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6 Planning strategies for agricultural research

Trevor Lewis

INTRODUCTION

British agriculture has been a success story for the last twenty-five years. Cereal yields have almost doubled, there have been considerable increases in poultry, lamb and milk production, and modest increases in beef-cattle and pig output. Total production has risen by a third and self-sufficiency in indigenous foodstuffs is now around 75% compared with only 60% in the late 60s. These achievements have been brought about by organisational improvements on farms, new crop cultivars, better breeds, targeted agrochemicals and more efficient machinery – largely stemming from the development and exploitation of public and private sector research, and driven by Government and EEC incentives. Priority has now moved from increasing output to producing for the market and the consumer, albeit with a concern for aspects of health, nutrition, safety, welfare, the rural environment, and the desirability of providing leisure opportunites in the countryside. These pressures have increased the need for more efficient production on a smaller area of land to enable our agriculture to compete for a larger share of the EEC food market. Different, and ever-changing demands are thus placed on the farming industry and the research base that supports it. For farmers, examples of new options include set-aside for arable land, farm woodlands grants and assistance in environmentally sensitive areas.

For the research community there has been an even greater re-appraisal of objectives and means over almost two decades. Currently, through the Ministry of Agriculture, Fisheries and Food, the Government is committed to supporting basic and strategic studies together with work in the 'public interest' such as food safety, environmental protection and animal welfare. However, research that offers prospects of commercial application or

exploitation in three or perhaps five years is considered to be more suitably funded by industry, and Government funds are progressively being withdrawn from this area. At the same time, the Department of Education and Science, which provides AFRC funds to support the underpinning science base for agriculture, is pressing all Research Councils for more high-quality research through greater concentration of activities, more selective allocation of resources and better value for money brought about by national and international collaboration to spread the cost. The emphasis too, is to move towards exploitable wealth-creating areas with commercial, health and environmental benefits to the fore. The consequences of these pressures on present and future agricultural and food research, are profound.

EVOLVING POLICIES AND RESEARCH STRUCTURES

The 1970s saw a series of introspective appraisals of the state of UK Science with several Select Committees, the 1971 Dainton Report noting the needs for selectivity and peer review, the 1972 Rothschild Report establishing the customer/contractor principle, the establishment of DES/MAFF dual funding, the Joint Consultative Organisation and Priorities Board. Scientific heart-searching continued through the 80s with publication of the ABRC's 'Strategy for the Science Base', the setting up of ACOST, the Barnes Review, the House of Lords Select Committee on Science and Technology (Agriculture and Food Research) and the Morris Report on the desirability of a merger of the non-medical biological sciences and environmental sciences.

AFRC's response to this evolving, and at times, fluid situation was to begin a restructuring programme in 1982 which after eight years has resulted in consolidation of the Council's 28 research stations and units into seven English and Welsh Institutes each with one or two main sites. In 1983 the Council produced its first corporate plan, subsequently updated annually, specifying for five years ahead its resources, perceived economic and social needs, research programmes, plans and policies, thus providing accountability for Government spending. Major changes have accompanied this approach: devolution of some management responsibilities, a 34% reduction over five years in the scientific work force, many more short-term researchers, increase in the proportion of DES core funding to universities and polytechnics, more aggressive commercial marketing and a wider international perspective (Anon 1990).

Parts of this exercise have been painful, and the days of the cosseted research worker have gone. The selection and re-focusing of programmes at a time of declining funding has necessitated the shedding over the past five years of some 1500 good and dedicated scientists and support staff from the Service. Much of the time of managers, scientists, and administrators of all grades is taken up with the quest for external funding. Despite the Council's success in attracting £17m from industrial and related sectors in 1990/91,

with several individual Institutes having already exceeded the Council's overall target for external funding of 25%, industry has not replaced funds through the various link schemes, levy boards and bilateral arrangements as rapidly as they have been removed by Government in the near-market cuts. AFRC was forced to make decisions on its infrastructure before industry was able to formulate its response. Additional strain has arisen from the changing policies underlying MAFF commissioning of research areas. Nevertheless, the overall aim of more flexible programmes, faster deployment of the new technologies, greater opportunity for rapid development of interdisciplinary research and increased interaction through co-ordination and 'networking' between Institutes and Universities in the UK and importantly across Europe, has been achieved. A period of stability is now desirable, not least to convince good young scientists that agricultural research in its broadest sense offers a worthwhile career.

Present long-term research planning with reduced resources must also take place against a background of geographical, political and social imponderables, significant changes in any one of which could distort an apparently balanced strategy. For example, on a global scale will it be necessary, or possible, to change the UK cropping spectrum to accommodate annual average temperature increases of perhaps 1.5°C–2.5°C, by solving the agronomic and crop protection problems that would ensue? Will the EC pressure to reduce nitrate levels in water have stifled food production in large parts of this country? Will the public be persuaded that there is a distinction between the 'agrochemicals' that constitute plant foods, and herbicides and pesticides perceived by some as harmful but by others as necessary to provide the range and quantity of high-quality, blemish-free produce demanded year-round? What crops would be grown if the General Agreement on Tariffs and Trade (GATT) ended all agricultural subsidies within ten years? Set against these and many other questions, research planning must concentrate on developing intensive quality production from less land rather than partially lowering the output from all land, for widespread 'half-cock' farming will sustain neither UK farmers, the support industries, the nation's food supply at a price it can afford, nor the environment and landscape which the population wants (Barber, 1990).

OPPORTUNITIES FOR EXPLOITATION

Alongside the policy and managerial changes outlined new areas of science have flourished. Versatility of approach and quality of output must be the cornerstones of research strategy. Additionally, researchers need to be alert to opportunities for commercial exploitation of current programmes, to opening up entirely new areas, and to preparing the ground to meet distant eventualities. A few examples from the broad sweep of plant and environmental research illustrate some approaches and likely timescales envisaged.

Research directed to current farming practices

At the pragmatic end of the spectrum, with pressures on commodity prices and farm incomes, any research that assists more effective use of plant fertilizers, pesticides and machinery would be welcome. Levy funding from the Home-Grown Cereals Authority, the Sugar Beet Research and Education Committee and the Potato Marketing Board is intended to provide solutions to the immediate problems perceived by growers. In conjunction, over a 5-7 year period public-funded research has much to offer in bringing soil, physical, engineering and biological expertise to bear on the underlying processes involved.

New concepts in machinery could lead to wide arable gantries for cultivations and treatments requiring less energy and inflicting less structural damage to soils. Microprocessor-controlled spraying equipment incorporating the benefit of electrostatic charging of droplets could improve deposition of chemicals on intended targets, lessen drift and wastage, and reduce energy needed for applications. The incorporation of the cereal-stripping header into small, high capacity and energy-efficient harvesters should provide cheaper machines than the present large combines.

Increasing use of fertilisers and pesticides is commonly seen as the prime cause of deteriorating water quality. This simple view ignores the fact that the soil is a complex mixture of inorganic and mineral constituents, humus and living organisms, all of which strongly influence the release and leaching of agrochemicals, with possible impact upon the composition of surface and ground waters. Over the next five years much effort will be required to refine methods for measuring and modelling the leaching of nitrate and pesticides through soils, the turnover of organic nitrogen in soil, understanding better the biological processes that contribute to these fluxes, and determining the optimal timing and amount of fertiliser requirements for different crops to avoid waste, cut costs, and meet the EC limits. Now is also the time to anticipate problems with heavy metals arising from the use of sewage sludge and domestic wastes on agricultural land and for land fill. Answers to these problems will benefit farmers, the agrochemical industries, local authorities and consumers alike.

There is much pressure, largely misguided, from the public and the media to reduce the reliance on pesticides in agricultural production and storage (Berry, 1990). Without their use it would be impossible for the foreseeable future to maintain the quantity, quality and reliability of produce necessary to feed a still increasing global population or to supply a sophisticated home market. Nevertheless, research should continue to explore ways of using these valuable compounds more effectively, to delay or avoid the development of resistance, and seek alternatives which may in the long-term be cheaper in areas where low input agriculture is practised, either through necessity or choice. Biological control agents from the vast pool of bacteria, fungi, viruses, arthropods and nematodes have potential in specific situations, and in glasshouses in particular are already an established part

of integrated control systems. Ecological and biological research is required to back up and assess the prospects for each agent and pest. Other short-term alternatives are being sought in the form of natural insect antifeedants from the largely untapped biodiversity in temperate and tropical plants, with longer term prospects of using genetic engineering techniques to manipulate biosynthetic pathways in crop plants so that they generate their own, inherent insecticidal compounds (Asakawa *et al*, 1988).

Speculative research

Alongside the research aimed at improving known crops and refining production methods, there must be speculative programmes exploring and extending the fringes of what might be possible over a 10-15 year timescale. Much of the AFRC's wide-ranging effort into biotechnology in agriculture fits in this longer-term approach. The underpinning science covers genetics and molecular biology aimed at manipulating genes, the study of gene products, enzyme structure and function and a wide range of topics in immunology, neurophysiology, and endocrinology. The potential outlets are exciting. In plant science they will surely lead to seeds with better establishment and disease resistance, and improved quality of protein (Fowden, 1989). Commercial transgenic crops will be devised with improved efficiency of photosynthesis, greater environmental tolerance and resistance to pests and diseases. The AFRC's forward-looking £14m initiative on plant molecular biology based at Institutes and Universities, is a manifestation of the Council's strategy to encourage this type of work that looks well beyond current agricultural horizons, but in this regard researchers must not lose sight of the problems of growing the eventual products of their endeavours on farms. Legislation covering the release of genetically manipulated organisms is well established, but it will be important to continue to reassure the public that this 'messing about with nature' is in everyone's long-term interests (to avoid a similar backlash to that which has already occured against pesticides). Use of the new technologies will lead to a clearer understanding of the functioning of organisms and how they react with the environment, which in turn will allow more conventional improvements in crop breeding and selection to be better targeted.

The technology now available to manipulate crop plants has encouraged some multinational companies to move into the seeds business with other novel approaches to crop protection. For example, the ability to breed in herbicide tolerance, although criticised by many environmentalists, opens the way for the development of cheaper, non-specific herbicides which would kill all plants except the crop containing the tolerant gene. Other targeted breeding, first directed towards improving the structure of oils from plants and seeds to provide better raw materials for soft margarines, cooking oils and toiletries, has now moved on to developing vegetables with better characteristics for canning and freezing. The AFRC's new research initiative on crops for industrial use, part of the Government's LINK scheme, is aimed

at developing new industrial uses relevant to the paper and pulp, construction materials, animal feeds and plastics industries. It may lead to whole crop harvesting, whereby an entire crop would be taken to a 'refinery' and broken down into its chemical components (Seddon, 1989). However, the development of some crops as new feedstock for industrial processing, may not benefit growers as much as processors, when the opportunities to obtain added value are generally greater, quicker and cheaper.

I have demonstrated that the farming, processing, support industries and public are all beneficiaries, to varying extents, of the broad approach to medium and long-term research adopted by AFRC. Indeed, some areas of research are moving so rapidly that it is difficult to predict which sector of industry or the public is likely to benefit most. The gathering momentum of the Council's studies on anticipating and coping with the effects of global warming provides a final example of an area in which research is unquestionably relevant to all sectors, nationally and internationally (Treharne, 1989). The challenge is daunting but any long-term research strategy that ignores it could blunt the industry's competitive edge, and jeopardise the economy.

It is not only necessary to consider the direct effect of changing climatic factors on the growth, survival, range and diversity of crop plants, but also the complex interactions of crops with weeds, pests, diseases and beneficial organisms. This has to be a very long-term approach and regrettably neither public nor private funding sources find it easy to commit funds on timescales extending to decades. This attitude must change if this particular problem, perhaps with more profound implications for agriculture affecting future generations than any other, is to be understood. It is no good recording long-term climatic changes if the biological data to which they must be related are absent. It would also be a short-sighted strategy that allowed the more glamorous laboratory research programmes now underway to squeeze out studies on 'real' crops, grown in 'living' soil under British skies.

Nearly 150 years ago, Sir John Lawes at Rothamsted had the vision, the resources and the freedom to lay down long-term experiments whose relevance to fertilizer movement and leaching, organic farming, set-aside and ecological succession is only now being fully appreciated. Current research strategies need to ensure that some equally far-sighted scientific legacies are put in place and kept running, so that future generations can benefit from our vision as we have from that of our forebears.

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CONCLUSIONS

Despite achieving the goals set by politicians and economists, British agriculture is under pressure. This is reflected in the opportunities for, and constraints on, research, changing scientific emphases and the need to plan within declining budgets. For twenty years agricultural science has undergone a series of introspective appraisals. AFRC has responded to this fluid situation by restructuring and producing a corporate plan specifying its resources, economic and social needs, and research strategies, thereby providing accountability for Government spending. The process has been painful but successful, though there are still imponderables which could distort an apparently balanced strategy.

The scientific opportunities for exploitation are immense. From the broad sweep of plant and environmental research supported by AFRC a series of examples from engineering, soil science and crop protection will show the areas meriting study and likely to improve farming practices 5-7 years ahead. More speculative research based on the new biotechnology and looking 10-15 years ahead offers prospects for major changes in farming operations and food production. Given that the Council's remit includes encouragement of quality science extending well beyond current horizons it is essential to maintain a long-term commitment to selected projects and to resist too much pressure for 'instant' results and conclusions.

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