



ROYAL AGRICULTURAL  
SOCIETY *of* ENGLAND

## PRACTICE WITH SCIENCE

*Extract 3: Applied  
Agricultural Research*

### PRACTICE WITH SCIENCE AND AGRICULTURE: THE NEED TO RE-INVIGORATE THIS PARTNERSHIP

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***The UK needs a competitive agricultural industry to meet the future challenges of food production and land use.***

***This competitiveness will only occur if innovations and new technologies are produced and quickly adopted by its producers. The motto of the RASE is "Practice with Science" which recognises that, to be successful, the practice of agriculture must work in partnership with science. The RASE believes that this partnership in agriculture is under serious threat, and that a new approach is required involving both public and private sectors working together in partnership.***

The Royal Agricultural Society of England (RASE) was established 170 years ago at a time when UK agriculture was at a low ebb. Enlightened enthusiasts had seen the potential to develop technologies for food production using the new understanding of chemistry, physics and biology, and RASE was formed to be a catalyst to these changes. The latter halves of the 19th and 20th centuries in particular saw upsurges in the science underpinning agriculture being translated into new technologies globally.

This enabled food production to grow between 1900 and 2000 at a rate that more than matched the growth in the global population which over that period increased from below 2 billion to over 6 billion people.

The motto of the RASE is "Practice with Science" which recognises that, to be successful, the practice of agriculture must work in partnership with science. It is concerned with knowledge moving in both

directions along the research chain and being adopted and adapted through further applied research as required. Unfortunately over the last 25 years, UK government policy has tended to separate science and practice to the extent that this partnership in agriculture is under serious threat. Throughout this report both agriculture and horticulture are considered under the heading of agriculture.

The implications of a non-functioning research chain are that new innovations and technologies will evolve and be adopted more slowly, UK agriculture will grow in productivity and competitiveness at a lower rate than other countries and this will result in a greater reliance on other countries to produce our food.

The food price spike in 2008 challenged politicians to re-consider their views on food security and the role of UK agriculture in food production. Nevertheless whilst a number of activities have commenced in government departments, relevant actions are still awaited.

#### THE NEED TO INCREASE FOOD PRODUCTION SUSTAINABLY

The separation of practice from science in agriculture has occurred at a time when food production and land management have never been so important. The UK exists in a global market place for food where the forecast is that due to population growth and to dietary changes in emerging economies, there will be a requirement to increase food production by 50-100% by 2050<sup>1</sup>, but this will have to be achieved with the added challenges of a

reduced area of agricultural land available to produce it, and of using lower inputs of energy, water and chemicals.

UK agriculture can and should increase its contribution to the food supply not only to meet the rising global requirement for food, but also to meet the rising demand for food in the UK which is projected to increase in population by about 25% over the next 50 years.

The UK is well placed to do this as it has an excellent climate and some of the most resilient soils capable of achieving much greater amounts of primary production. At present only 60% of our food is produced in the UK.

The need to increase food production in the UK sustainably has recently been recognized by the government which has said that "*Domestically, we want a profitable, thriving, competitive UK food sector to continue to play its part in keeping us food secure*" and that

***This Report was prepared for the RASE's "Practice with Science"***

***Advisory Group by the Group's Chairman, Professor David Leaver. David is a former Principal of the Royal Agricultural College, Cirencester, and former Professor of Agriculture at Wye College.***

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<sup>1</sup>The Royal Society (2009) Reaping the benefits. Science and the sustainable intensification of global agriculture. The Royal Society, London.



*“Sustainable increases in food production can be achieved through improving productivity and competitiveness, while conserving and enhancing the natural environment”<sup>2</sup>.*

The importance of new technologies in providing solutions to these challenges facing food production and land use have been emphasised on a number of occasions by the Government Chief Scientific Adviser, Professor John Beddington. At the 2010 Oxford Farming Conference he said that *“Deploying new technologies, processes and knowledge that make our agri-businesses more sustainable and efficient will be critical in meeting our economic, environmental and social goals, including promotion of a thriving food sector”<sup>3</sup>.*

## NEW TECHNOLOGIES AND THE FUTURE OF AGRICULTURE

A technological revolution has occurred in the last 10-15 years which is certain to impact in a significant way on agriculture in the future. These new technologies include biotechnology, GPS technology and in communications in particular by mobile telephone technology. The introduction of new and improved traits for crops and livestock, the development of technologies to monitor crops, livestock and the farm environment, and automated processes to assist in optimising production processes will continue to transform future production systems.

This is emphasised in a recent review of research priority areas by the Commercial Farmers Group<sup>4</sup> which identified two of the main priority areas as:

1. Genetic improvement in crops and livestock exploiting the latest biotechnology methods to increase productivity, to control pests and diseases, to reduce environmental impact and to increase nutritional benefits to human health;
2. Increased productivity and reduced environmental impacts of crop and livestock production systems through precision technology developments.

## BIOTECHNOLOGY

Biotechnology in crops (including GM) is needed to develop the “greener revolution” that is required to enable increased

production to be achieved with lower inputs of energy, water and chemicals. Priority traits will include nitrogen fixation, increased efficiency of N, P, and K use, improved water use efficiency, resistance to pests and diseases and provision of nutrients to improve human health.

Biotechnology in livestock, in particular genome-wide selection methods, will allow faster rates of genetic progress to be achieved with the objective of increasing productivity, improving the quality of the product for human health and reducing GHG emissions and nutrient (N + P) losses from the system.

## PRECISION TECHNOLOGY

Precision technology in agricultural and horticultural crops will lead to increases in efficiency of production (productivity) and reduce environmental impact, through reducing the external inputs of energy, water and chemicals, and by reducing soil degradation.

Precision technology in livestock is likely to be influential in nutritional management of livestock and in the application of inputs during field operations. This technology will lead to increases in the efficiency of production, to reduced energy inputs and to reduced environmental impacts from nutrients and GHG's.



## PRACTICE WITH SCIENCE

### IMPACT OF PUBLIC SECTOR FUNDING POLICIES FOR AGRICULTURAL RESEARCH

The partnership between practice and science worked well until the mid-1980s with many university and research institute scientists being involved in looking for practical solutions through research to improve the productivity of UK agriculture

and doing this in collaboration with extension workers and farmers.

However over the last two decades public funding of science has not encouraged this partnership<sup>5</sup>. Government policy has been predominantly concerned with expanding its funding of science research in universities and research institutes with the objective of making this science “world-class” as judged by the league tables relating to scientific publications in international journals. To achieve this objective the government and its agencies have concentrated their efforts on supporting basic science research. At the same time they have withdrawn funding from applied research with the expectation that the industry (farmers, suppliers, processors, wholesalers or retailers) would pick up the innovations from basic science and develop them into new products and technologies.

The first part of this policy has been highly successful with the UK now being recognised as one of the top nations in basic science (based on the citation index of its scientific publications). However, the second part involving the withdrawal from funding research directed at increasing the productivity of agriculture has not resulted in the private sector replacing the lost funding from the public sector. One outcome of this has been a falling behind in growth of productivity and competitiveness of UK agriculture<sup>7</sup>.

Nevertheless there remains a considerable confusion over how much public sector research funding is supporting agriculture. At first sight this would appear to be substantial as government funding of “agricultural research” for 2010 is claimed to be £280m<sup>8</sup>. However this is misleading as this amount is mainly spent on basic science aimed at a deeper understanding of how plants and animals function and on research to support government policy objectives. Only a very small proportion of this funding appears to be directed at improving the efficiency and competitiveness of UK agriculture.

The amount of research funding provided by the farming industry is also small. The farming industry is made up mainly of micro-businesses with low profitability and not surprisingly it does not make a significant contribution to agricultural research funding.

The levy bodies of the Agriculture and Horticulture Development Board (AHDB) funded mainly by farmers contribute about £23m per year<sup>7</sup>. Other agricultural organisations provide a further £6m and the trade £56m to agricultural R&D<sup>7</sup>.

A clear conclusion is that the outcome of focusing government research funding on basic science and the associated loss of public infrastructure and expertise in applied research

<sup>2</sup>Food 2030 Department of Environment, Food and Rural Affairs. London, January 2010 | <sup>3</sup>Professor John Beddington (2010) Key issues in agricultural science. [www.ofc.org.uk](http://www.ofc.org.uk) | <sup>4</sup>Commercial Farmers Group (2009) Priorities for agricultural and horticultural R&D. [www.commercialfarmers.co.uk](http://www.commercialfarmers.co.uk) | <sup>5</sup>Commercial Farmers Group (2008) The need for a new vision for agricultural research and development

<sup>6</sup>NFU (2008) Why science matters for farming. National Farmers Union, Stoneleigh | <sup>7</sup>Thirtle and Holding (2003) Productivity of UK agriculture. Causes and constraints. Chapter 4. <http://statistics.defra.gov.uk>

has created a gradual distancing of agricultural practice from science.

#### HOW ARE PRACTICE AND SCIENCE LINKED?

The research chain, sometimes called the research pipeline, links both science with practice and practice with science. It is concerned with knowledge moving in both directions along the chain and being adopted and adapted through further innovation as required. The adaptation process is through applied research, and this is the area which has been hardest hit.

It is also important to understand that a successful research chain is also likely to be different for different types of new technologies.

The development of new technology products in agriculture such as vaccines, antibiotics, livestock feeds, seed varieties or crop chemicals appears relatively simple to understand although expensive and time consuming to carry out.

It is sometimes called the “pharmaceutical model” of the research chain and is characterised by a company identifying a potential market, and then using knowledge acquired through basic science research or applied research, from within the company or in the public domain, to develop a new product. The company then has to satisfy the legal requirements for selling the product, obtain necessary Intellectual Property Rights protection and ultimately market the product.

This “pharmaceutical model” of the research chain fits well with the present public sector funding model which supports basic science research to generate new knowledge with the expectation that industry will carry out the necessary translation of research into practice. In this case, industry provides the link between science and practice and through understanding the needs of the agricultural industry it also provides the link between practice and science.

Nevertheless a new product will not necessarily have been tested over a wide range of farm conditions. Performance in practice of a new crop cultivar or a new animal genotype or feed will be influenced by a range of controllable and uncontrollable factors such as soil type and preparation, nutrient or nutritional regime, disease status, management, and weather. This requires applied research by the industry to test these interactions and this has been lacking in recent times with the loss of field-scale comparisons and demonstrations.

Many of the new technologies required for the future will not however be delivered by the pharmaceutical model of the research chain. The development of new systems of production which might include for example soil cultivation systems to reduce energy use, chemical input or water loss; cropping systems to reduce pest and

disease losses; nutritional regimes for livestock to increase feed efficiency; grazing systems to increase livestock productivity, reduce GHG emissions and increase carbon sequestration.

In these examples there could be a need for some industry funding of research, particularly if new or existing products are involved, but as there are potential public benefit outcomes arising from changes in productivity from such systems, including environmental (diffuse pollution/GHG emissions/biodiversity) and social (animal welfare/rural livelihood) benefits, it is strongly arguable there should also be public sector funding of this type of research.

The objectives of sustainable food production systems are to deliver beneficial outcomes economically, environmentally and socially and this often requires multi-disciplinary research<sup>9</sup> which has a sustainable production system and not a saleable product as the output. The research chain in this case is much more complex and requires a different type of research chain and funding.

#### RESTORING THE PARTNERSHIP BETWEEN PRACTICE AND SCIENCE

##### MAKE BASIC SCIENCE RESEARCH MORE USER-FOCUSED

The tension between basic and applied science research is not new and does not only apply to agriculture. It is often considered that basic science should only be concerned with the deeper understanding of nature, and should not be influenced by its potential use by industry. This simplistic view that research to understand (basic science) and research to develop use (applied research) should be separate was challenged by Stokes in the USA<sup>10</sup> who emphasised that “we need a more realistic view of the relationship between basic science and technological innovation to frame science and technology policies for a new century” and he considered that “recognising the importance of use-inspired basic research.... can frame a new compact between science and practice”.

It is important that “blue sky” basic science research continues. However, if the principle of “use-inspired basic science research” was adopted by the government and its agencies when funding a proportion of research programmes, and by research providers (universities and research institutes) in developing the career structures and rewards for scientists, this would represent an important first step in restoring the partnership of practice with science.

##### LINK PRACTICE WITH SCIENCE AT THE RESEARCH PROVIDER LEVEL

The loss of capacity in both infrastructure and expertise in agricultural research has reduced the innovation needed to translate basic science and ideas generated at the applied level into practice, as has the facility to feed back information from practice to basic science about the needs of the industry.

The research institutes in particular have an important role in extending “use-inspired” research into application through field-scale experimentation and in collaboration with industry research organisations. This will require them to restore adequate capacity in applied research including both infrastructure and expertise.

##### LINK PRACTICE WITH SCIENCE AT THE INDUSTRY LEVEL

There is a need for the agricultural industry, the private sector and research providers to co-operate in establishing appropriate means of bridging the research chain gap.

The agricultural industry has been pro-active over many years in attempting to replace the loss of government applied research funding and advisory services by setting up farmer-led research organisations (eg The Arable Group [TAG], Maize Growers Association, Kingshay Trust), industry extension services (eg through the levy bodies, sector trade businesses) and farmer discussion groups. Their link with basic science has however become increasingly tenuous due to the lack of relevance of this research to the industry.

It is important that AHDB provides leadership to the industry in increasing agricultural productivity and sustainability by developing links with funders and research



providers in the private and public sectors to ensure that appropriate applied research infrastructure and expertise is now put in place. The RASE has an important role to play in continuing to work with both private and public sectors to promote exchange of views, and in its knowledge transfer activities on behalf of the agricultural industry.

#### CURRENT INITIATIVES TO ADDRESS THE PROBLEM OF LINKING PRACTICE WITH SCIENCE

Since 2008, the issue of agricultural R&D has been and continues to be widely discussed in government and by the industry. The recent government strategy report Food 2030<sup>11</sup> has called on government, research councils and industry to “develop new technologies and techniques for sustainable agriculture and land use, and better knowledge transfer”. The UK Cross-Government Food Research and Innovation Strategy<sup>12</sup> has nevertheless highlighted the complexity of research strategies for food research, indicating that “The topic of food is inherently complex and multi-faceted, and the research and innovation landscape reflects this complexity”.

The food price spike in 2008 challenged much of the previous thinking on food security, the importance of UK agricultural production, and the relationship between agricultural R&D and competitiveness.



Actions taken by government include:

- Food 2030 published in 2010 is the government strategy for food over the next 20 years;
- UK Cross-Government Food Research and Innovation Strategy is a research strategy<sup>12</sup> report for food research and innovation that extends across the UK public sector;
- Food Research Partnership was formed by the Chief Scientific Adviser, Professor John Beddington, to provide a high level forum promoting cross-sector dialogue and collaboration across government, the research community and the private sector;
- The Technology Strategy Board (TSB) has established a new “Sustainable Agricultural and Food Innovation

Platform” to fund innovative technological research and development at a level of £90m over five years;

- BBSRC will coordinate a multi-partner food security research programme across research councils and government;
- BBSRC Advanced Training Partnership Scheme has been developed to provide high-level training (masters, professional doctorate and continuing professional development) to meet industry R&D needs;
- BBSRC have proposed the development of a new farm-scale research facility at North Wyke.

These initiatives are to be welcomed, but in themselves are unlikely to deliver the dynamic research chain that will be needed to meet the 2030 challenges.

## RECOMMENDATIONS

The country needs a competitive agricultural industry to meet the future challenges of food production and land use. This competitiveness will only occur if innovations and new technologies are produced and quickly adopted by its producers. Whilst cooperation between countries is needed, the UK cannot continue to rely increasingly on other countries for its agricultural innovations.

The RASE believes that a new approach is required involving both public and private sectors working together in partnership as follows:

- Currently £280m is directed by government and its agencies at what is designated as agricultural research, but this appears to be having little impact on either total production or productivity of the agricultural industry. Agricultural research should be aimed at increasing production and productivity in sustainable production systems with the clear aim of increasing competitiveness of the agricultural industry;
- Whilst “blue sky” basic science research underpinning agriculture is important, it should not necessarily be at the funding level of the past ten years if this prevents funds being directed at this industry-directed research. The principle of “use-inspired

basic science research” should be adopted by the government and its agencies when funding a proportion of research programmes. These programmes should have increased agricultural productivity as a proposed outcome;

- Research providers (universities and research institutes) should recognise that research aimed at “use” rather than “understanding” is of great value to the country. This recognition should be reflected in the expertise of scientists appointed and in the career structures and rewards for these scientists;
- Universities appear to have no mandate to deliver benefits to the agricultural industry at present, and until universities are encouraged to carry out more industry-directed research, a number of research institutes should be retained to lead research for the various agricultural sectors;
- Research institutes can extend “use-inspired” research into application through field-scale experimentation and in collaboration with industry research and knowledge transfer organisations. The restoration of an adequate capacity

in applied research will be necessary including the required infrastructure and expertise;

- AHDB should provide leadership to the agricultural industry in developing a positive strategy to increase agricultural production, productivity and sustainability. This will mean developing collaborative links with government and with research providers in the public sector, extending current agricultural extension activities, and supporting the creation of demonstration farms;
- The levy bodies of AHDB also have an important role in utilising their levy funding to support applied research in their sector areas, where possible in collaboration with other public and private sector funders, and to support knowledge transfer activities.

Further copies of this Report can be obtained from: Joanna Righton, Secretary, “Practice with Science” Advisory Group, joannar@rase.org.uk, tel: 02476 858254

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<sup>11</sup>Food 2030. Department of Environment, Food and Rural Affairs. London, January 2010

<sup>12</sup>UK Cross-Government Food Research and Innovation Strategy (2010) Government Office for Science. London, January 2010