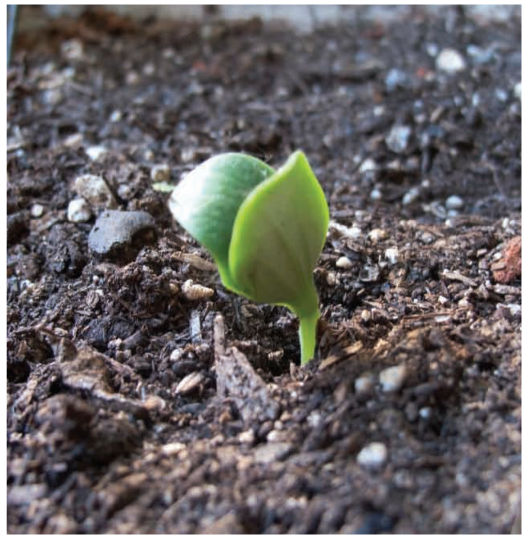
'Time and time again, successful cases of growth in agricultural output in high-growth regions are based on modern plant breeding technologies. This includes breeding crops to suit different climates, to shorten the crop cycle, and to reduce the use of water and fertilisers. The result is higher agricultural output relative to input.'
Economist Intelligence Unit, March 2012 [23]

Before Romania's accession to the EU in 2007, herbicide tolerant (HT) GM soya beans accounted for 68% (about 137,000 ha) of all soya beans planted, averaging 31% higher yields. Cultivation then had to be stopped because the crop has been awaiting approval for cultivation by the EU since 2005.

According to the Romanian Agriculture Minister, Romania's annual loss from not cultivating GM soya beans amounted to approximately €1 billion.[17]

$1.1 billion

The Brazilian agency EMBRAPA (Empresa Brasileira de Pesquisa Agropecuária) has become one of the world's biggest funders of agricultural research and development, with a budget of approximately US$1.11 billion in 2009. Productivity growth in recent decades has allowed Brazil to become one of the world's largest agricultural exporters.[22]



UK needs to capture future opportunities

The powerful combination of a strong science base and unrivalled farming knowledge provides solid foundations through which the UK can turn science into an economic growth opportunity on three levels:

1. **The development and export of the technology around the world.**
2. **The ability to sustainably increase crop yields in the UK and throughout Europe to maintain agricultural competitiveness with the rest of the world.**
3. **Adding value to the UK's largest manufacturing sector of food and beverages.**

Whilst the success stories of China, India, Brazil and the US demonstrate the potential of agricultural technologies, the UK is uniquely placed to maintain its position at the forefront of European R&D.

Public spending on agronomic research in the UK is around £400m per year - with the Coalition Government committed to maintaining this in cash terms until the end of the current Parliament (expected in May 2015).[24] This supports a viable and vibrant pure research base, yet the UK is missing out on the potential benefits of commercialising many innovations through transformational research, due to EU level reluctance to pursue science-based decision making.

European policy has also begun to recognise the value of innovation, with recent proposals to reform the Common Agricultural Policy (CAP) containing measures that could boost spending on R&D for a range of productivity boosting methods for farmers to exploit.

However, a proactive approach is required from the UK Government to work with like minded European partners, public research institutes and the private sector to realise the economic value from R&D in the sector. This will ensure that Europe, and specifically the UK, benefits from its growth potential in a similar way to the gains that have been made in healthcare biotechnologies and other science based sectors.

"With governments, the private sector and development agencies faced with feeding an increasingly populous and hungry world, research to increase agricultural productivity and protect crops from climate change and disease has moved back up the agenda."
Financial Times, October 2011

Innovators, and those who bring the innovations to the market, rely on a political and regulatory environment in which innovation is fostered and promoted, and where science is at the heart of decision making. Market certainty encourages investment.

Europe already imports 72% of its animal protein feed (e.g. soy), most of which derives from GM crops.[25] This highlights an additional problem of maintaining the status quo; European consumers will ultimately suffer if farmers are not given the choice of accessing the new technology, as both commodity prices on world markets and the purchasing power of emerging economies increase.

At the same time research institutes are engaged in exporting scientific expertise in biotechnologies to new markets. But this ambition has been constrained by the uncertain regulatory environment for agricultural biotechnology in Europe itself, which also limits access to overseas markets.

Many scientists and professionals from the EU find better employment in more technology-friendly environments in other parts of the world. Although research in this area started in Europe, the lack of opportunity for research and practical application means that this intellectual capital is increasingly at risk.

Missouri's bio-economy success

Missouri had set itself a target of becoming a world leader in plant science and the biotechnology economy, 'transforming Missouri's economy by creating next-generation jobs in the life-and plant-science fields and by attracting new high-tech businesses to the state'.

This builds on initiatives such as the Donald Danforth Plant Science Centre in St Louis. The Danforth Centre is a not-for-profit research institute, set up with donations from the Danforth and Monsanto foundations, tax credits from the State of Missouri, and land from Monsanto.

The Centre employs more than 170 scientists and scientific staff, and attracts an average of nearly $11 million in annual grant and contract funding from a variety of public and private sources. It also leases research facilities in its business park buildings to plant-science start-ups, providing the 'research, resources and relationships necessary to help plant and life sciences and clean-tech companies from the incubation stage to post-incubation stage achieve commercial success'.

Such an SME-generating science hub could be replicated in Cambridge, Hertfordshire or Norwich given the right national strategy.[26]

Public policy is increasingly recognising the benefits of crop improvement technology and the need to capture these benefits within the UK. The recent UK Government's Foresight report, The Future of Food and Farming 2011 stated:

'No one technology or intervention is a panacea, but there are real sustainable gains to be made by combining biotechnological, agronomic and agro-ecological approaches. Because of the significant time lags in reaping the benefits of research, investment in new knowledge needs to be made now to solve problems in the coming decades.'

Building on the UK's strengths

Super Broccoli

Collaboration between the Institute of Food Research in Norwich and Monsanto has produced a new variety of broccoli that contains glucoraphanin, a phytonutrient that increases antioxidant enzyme levels in the body. This was produced using conventional breeding techniques and is now on sale in the UK.[31]

From laboratory discovery through to farm-scale cultivation, crops go through a typical technology development cycle. The UK has a particular strength at the early discovery stage of R&D. This success drives private and public investment in the UK which is relatively high compared to other EU countries.[27] For example, the Biotechnology and Biological Sciences Research Council (BBSRC) spends around £445 million per year on biotechnology and biological sciences.[28]

However, investment from the private sector has the potential to be much higher, were it not constrained by the dysfunctional regulatory regime and absence of a clear UK strategy for the sector.

The UK has successfully developed clusters of research expertise with biotech firms found in Oxford, Cambridge and Dundee, many of which are spin-offs from university research departments and research institutes. This reflects the success that has been achieved in other sectors, such as healthcare technologies, where the UK has achieved significant SME growth and has attracted investment from global multinationals on the back of its scientific reputation.

BASF worked closely with the National Institute of Agricultural Botany (NIAB) in the UK in the development of 'Fortuna', a culinary potato variety with GM resistance against late blight taken from a South American wild potato. Fortuna offers economic and environmental benefits owing to its complete resistance to late blight, a devastating disease causing global losses estimated at £3.5 billion per annum. NIAB successfully hosted regulated trials with Fortuna in 2007 and 2008, the results of which contributed to an application, recently submitted to the EU authorities.[32]

These SMEs are already successfully exporting the intellectual property for their innovations overseas for development and commercialisation, and our institutes have attracted international partnerships. The UK now needs a clear strategy to maintain its position at the heart of the international trade in agricultural technology, research and intellectual property.

Retaining intellectual capital

Without such a strategy, and with continued limitations on the agricultural technology industry in the UK, our brightest graduates from highly respected universities and those working in specialist research institutes will perceive their future careers as being better served outside the country.

Research from the Rothamsted Institute found that the UK is already losing its expertise in applied sciences, with those employed in applied R&D work increasingly getting older and fewer.[29] There have been three significant closures of public research institutes associated with agriculture in the past decade. The closures of Long Ashton Research Station in 2003, Silsoe Research Institute in 2006 and the Hannah Research Institute in 2007, have all contributed to a decline in our public agricultural research base.

R&D partnerships still pushing ahead

These closures have inevitably resulted in job losses and increased gaps in the translational research needed to commercialise innovations. Yet a number of partnerships between UK institutes and the major private sector companies involved in agricultural R&D are still pushing ahead.

These are examples of the potential of UK research institutes and private investors to develop world-leading innovations for export and support highly-skilled jobs in Britain, but there should be many more. Research by UK institutes into tackling the big challenges of growing food sustainably is evidently delivering results, driven by positive Government support via BBSRC, DfID and others. It is also clear that future R&D must also focus on innovation in soil science alongside advanced breeding techniques, including the interactions between soils and plant genotypes, in order to deliver increases in productivity.

However, delivering this innovative pure research is just the first step, and until the innovations can be commercialised and exported from the laboratory to a farmer's field, the UK will not realise the full benefits of its knowledge base.

China, Brazil and Argentina all have coherent national policies on agricultural technology which are delivering exports and economic growth. England, Scotland Wales and Northern Ireland need to set themselves strategic ambitions to achieve the same success.

James Hutton Institute

The James Hutton institute undertakes research on crops, soils, land use and environmental science, with facilities in Aberdeen and Dundee employing more than 600 people, making it one of the biggest research centres in the UK and the first of its type in Europe.

Their research is helping to lead the fight against potato late blight; the most devastating crop disease in agriculture, costing UK growers £20m a year to keep in check. By identifying proteins that are secreted during the infection stage, and using information extracted from the recently published potato genome, the Institute has discovered important new novel disease control strategies for this extremely costly crop ailment.

The Institute has also developed a series of generic genetic technologies used to deliver diagnostics that have been widely deployed in barley breeding across Europe. The barley genetics programme has successfully been used to identify new flowering genes as well as genes controlling the number of grains per spike of barley. The programme has therefore delivered a range of biotechnological approaches for crop improvement.[36]

The most significant barrier to commercialisation is the high cost of taking a new crop technology through field trials and the prohibitive delays of the malfunctioning European regulatory approvals process. Indeed, the UK Government should be praised for its ongoing efforts to make this science-based process work as originally intended. Until this can be resolved, strong and strategic leadership is needed from the Government to demonstrate to private investors that the UK agricultural technology sector is open for business and can deliver secure returns on investment through its intellectual property and exports.

In the US, where there is a positive government strategy and regulatory system for agricultural technology, companies find it easier to engage in collaborative partnerships with public sector research institutes (see the case study from Missouri on page 11). A recent inquiry by a House of Lords Committee also heard that the UK had 'nowhere near enough' transfer of innovation knowledge, but that 'other states in Europe do'.[33]

Public policy makers must act now to prevent further loss of intellectual capital and to unlock the huge potential inherent in the UK's science and R&D base. Otherwise we risk not only falling further behind the US and emerging economies, but also losing our advantage within Europe.

Embrapa Labex

The Brazilian agricultural research institute Embrapa Labex ("laboratory exterior") programme places experienced Brazilian research scientists in elite overseas institutions. The Rothamsted research station in Hertfordsire has hosted an Embrapa lab since 2010, and Embrapa plan a new laboratory in China in 2012. This is an exchange not only of science, but of people and policy makers, and is crucial to long-term economic success in science sectors.[34]

Jealott's Hill, Syngenta

Syngenta invest nearly $200 million per year in their R&D facility at Jealott's Hill in Berkshire, an unrivalled knowledge hub for plant science expertise which employs around 1000 people, including some of the world's leading plant scientists. Jealott's Hill is a central pillar in Syngenta's $1.25 billion annual global research programme co-ordinating and supporting projects to develop technologies, including biotechnology applications, which integrate to deliver resilient and sustainable agricultural systems on a global basis.

In addition to major research collaborations with Imperial College, Manchester University, Warwick University and Nottingham University, Syngenta partners with hundreds of organisations and public bodies in the UK each year to achieve common objectives. Syngenta also manufacturers agricultural technology products in the UK, supporting another 400 jobs and exports with a market value of $2 billion per year. The company genuinely discovers, develops and manufactures world leading products in the UK.[37]

A licensing agreement between Dow AgroSciences and the John Innes Centre (JIC) in Norwich focuses on enhancing plant root systems by looking at genes involved in anchorage, water use and nutrient uptake. This project hopes to build on research conducted by JIC to support plants' ability to survive stress, increase nutrient uptake and provide yield stability in parts of the world with less favourable growing conditions.[30]

What is needed to make the UK a global leader?

A positive Government strategy for agricultural science will also encourage UK projects to take full advantage of framework funds from Horizon 2020 - the €80bn EU research and innovation fund designed to secure Europe's global competitiveness.[35]

The UK has the intellectual capital to be a world leader in R&D and commercialisation in the agricultural biotechnology sector but this is stagnating at a time when the global need is at its greatest. The sector requires stronger political support to reverse this trend, to remove barriers to the commercialisation of agricultural research in the UK, and to put the UK at the centre of global agricultural innovation and trade.

This report concludes that the Government and the UK's research base can work together to reverse the decline and maximise the opportunity, by:

1. **Incorporating agricultural research into Government economic policy planning, with the aim of maintaining the competitive lead of UK research institutes in the development and export of agricultural technology from Europe. Specifically, agricultural biotechnology should be included in the next Life Sciences Strategy document.**
2. **Setting up a dedicated cross departmental working group, involving academic institutions, research bases and industry to publish a UK strategy for growth in the agricultural technology sector. The group should be set up as a priority and deliver its initial findings by the end of the financial year 2012/13.**
3. **Utilising agricultural research and knowledge as a driver to increase political and economic links with emerging and established markets, including those which are leading the way on increasing food production. The Government should champion the UK's excellence in agricultural knowledge.**

These measures will provide investors with a clear signal that the UK is open for business and willing to encourage research and development in this sector.

[1] The term used to describe the increases in crop yields, in particular wheat, that were achieved in developing countries during the 1960s, through the efforts of International Maize and Wheat Improvement Center (CIMMYT) led by Dr Normal E. Borlaug; http://borlaug.tamu.edu.

[2] Which generates perfectly complementing homozygous parental lines for hybrid production. New plant breeding techniques - State-of-the-art and prospects for commercial development, European Commission JRD 2011, http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=4100)

[3] www.jic.ac.uk/corporate/about/history.htm

[4] http://phys.org/news/2012-01-science-rice-growers-affected-japan.html

[5] Global status of commercialised GM crops, ISAAA, 2011 www.isaaa.org

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