RURAL Briefing

SCIENCE AND AGRICULTURE
THE WAY AHEAD ?

Agriculture has become increasingly dependent upon high quality scientific input to its knowledge base and management practices. These are now under severe pressure to change very rapidly as the UK reacts to global competition, reforms of the CAP and, at the same time, continuing home production to higher and higher standards of food and environmental integrity. The demand for science to contribute to Agriculture's ability to adapt to these changes and enable it to deliver what policy and wider society expect is now sharply focussed. The pressure for great teamwork is on.

How then are our scientific resources balanced? What is being done and what are the prospects for the solutions needed by the industry in the outlook period as it grapples with the pressures of its markets, its stewardship of the countryside environment - and the scepticism and demands of politicians and public alike ?

What - in short - is the way ahead ?

Responsible Use of Resources in Agriculture and on the Land

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Briefings provide RURAL supporters and others with coverage of the policy issues examined and debated under the Society's arrangements, and which help to inform the policy development process and those close to and affected by it.

Briefing No 15 discusses the issues involved in the way ahead for science and agriculture. The debate is important because of the rapid pace and extent of change facing the industry and the importance of the scientific and technological basis for many of the practices that will be required as both higher standards and stiffer competition apply in everything aspect of land management

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SCIENCE AND AGRICULTURE: THE WAY AHEAD ?

Introduction.

Agriculture as an industry is experiencing profound and accelerating change, and the pressure on businesses to improve efficiency is such that the importance of the scientific basis of decision taking has rarely been greater. Moreover, the demands to-day are for science to contribute across a much wider array of decision making in all aspects of environmental management, and in a much more highly developed agri-food chain context.

In this scenario there are three key sets of interests and for each of these certain issues arise.

- **The National interest.** Requires scientific support for sound Government decision taking, an adequate research base, and ability to respond to as yet unidentified demands, including demands arising from new and increasingly trans-national policy initiatives.

- **The Public interest.** Includes the availability of goods and services of requisite quality; the satisfaction of aspirations such as wealth-creation and environmental integrity - this last often articulated by single interest groups - and in bringing objectivity to what is otherwise an intensely subjective scene.

- **The Industry interest.** Includes the commercial health of businesses in markets which increasingly cross national boundaries and over which national governments often have no control. Agriculture is also expected to operate sustainably and to deliver non market goods and services, including animal welfare, landscape, biodiversity and habitat, where objective analysis and the scientific basis is, at the least, uncertain. New orders of efficiency and innovation are needed, and science and technology are the means of delivering many of these.

There is a need to recognise the power of science and technology. This has been the principal means by which society has made many of its most important advances and created the knowledge and resources that make possible current lifestyles. The nature, quantity, quality and continued expansion of knowledge tell us that enormous advances are possible. Nowhere is this more striking than in all aspects of food production. Having, for the immediate future at least secured the food supply of the developed world, the question arises; what next?

Society, again in the developed world, is generally rich. As such it has changing views and ideals and different anxieties. It can afford to express these in the market choices it makes, and in its political processes and policy priorities. Curiously, for science and agriculture this has led to some conflicts of logic and perception. The application of science to this sector offers huge opportunities - gene technologies for example - yet the perception is very different and public debate focuses almost wholly on possible threats. Thus, there has opened up a significant gap between the reality and the perception. In a society no longer anxious about is food supply policy is now developed around such public perception rather than the scientific evidence.

Unsurprisingly perhaps, against this background, there is a weight of opinion in the land-based sector which sees itself badly in need of scientific support, but feels distanced from science policy, the setting of research priorities and the potential benefits of much current research effort. The critical and rapid change, which is in progress across the entire industry, has some radical new features: major human, land resource and business organisational re-structuring; global integration of commodity markets; unprecedented economic pressure; new and increasingly demanding regulatory and market standards for environmental and product integrity, and more. What is

important about these factors is that they all happening together, they are all increasing in severity of impact and this process is set to accelerate in the outlook period as CAP reform progresses. Science offers potential tools to assist with the management of these pressures; the hunger for technology is therefore real and substantive.

The science resource.

The organisation and distribution of scientific effort through the Research Councils and Institutions will be familiar. Less familiar perhaps is the size and scope of the DEFRA science effort that has taken shape since the Department was formed in 2001. A digest which explains this was prepared by the Science Directorate of the Department for this seminar and is at Annex A to this Briefing.

Some key facts and figures about DEFRA science:

- The Departmental spend on science annually is almost 1/3 of a billion pounds - £150m on R&D and £170m on scientific services including monitoring, surveillance and advice.

- At any moment, there are 1600 R&D projects, contracted with 100 plus research providers including the DEFRA Laboratory Agencies, Research Council Institutes, Universities and the Private Sector. There are 2500 plus scientists engaged, most at the Department's agencies.

- Science is procured to underpin policies and their development, to meet the demands or statutory obligations, and to provide necessary foresight and "horizon scanning" capacity – in particular to deal with risks.

- Nearly all research is of a strategic or applied strategic character, with an increasing role for social and socio-economic advice.

- The policy range is large; global atmosphere; pollution of land, sea and air; waste; energy; farming and the food chain; the rural economy and its problems; fisheries; pests and diseases; CAP reform; biodiversity; animal health and welfare; novel crops; and land use.

DEFRA published its Science and Innovation Strategy in 2003 which set out the basis of funding to 2006. It has also been running a "Horizon-Scanning Programme to identify new lines of enquiry at the margins of current thinking, and a Science Forward Look which seeks to identify challenges anticipated in the ten years to 2013 will be published shortly.

Other Departmental activities of immediate concern to agriculture interests are: some £25m funding contributed to BBSRC research; a Research Priorities Group, set up following Sir Donald Curry's Report; work with the Medical Research Council and Food Standards Agency on TSE research; the launch of a new Science Advisory Council which, inter alia, will advise on emergencies and crises; and work with the Levy Bodies of Agriculture and Horticulture.

An impression of the scope of some of this endeavour at the practical level can be obtained from the R & D Newsletter published by Land Use & Rural Development Directorate. The latest issue, published as this seminar convened, is obtainable at

The public provision of research

From this brief outline there flows a number of issues including; who is this science for - is it only

for Government, ie the Department - or is for the wider community? Is the research base adequate and does it have to be located in the UK? Is the direction of research appropriate? How far is research effort integrated across the scientific institutions? How successful are we at putting science into practice?

Concerns were expressed about and for the science community. One - a scientist - thought that a little humility might not be amiss. After all very, very few scientists truly created entirely new knowledge; most simply added something or a technology to improve existing ideas. Such questioning may not be welcome, given the sensitivity that currently pervades the profession, but there is a need to recognise that science has to justify its cost to society as a whole. The notion that scientists are still not close enough to their customers was expressed, and it was noted that this perception still persists in spite of years of effort from BBSRC and elsewhere to build in relevant communication and interaction activity to the research and knowledge transfer process. Fundamental researchers are still regarded as the real 'stars'- rather than those who put in end-user solutions.

Questions were asked about the role of universities, the decline in the number of agricultural graduates and an apparent channelling of graduates into schools or faculties rather than departments. It was important to avoid narrow specialisation. Agricultural research often involved sectors that overlap. The USA model was thought to have been successful because of its mix of training, research, return to business practice, extension service and support to universities. Some UK faculties have virtually no contact with the agricultural community. In society at large it is interesting to note how opinions are formed. There is a deep-rooted suspicion that science is driven not by the needs of society - but by personal ambition or corporate profit.

Close observers of the scene over the last twenty or so years noted a severe decline in the funding of agricultural research. Following implementation of the Rothschild Report recommendations, publicly funded research has moved away from near market subjects, and the application of the customer/contractor philosophy has focused research on the needs of government rather than the industry. The overall effect has been a haemorrhage of research council funds away from agriculture - indeed the £25m was stated to be half of what the former Agriculture Research Council had received. Despite the Science Minister's claim to have doubled the science vote, the DEFRA element was said to be probably only half of what it needs to be - given the size and scope of the research task to be addressed.

Bids for more funding had been made but the outcome was not known, and indeed it was anticipated that science would be competing with other Government priorities for a favourable outcome. There were undoubtedly strong political constraints on policy - typically responses to pressure group and Treasury priorities.

Given that the overall spend may not increase much - or at all in real terms - this presents difficult choices. Which projects should be earmarked for "sunsetting" or running down in favour of new or more urgent topics? What should be our attitude to risk, for example, how serious a threat are TSEs? How do we value human life? Might the expenditure on BSE be better deployed? Should we take a more 'annual' view of some funding? These and similar questions ought to be addressed on the basis that publicly funded science is for society at large - and therefore a basis for policy, not - as is often supposed - a basis for driving ***particular*** policies. Other policy drivers will pose questions for science to answer.

It was noted that the policy for organic conversion did not fit well with that ideal; although it was also argued that organic conversion was not a "balance of payments" issue - but rather a market-led

phenomena that appeared to carry some environmental benefit.

However as knowledge increases and public awareness is raised to a wider range of interests or issues it becomes harder for government to discern what it is that society as a whole, as distinct from articulate and often strident minorities, really wants - and harder still to deal with its needs. These are often not the same thing at all. Currently it seems clear that the political drivers favour more socio-economic objectives. There is already a tension because Agricultural production takes the lion's share of the DEFRA science budget, a situation that may become less sustainable over time.

Research relating to agriculture during the last half-century has been directed almost exclusively towards food security, procuring of yields of quantity and quality protected from crop and animal disease predation. Scientific capability has now greatly improved beyond those demands. Equally, the demands have changed and continue to change rapidly, in particular in respect of environmental standards and in the science to underpin enforcement regimes designed to lower agriculture's external costs.

The role of research in the current evolution of UK agriculture

Agriculture has delivered much of the current heritage of treasured landscape, biodiversity and habitat and the industry can be a more positive force for delivery of environmental and other benefits to society. Successful enterprises, even some of the most intensive operations, demonstrate how this can be done. Science now has a crucial part to play in harmonising both the environmental responsibility and commercial viability of farming in the future. On one hand the external environmental costs of past and some present operating methods have to be reduced, and past damage recovered. On the other society aspires to higher standards in everything it demands from the industry; more and better "non-market public goods" such as landscape biodiversity and habitat - and at the same time competitively priced high quality food. This includes greater choice and demonstrated nutritional benefits. This is a major challenge to a social system, which is comfortably ensconced in its traditional, or unchanged image of rural life. The market, which paid for food, will not pay for the non-commercial social benefits.

Science to underpin new regimes of policy and practice must be a major means of identifying what needs to be done and how it might be achieved. The design of Entry Level and Higher Level environmental schemes, dealing with diffuse pollution, excess applications of chemical inputs all serve to illustrate the range and precision of the science needed both to provide a basis for enforcement and to allow the industry adopt best practice for sound economic reasons or to regulate itself.

Problems or conflicts occur where the science is ignored - as is widely held to be case with Nitrate levels and the EU Water Framework Directive; popularly marginalised - as in the case of GM technologies; or absent or inconclusive - as in the case of badgers and Bovine TB. Science has a key role to play in informing policy when market conditions and production systems no longer deliver traditional public goods as by-products. It must contribute to the definitions of policy parameters and operating systems, and devise innovative technologies to assure delivery of the desired outcomes. As we move further down the route of controlling diffuse pollution, CAP reform, cross-compliance and Single Farm Payments, increasingly refined methods are needed. A move from maintaining hedges and walls, to a future which prioritised sustaining microbial balance in soils would be a quantum shift.

The seminar returned to the theme of a "thriving agriculture" - a main plank of government policy. It was pointed out that agriculture will only thrive if it can compete in an international market.

That requires relentless pressure to cut the unit costs of production. It may be in society's broader interests to accept that this commercial reality must determine activities in some regions. By doing so a relatively smaller area of highly intensively managed commercial farming might release other land for extensive methods with a higher priority for environmental and other social benefits. Current research is not helping us to carry out this evaluation - for example even a prestigious institute such as Rothamsted, is bound to respond to research drivers that are socially derived, so that it's work is less helpful to a quest for production efficiency. Farmers, it seems, are not able to contribute effectively to the research prioritisation process, and some expressed concern about the varying value of research among the Institutes.

Another dimension of this dilemma is illustrated by the position of "integrated" farming systems as demonstrated, for example, by LEAF farms. Experience so far is that these systems can be production competitive, deliver measurable and highly varied environmental and other benefits in a locally sensitive setting across a wide variety of different types of enterprise. Such businesses show how highly differentiated systems can exist and yet deliver a co-ordinated policy result. This is important given the Sustainable Development Strategy, yet the potential of these systems is seriously under-exploited. This is partly because of the loss of confidence in 'conventional' agriculture. Conventional agriculture is ***still not seen as part of the solution*** by contrast with 'organic', which has an automatically-assumed political and market appeal. There is a lack of research effort and of the promotion of best practice on conventional farms. Agriculture and Environment are now inseparable in terms of policy. Around 75% of the land surface remains in agriculture of one sort or another, and it will have to be managed under increasingly volatile economic regimes as CAP reform proceeds.

The new role of farming in the UK demands a wider understanding of the interaction of species is needed, for example some populations are interdependent in unforeseen ways as has been shown by recoveries of breeding waders on cattle-grazed marshland. Given the scientific knowledge, husbandry systems can then be designed. It has proven easy, for example, to build for sand martins showing what can be achieved if there are clear incentives. It remains the case however, that investment in such tailored solutions will be needed. Some farmers have turned wildlife into successful businesses and others may be helped to explore such possibilities.

These issues go to the heart of defining future farming systems. " Organic" is perhaps more a "brand" rather than a solution for so diverse a set of circumstances. In the wider agricultural, scene farmers need to know just what is needed. The "environment" is not exact. "Sustainable" is perhaps too difficult to define - ***but "unsustainable" is not.*** So as progress is made with cross compliance and design of the directives which have to be applied on the ground, more of the science needs to be properly targeted on that which is unsustainable and yet valued. Farming's operating environment is perhaps uniquely susceptible to the variable and inescapable external factors. There is a need to challenge existing tried and tested methods and, in some cases, to evolve new criteria. For example does NIAB listing any longer tell us all we need to know about new varieties? These factors illustrate the need for sound science on the ground. This must be "inclusive", involving the industry and producing information in a form that can be "applied".

These ideas pose yet other questions. Is science ***just*** about policy that works? How does the public "get its money's worth"? How do we deal with contingencies - like FMD? Is science a delivery system - or is it also meant to help us form visions? There is a need to get knowledge into practice more effectively. There is real difficulty with visions that pay too little attention to those on the ground who have to deliver - a 'footpath' is needed.

Providing the required research.

Concerns were expressed for the intake of scientists and retention of high quality members of the research community. The latest figures from the higher education field indicate a dramatic drop in the number of maths and science students, reduction in the science departments of universities, falling numbers of science graduates entering research, and a growing sense of science not providing the career excitement and satisfaction that had traditionally been assumed. For those already in the profession a parallel sense of frustration now prevails. Many are becoming disenchanted with their prospects, career insecurity and a philosophy that feels like "competitive tendering for one's next three years worth of project work and employment".

A parallel concern lies in what was described as the connectivity of scientific endeavour. There is already difficulty over the 'lines ' between Strategic and Applied research. It becomes more difficult to distinguish between the two and in consequence more difficult to "justify" or make research proposals. It can lead to substantial wastage of researchers' time, if applications are sidelined as a result of being held by the funder to lie on the other side of the boundary it regards as its territory.

The very nature of the proposal process compounds the problem. There is no funding for the proposal process. Researchers find themselves consuming resources from current projects - if only in terms of time and effort - to fund the proposal for the next one. It may also require the employment of specialist staff expert in the attractive presentation of applications for funding. This process was described as both demoralising and often an unproductive and bad use of scarce resources. The recently announced 'cross-research-council' RELU Programme was singled out as potentially of particular concern in this regard. Others expressed concern, given the huge arrays of projects with real questions, about the overall focus.

Attention was drawn to the international or trans national nature of science - and the need, in accessing the research base, to examine European and global connections. There is a conviction that opportunities are being missed both directions – in the import and export of know-how and expertise. The EU Commission was criticised for "getting in the way of trans-national co-operation". It was felt that EURONET was a better method of looking across the international network.

A need was felt to deal with both an inherent conflict between the process of competitive funding of specific research requirements, which was described as "projectisation", and the requirement to build a strong research base. This demanded a better organisation of research programming. Accompanying these aspirations was a repeated call for better knowledge transfer, better delivery of research into the longer term - in particular to deal with the "strategic funding gap" and clearly differentiated funding of both fundamental and applied/strategic research - a better structure for the research organisation.

By contrast, the Levy Boards were singled out for positive support and are regarded as important vehicles for short-term research programmes. However, knowledge transfer is still regarded as difficult even in this client area. It is difficult for Boards to communicate effectively with diverse communities of growers, to meet the instant demands of growers, to respond to their economic pressures, and to convincingly present the case for continuing industrial investment in research. Rather, when market conditions are hostile, research may become an early casualty of essential cost cutting.

It was also felt that some current "policy pushes" are actually weakening science. There is a real problem in the lack of engagement of politicians in scientific debate. This may be one dimension of a wider problem - the desperate need to obtain better scientific penetration of the public mind.

One conclusion is that, almost by definition, there is so much uncertainty involved that the debate is politically unattractive. However experience from Scotland where researchers hold an annual Science and Parliament Day, and of the Royal Society's pairing schemes, suggests that progress is possible.

Much public research is driven by the public perception of risk. Participants attached significant importance to this recognising the role of science in risk analysis and management. They wondered if research programmes were too often based on the perception of the risk rather than analysis of the evidence for it; BSE and bovine TB/Badgers being examples in point. The funding of organic conversion plays to just such a risk/perception imbalance. Science must have a role in correcting ill-founded perceptions but to do so it needs public confidence. The seminar was aware that public attitudes were greatly influenced by "who bears the risk and who accrues the benefit". This presents a particular difficulty for new and untried systems and farming practices.

By contrast, truly socially destructive and publicly expensive phenomena such as obesity, adverse nutrition/diet and ageing appear to rate poorly in risk awareness. The debate returned repeatedly to the issue of risk and pressure-group influence. There was clear conviction that disproportionate funds are being expended on projects, which reflect single interest group agendas rather than properly evaluated risk. Moreover that while such groups often espouse honourable and positive causes, such as the abolition of slavery, some have exerted an adverse effect on society at large through disruption of privately funded research such as GM technology, stem cell culture and the closing down of animal welfare related research. The lesson from this appears to be that science must play a more pro-active role in the analysis and evaluation of such arguments.

The purposes of Agricultural Science

Those close to science policy development welcomed the opportunity to explore ideas about "what is the science really for"; What is the importance of risk assessment to the role of science; how can we deal with risk perception and farming practices; how do we deal with the pesticide / fertiliser issue - is one solution to confront the single interest groups because to react to perception is to duck risk assessment? It can be seen how such issues require applied research to inform policy. There is a contrast with 'curiosity driven' or fundamental research. This may not lead immediately towards achievement of a policy objective, but may ultimately lead to amazing advances such as a virus to attack a bacterium that, in turn, would lead to significant improvement in farming methods and so help to resolve important policy questions. Key issues are who sets the policy, and how research feeds back into policy implementation. This is important for the whole of government. For example the "environment", involves not only the farmed landscape but also cities and global air and water issues. It is some years since the Royal Commission on Environmental Pollution pointed out the important role of science in setting environmental standards. Similarly the seminar also noted that food risks cannot "simply be left to the FSA."
DEFRA research does not exist in a vacuum; there are other research agencies with relevant agendas, but the impression of discontinuity persists. Foresight exercises are never complete but their evolution and questioning should be continuous and a shared activity among interest groups, including farming. This may mean incorporating discussions with potential users within the technology transfer process, before research itself is undertaken.

From 1940s to the 1980s, new science and technology was delivered to farming as a result of policies primarily concerned with food security. That changed with 'privatisation' of much of the technology transfer process, the removal of near-market research from public funding and the switch to commercially based advisory and extension services. This has had implications for, for

example, plant-breeders rights, IP, and much of the style of decision-making. Society has, in effect, lost "ownership" of the research process that now belongs to the commercial interests who fund the work and accept the risk. The pressure-group-led protests against GM technology are in some senses a re-statement of the desire to "own" the processes - perhaps a fear that "they" rather than "we" might derive a benefit - a rejection of the profit motive as the means to run successful, socially responsible businesses rather than a "publicly funded food security service". It is at least arguable that this history accounts in part for unease and disquiet. That, combined with recent food scares, the sheer visibility of farming because of the land area it occupies and the multiple uses to which society puts land, and the public subscription still going to the industry via the CAP, is said to give society an entitlement to be assertive and demanding - even untrusting - of the industry. Something elemental in the psyche of the purposes of research for "the public" (whoever "they" are) may have been mislaid along the route of change.

Distrust is increased by the moves research establishments must now take to protect their IP in research results. It is at least arguable that some of this knowledge might be better shared than not. Although the taxpaying public might agree, an Institute Director with a budget to balance would not. Such a Director is almost forced to spin-off potentially commercial research results into commercial enterprises. So the "societal" ownership of the products of research may now be lost on both user and research fronts. This creates another negative in the relationship between scientists and society. Moreover the situation for the scientist is very uneasy; there is a difficult IP / patent law position, difficulty about just where public ownership begins or ends in partially-public-funded institutions and occasional lengthy paralysis of action whilst difficult decisions are made about publication, patenting, restrictions of use, rights and more.

Participants wondered if analysis would show any real benefit for the methods now used; the culture of spinning-off or spinning out. The feeling is that the IP culture has been "overdone". Perhaps as a result, we have not sufficiently benefited from our Biotechnology advances. One Institute suggested that by 'giving away' their research on ecology and biodiversity they received benefit through the co-operation thus engendered. It was wondered if such an approach might assist other Institutes to 'raise their profile' - 'friends' value such a resource.

Crucial to the future of farming is accuracy of government signals. DEFRA has stated that it wishes to see a thriving agriculture but it does not indicate what size this industry should be. If it is to be internationally competitive then it will almost certainly be different and smaller than the agricultural industry that has been protected under the CAP. Science policy does not throw much light on this - its role is to underpin the various policy initiatives. We may not necessarily conclude that one purpose for public science is to enhance international competitive strength of UK farming, - for example after the style of the USA, which is more transparently supportive in this manner. The picture is confused because of the number and range of farm enterprises and the fact that they may have differing public good implications and that at any given time, many may become temporarily non competitive depending upon changing market conditions. There is also the issue of what, as well as, or instead of, orthodox farm produce, farmers might be able to "market" in the prevailing policy and reward climate; eg amenity, stewardship, landscape, biodiversity and habitat. Competitive farms are one thing; a competitive industry quite another.

The feeling remains, however, that the policy objectives for environment will most successfully be secured alongside a viable industry that can compete through cost reduction, innovation and food quality assurance whilst compliant with environmental best practice and / or regulation. Critically this requires the retention on the land of personnel with the management and skill sets essential for countryside management in which innovation and quality assurance feature equally. It is argued,

that this is the best reward for public expenditure and therefore a legitimate area for public investment in the essential scientific research.

Increasingly, farming describes itself as in need of "smart" solutions whether for production needs or for land and environmental stewardship. Much of this community feels that it can readily identify problems, but solutions that do not adversely affect costs are far less easy to find. This might be expected from marginally competitively or indifferently managed units but the same mood now prevails among many of the most efficient and responsible enterprises. Some solutions will come from the market; others will not; for example, those needed to respond to new regulation or where complex interactions of many species are involved across large and/or multi-owned tracts of landscape or habitat. It is surely a purpose of publicly funded research to answer these needs, and one dimension of this is the need to support emergent or new technologies, including those developed elsewhere in the world, that can be adapted to meet UK needs - including GM technologies.

The point is frequently made that agriculture, and therefore by implication agriculture's scientific component, makes a relatively small contribution to GDP - less than 2% on some analyses. However this is too narrow a basis of assessment. It ignores both the downstream food chain and the natural world and environment where the footprint is uniquely large. A true context for assessing the need for scientific investment must include an understanding of the impacts of human action on the natural world as well as the outputs farmers sell.

Commercial agriculture is primarily about meeting customers' needs. Most thinking about this is still inside the farm gate. However, a much more integrated food chain philosophy is rapidly emerging, as is a parallel one for non-food crops. The development of the fundamental knowledge into technologies that facilitate these chains and benefit society as a whole can be regarded as a public good. Cases can therefore be made for publicly funded science to support further development in these chains; eg for crops such as new types of wheats for different purposes, to facilitate production of competitive new raw materials or added value products, to protect against threats such as toxicological or pests, and to enhance the parts played by crops in properly integrated farming systems. It was recognised that a function of publicly funded science is to identify capabilities that others then develop.

Food production will remain the prime commercial purpose of farmers and agri-food and service businesses, but more and different things can be done. One function of research is to find out what is actually needed, and what public opinion really demands. Whilst commercial research provides an excellent and objective measure of demand for traded goods, there is no equivalent authoritative evidence about the demand for non-market public goods. Such demands are generally expressed by pressure groups who do not have to bear the cost of providing such goods or services.

A prime factor at present is lack of trust in scientists. The situation has not been helped by incidents such as the "scrapie brain muddle" which did a great deal of damage to general credibility. This in turn points to a need for Quality Assurance in the scientific process. Nevertheless, government science is likely to remain the only practical source for dealing with what are perceived to be huge knowledge gaps in such areas as human toxicology, water and pesticide residues, and the environmental impacts *upon* agriculture - where, for example, diffuse pollution is believed to be damaging agriculture on a scale not yet comprehended.

This leads to the deduction that science should be developed so that an understanding of complete systems is assured - not just this, or that, system or crop - but the interaction of the whole. This

may 'benefit' agriculture - but the real beneficiary is the wider community. The actual costs and benefits, and where they fall have to be understood. Such an understanding is a prerequisite for designing strategies to drive the desired changes, which incorporate an awareness of how economic pressures change, and, therefore, redirect the movement of resources within the system.

Agriculture is truly multi-functional and capable of multi-functional delivery but it needs the aid of science to address the "public good" demand. Examples where this applies - and where 'old' 1950s or 1980s research might be instructive - include better or greater water efficiency, energy efficiency, alternative energies, less intensive use of land and pressure on livestock, better understanding of traditional practices such as herbal meadow grazing which apparently confer little-known mineral and other health benefits. Other impacts on the countryside are far from fully understood; much current hedgerow management is certainly unsustainable in the long term, ditches are often neglected with long-term damage as a result, complex habitats are still "falling apart" without us realising it, and recovery of past damage is insufficiently well informed. There is a complex set of expectations in this issue - and it is made more difficult by the need to manage the interaction of systems and people over very large tracts of countryside where competing priorities have also to be reckoned with.

Food security raises a variety of concerns. They include the quality and availability of food in the longer term given such factors as climate change and population growth. At the moment there is no threat to the UK's food supply that producing more food at home would relieve. Food is a globally traded commodity. Greater exposure of UK farming to competition poses the question of what changes in patterns of land use might occur, and what the future use of resources currently committed to agriculture might be. A concern was expressed that experience tells us that lost markets are seldom if ever recovered and sectors or industries similarly 'lost' are seldom if ever re-created. So far as farming is concerned this has an impact in terms of the total worth of the industry's complete skill set and land character base to the wider community. Science has a role in contributing understanding so that these community values are not lost by default.

So far as climate change is concerned an additional important factor is that, whilst actual climatic changes on the UK may, or may not, be significant, the behaviour of government in bringing forward policies that respond to perceived problems can be highly significant. Wind energy provides an apt example. There is a role for science in adducing evidence for this type of policy development as well as for developing solutions to the policy outcomes.

Connectivity at all levels greatly exercised participants in this debate. Just as better connectivity was sought in the science system and across science sources, so it was required at the applied level. Those businesses optimistic about their viability in a reformed CAP era recognise that they have to become more active partners in this connection process. There is still a role for breakthrough knowledge and the products of research to be promulgated by demonstration, particularly for scientific and technical input to secure policy objectives. The seminar was clear in its view that a most beneficial route is for ***demonstrations ON farms,*** rather than demonstration farms, on the grounds that better value for money will be achieved through a network of farmer 'contractors' whose main business is to farm rather than to run a demonstration establishment. Dissemination is likely to be faster and wider spread; and the technologies and systems demonstrated are likely to be more numerous and varied, and have a more realistic or authentic context. In short, more could be secured both in terms of knowledge transfer and by being closer to a pyramid-selling type of information cascade.

Underlying much of the foregoing debate was an assumption about the fundamental role of Information technology and the part this needs to play in knowledge transfer and operating systems. By implication IT is as yet an under-exploited resource. There is a role for science to expose this, to advance fundamental understanding and to provide support for smart technologies and solutions. It is an area where research and development need to go hand in hand.

Participants, invited to list briefly some main headings in response to the question "What is UK Agricultural science for?" rapidly produced the following headings.

Sustainable Development	Animal Welfare
Biosecurity	Biodiversity including of soils
Habitat Evolvement	Reduction of excessive Inputs
Food security and safety	Diet and Nutrition
Toxicology	Energy use
Climate Change	Alternative Energies
Mechanical solutions	Integrated Farming Systems
Water Efficiency	Land Use
Eco-system functions	Research on Research (QA : Is it valid?)
IT	Intelligent systems and Smart technologies
EU impacts	Policy responses and implementation.

Less labour intensive habitat management.
Monitoring of sites of desirable attributes.
Provide fundamental knowledge to enable development for a wider community benefit.

The way ahead?

This seminar demonstrated the importance and relevance of science to the changes now taking place in agriculture. It emphasised the need for continued research to improve the efficiency with which food is produced, taking full account of the non-market as well as the market values involved. It showed how deeply scientific analysis, including social science inputs are required if the redirection of agricultural policy towards public good purposes is to be successful. It drew attention to critical issues relating to confidence and trust. This affected the ability of those who were the recipients of scientific research to make mature judgements, whether they were politicians, representatives of interest groups, producers or consumers. Building and creating trust is a long-term project and involves many partners but it is of high priority for both scientists and the community at large.

Inescapably there were major issues about the provision of science. Those who provide funds, whether in industry, government, through NDPBs or NGOs, necessarily have to relate it to the basis on which they have secured resources. However, it is clear that science itself is seamless and there is a profound need to bring together the insights from all sources if we are to derive maximum benefit from the funds that are available. This poses questions about the complexity of the systems of funding in the UK, the inherent system inefficiencies, the impact of competitive allocation processes on co-operation between researchers, the exploitation of research via patents or simply through sharing results with other research workers and the means by which research outputs are communicated to research users. It was clearly recognised that science is global business and that in seeking solutions users needed to explore not just the domestic provision but that available elsewhere in the world.

A recurrent theme was the importance of people in the provision and uptake of science. The need to create an environment within which high quality scientists would be attracted to and remain with a research career was contrasted with the insecurity most scientists felt in the contemporary environment. The absence of language that articulated in an understandable way to the community at large the risks and opportunities uncovered by science was seen as responsible for the negative and sometimes hostile attitude of the public to scientific innovation.

The translation of scientific understanding into practices that would lead to farming systems that fitted better the current public demands to give higher priority to environmental and animal welfare issues was seen as essential if new policies were to be effective in securing the goal of sustainable development. No simple solutions were on offer for any of these problems but the clear message was that we had to address them if we were to capture for society as a whole the very considerable benefits that continued investment in taking science forward would make possible.

Addendum

Seminar participants were invited at the end of the debate to state in under one minute their most significant point or points from this debate. The following is a synopsis of those points.

1.Food security, quality, quantity, nutrition and health are all linked. We need to look much more closely at the rates of change taking place and the parts to be played by agricultural science.

2.1. Farmers will take up new solutions given the right signals. 2.2 There are too few multi-dimensional farms. 2.3. Knowledge transfer and utility is a key issue for the future of agriculture.

3.1. We need to use science to deliver food security in all senses. 3.2. Land management is a highly skilled business - it needs science to help in both managing land better and in keeping costs down.

4.1. Agriculture's externalities have a benefit for society. 4.2. We need research on the operations and impacts of pressure groups.

5.1.Agricultural systems need to use science to ensure that they do serve the public - and achieve win-win through complementarity, partnerships and 'market' managers.

6.1. There is a need to for better engagement of stakeholders and public in order to be seen to be doing - effectively - the research the public needs. 6.2. Better communication is needed both for new techniques and where we are already working - the more the better.

7.1. Who owns the science? Society - but this attended by frustration. 7.2. Parts of the system are being abused in and by the communications process.

8.1. Complementarity and the availability and better integration of scientific resources all matter - not just in what is done but in the benefits for the wider community too. 8.2. Better delivery direct to the land manager/decision-takers is required.

9.1 Farmers are quick to adapt, to change and to use science. 9.2. Environmental science is a significant challenge. 9.3. Farmers do believe and trust scientists.

10. The applied value of the science is what matters most.

11.1. We need to keep some sense of perspective and relativity, especially where public unease / risk is involved. 11.2. There needs to a strong policy link both to Research and Development. 11.3. The benefits have to be 'sold' and we have to answer the question "Who takes the benefit from research?"

12.1. We need to have a much more open dialogue with the EU. 12.2. Could we or should we direct science in much more concentrated way towards problem areas such as pests? 12.3. Standards and rigour - for GM, conventional, organic are non-uniform; we have a regulatory muddle.

13. The UK is very lucky to have the resource of good soils and a benign climate. Science needs to help retain that and deliver the benefits from it.

14. 1. We need more science to deal with countryside issues. 14.2. It costs at least £50-£60k to make some quite simple research proposals ! 14.3. We need to look much harder at tax and fiscal tools.

15.1. We need much better mutual understanding in the scientific and wider community. 15.2. We need to move away from 'one size fits all' ideas.

16.1. The science resource is large - we need to look harder at the complementarity issues. 16.2. The role of science is undervalued in national strategies.

17. We must not underestimate the distrust of society.

Annex A / .....

Annex A to
RURAL Breifing 15

DIGEST OF A NOTE PREPARED BY THE SCIENCE DIRECTORATE DEPARTMENT OF ENVIRONMENT, FOOD AND RURAL AFFAIRS

RURAL SEMINAR : SCIENCE AND AGRICULTURE: THE WAY AHEAD

ASPECTS OF THE POLICY BACKGROUND

Introduction

1. This note sketches out some of the background issues, concentrating on Defra's current approach and activities on science and agriculture. It is designed as a starting point for discussions at the Rural Seminar – and raises a number of questions for discussion.

2. First, some key facts and figures about Defra science:

- We spend almost half a billion pounds on science annually - £150m on R&D and £170m on scientific services including monitoring, surveillance and advice.

- At any moment, there are 1600 R&D projects, contracted with 100 plus research providers including the Defra Laboratory Agencies, Research Council Institutes, Universities and the Private Sector.

- There are 2500 plus scientists in the Defra "family", most at our agencies.

- Our science is procured to underpin our policies and their development, to meet the demands or statutory obligations, and to provide necessary foresight and "horizon scanning" capacity – in particular to deal with risks.

- Thus nearly all of our research is of a strategic or applied strategic character, with an increasing role for social and socio-economic advice.

3. Defra was created in June 2001. It has one of the widest subject portfolios of any Government Department, spanning all the areas of responsibility of former MAFF, the environmental work of former DETR, plus hunting from the Home Office. We have a growing "own agenda" on the international stage as well as for a large range of rural affairs matters where we need to work closely with other Departments (those who deal with transport, planning, housing, regional delivery), exercising a lead and bringing influence to bear. The policy range is very substantial; ... global atmosphere; pollution of land, sea and air; waste; energy; farming and the food chain; the rural economy and its problems; fisheries; pests and diseases; CAP reform; biodiversity; animal health and welfare; novel crops; and land use. The key point is that virtually all of these policy areas demand high quality science for underpinning policy development and implementation.

4. We published our Science and Innovation Strategy in May 2003 which sets out the basis for science funding, covering the three years to 2006. Each and every individual strategy with plans and anticipated costs have been published on our website.

5. We are concentrating on emerging risks and opportunities. Our policies must be evidence-

based; much of our science deals with the "here and now" but it is important to anticipate future policy drivers. Thus:

- For the past two years, we have been running a Horizon Scanning Programme, with new lines of enquiry at the margins of current thinking.

- We shall soon be publishing a Science Forward Look which seeks to identify the challenges we face over the next 10 years to 2013, including the social and socio-economic dimension. This will form the basis of our work to minimise risks and maximise opportunities, and be a platform for our science investment needs in terms of facilities, professional skills, laboratories and capital needs.

6. We are working closely with other funders on strategy development and programme co-ordination:

- With the Research Councils (we currently fund about £25m annually at the BBSRC alone).

- We have a Research Priorities Group – set up after Sir Donald Curry's report on food and farming which links the main funders of agriculture and agri-environment R&D in Great Britain.

- We have significant commitments with HEFCE and SHEFCE on veterinary research and teaching.

- We work with the Medical Research Council and the Food Standards Agency on TSE research.

- We are developing joint approaches to laboratory infrastructure development of the veterinary laboratories of Defra and BBSRC.

- To improve quality assurance, we have developed a code of practice with standards for labelling, storage and sample tracking.

- In a new programme, we are peer-reviewing the outputs of Defra funded R&D. There are detailed science audit and review processes for all Defra Agencies.

- In terms of developing our scientific skills, we have introduced a new Head of Profession role to ensure appropriate continuing professional development for all our staff and their optimal deployment to meet future needs.

7. More generally, we are making our science more open, transparent and credible, seeking to create a greater public trust and confidence in the science we do, but against a background of considerable difficulty.

8. We have recently launched our Science Advisory Council, a very senior external new advisory body, chaired by Professor Roy Anderson FRS. This will provide advice to the Chief Scientific Adviser, and through him to Ministers, on the scope, balance and priorities for Defra science – and will advise and as necessary challenge internal advice when we are faced with emergencies and crises. SAC will work in the open and publish all these proceedings. We are publishing full details of our programme activities as well as each of the 600 R&D reports we

receive annually from contractors. More generally, there is a determined effort to increase our public consultation activities (e.g. radioactive waste management, the GM science debate, the presentation of our Science and Innovation Strategy last year in open forum, attended by 400 people).

9. BBSRC and NERC are major funders of "blue skies" research and significant contractors for Defra. Details of their science strategies can be found on their websites.

10. We work closely with the levy bodies operating in the farming and food chain industries which the Department sponsors. These include the Homegrown Cereals Authority, the Meat and Livestock Commission, the Horticulture Development Council and others. Collectively, levy bodies spend in excess £35m a year on R&D. We have a substantial and growing LINK Programme involving 50:50 funding by Government and industry consortia of nearer market projects.

Science and Agriculture

11. Defra's over-arching aim is to promote any competitive and efficient farming and food sector which protects and enhances our countryside and wider environment and contributes to the health and prosperity of all our communities. The UK farming and food chain faces increasingly strong competition, new technologies and high consumer demands – all of which are driving rapid change in the food chain. Recent reforms of the Common Agricultural Policy - decoupling subsidies from production - will give producers greater exposure to the market place and improve flexibility to exploit opportunities. In December 2002, Defra published its strategy for sustainable farming and food. The key goals include:

- A more effective food chain.
- Enhancement of the environment.
- Investment in farmer training, capacity and research.
- Nutrition and safety.
- Animal health and welfare.
- Improving the contribution of farming to rural communities.

12. During the period of our Science and Innovation Strategy, the main priorities will be:

- Sustainable farming systems which means:
  - Developing and testing more resource-deficient and less polluting agricultural systems.
  - Quantifying emissions to air, water and soil from agricultural production with effectiveabatement strategies.
  - Improving our understanding of the impacts of climate change on agriculture, looking at adaptation strategies.
  - Developing sustainable animal production systems within an economic, environmental and ethical framework.
  - Improving the efficiency of organic produce, quantifying environmental benefit.

- Food chain and consumers:
  - Promoting food chain sustainability, efficiency and lowering waste and resource use in production.
  - Improving the safety and quality of foods including nutritional qualities and cost.
- Animal welfare:
  - Understanding the factors which contribute to improved welfare of domesticated and wild animals, analysing the value to consumers of higher levels of farm animal welfare.

- Managing pests and diseases:
  - Improving our understanding of existing and emerging threats to plant health.
  - Looking at the impact of pesticides on agricultural and aquatic environments, minimising risks associated with their use.
  - Devising alternative plant protection technologies (e.g. bio-control methods and integrated crop management systems).

Science Forward Look

13. This study has investigated a range of trends which we believe will influence the research needed to meet the future strategic outcomes of Defra. Key drivers have included an examination of international policy changes (e.g. CAP reform) plus international and national social developments that could have significant impact on Defra's policy and their development. These include an ageing population, population movements, health and lifestyle; employment and skills; and mobility and consumption patterns. Scientific and technological trends include ICT, genetic and nanotechnologies, non-destructive and remote sensing technologies, process technologies ect. In addition to climate change, other environmental trends include the security and supply of energy and natural resources and their protection, plus the need to deal with biohazards whether natural or through the agency of terrorism.

Some Questions.

- What pace of technological change is feasible?
- How good/bad is our knowledge transfer work?
- What are the attitudes of the farming and food sector towards innovation?
- Is there any degree of resistance to social pressures for change?
- Can opportunities for farmers be developed through ICT (e.g. farm monitoring, planning, decision support, trading)?
- Is there room for more self management in agriculture systems rather than inspection regimes?
- What scope is there for specialisation and intensification of primary production in highly advantageous regions – but with more multi-functionality, part-time farming, extensification in more marginal areas? What are the science investment issues arising?
- Will biological pollution (insects), bacteria, viruses etc. become the pollutants of the 21st Century? What are the threats? And what will be the role of farming activities in either causing or controlling those threats? Should health be a key driver of farm production?
- Can sustainability be quantified according to the benefits of mixed, organic, precision and integrated farming?
- Is biomass energy production feasible and acceptable?
- What strategies could be developed to optimise the role of agriculture in nature

conservation?

- Is agriculture and food supply at risk from a narrow genetic base?
- How can science be optimally positioned to serve policy in achieving the desired future?
- Are our structures for the delivery of scientific research gaining sufficient investment (in the long and short term)? Do we have the right skills? Is there sufficient flexibility?
- What is the role of international (and particularly EU science)?

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RURAL's FUTURE SEMINARS
will continue to examine policy themes central to the development of policy for Farming, Food and Countryside.

In next issue:

Farming and the Food Chain - Coming Closer?

See the next RURAL Briefing

RURAL plans to continue to programme events which capture this WAY AHEAD theme with the aim of promoting constructive input to the policy overlay beneath which farming food and countryside practitioners function.

Do you have views on these issues or indeed on other issues to which RURAL should turn its attention?

If so, please contact John Hickman CBE, Director RURAL,

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Membership of RURAL costs £15 (individual) or £500 (Corporate) and enables supporters to contribute to the policy information and development process. It brings RURAL Briefings, important network opportunities and access to topic information.

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