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Agricultural and food research – who benefits?

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3 Economic benefits and the public good

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INTRODUCTION

This paper must start with two apologies. First, from Professor David Pearce, who found himself unable to take part in this conference. Second from its author, who has decided not to attempt to address the title to which Professor Pearce had proposed to speak ["'Non-use economic benefits' and the 'public good'."] but to explore ways in which the benefits and costs of research affect economic values which lie beyond the market place itself.

Such non-market costs and benefits appear to have risen in relative importance in recent years. The European Commission's recent paper on agricultural policy was entitled 'The Future of Rural Society'. In the British Government's recent White Paper on the environment, 'This Common Inheritance', considerable coverage is given to agriculture. This is in sharp contrast to earlier policy statements on agricultural policy which gave prominence to the need to ensure food security, (the UK 1947 Agriculture Act and the Rome Treaty for example) or on the need to use farm resources in order to achieve economic benefits measured in terms of market performance, (the White Paper 'Food from our own Resources' provides a key example.)

One part of the explanation for this change of emphasis is the persistence of excess supply in the production of food. It is difficult to convince contemporary politicians that there is any serious risk of hunger so far as the population of the richer industrialised economies is concerned. Having laboured with the problem of surplus it seems absurd to continue agricultural policies designed to deal with scarcity. Such a view may be myopic. The food production system is more complex and fragile than many of its critics recognise – events in the Soviet Union demonstrate how even relatively successful industrial economies can 'get it wrong'. Despite this it

is difficult to resist the conclusion that the value of additional food to the market economies of the West is extremely low and that there is a major need for a reduction of the resources currently committed to its production.

This reduction in the value of food has occurred within an economic climate in which other important changes are taking place in how we value rural resources. Rising real incomes have increased the opportunity for people to travel, both in terms of where they live and where they work and in relation to their leisure activities. The rural scene has thus become an ingredient in lifestyles which value it for its pastoral peace and beauty rather than its ability to generate income. The growth of population, the rejection of high rise living and the need to accommodate industrial expansion have competed with agriculture for land use. In many parts of the UK it is planning restrictions rather than market forces which prevent the sprawl of towns into their rural hinterland. Even so, in many of the more densely populated parts of Europe the distinction between town and country is becoming increasingly blurred. In these regions, in particular, rising incomes and increased leisure have fuelled a growing interest in the countryside as a home for wildlife. Agriculture, which essentially involves controlling nature in order to produce food, conflicts with the interests of those who wish to see a varied and rich community of plants and animals as part of the rural scene. The number of those who share this concern probably greatly exceeds those who actually look for wild plants or animals 'in the flesh' as a result of the persuasive coverage they receive via the media and especially through television.

Growing competition for the resources farmers use and abundance of food are not the only reasons for concern. Increased understanding of the interaction of human activity with the environment has give rise to a number of anxieties which are likely to affect the way we live in the future and not least to influence the constraints within which agriculture must function. Global warming, already the subject of a CAS conference, represents a long term but threatening menace to society as a whole. Whether we seek to control it or simply to respond to it, agriculture must be involved. Bio-diversity constitutes a capital stock upon which future generations may need to draw if they are to cope with challenges ranging from food to raw material production. The contamination of water supplies and the atmosphere by the waste products of industry and agriculture constitute a cumulative threat to the health as well as the wealth of the world's people.

In considering the benefits to be derived from research related to agriculture and food it is thus essential to take account of a range of issues which do not figure in the determination of the market price of food and which may not be reflected in the price which farmers and food manufacturers pay for the raw materials they use. This paper is concerned with these issues. It discusses five main themes:-

(i) The economic character of 'public goods'.

(ii) The problems of identification and measurement.

(iii) The research agenda.

(iv) The international dimension of research.

(v) The problems of communication.

THE ECONOMIC CHARACTER OF 'PUBLIC GOODS'

In this paper the term 'public goods' is used to refer to all those outputs of industrial activity which are 'enjoyed or suffered' by the public but do not figure in the costs or revenues of the businesses which give rise to them. They are outputs to which no-one can claim a title, they have the characteristics of common property from which all may gain but no individual has any financial incentive to continue to provide. The traditional landscapes of most countries are valued in this way by their citizens. The visual pleasure of a pattern of hedges, trees, streams, fields of varying colour and buildings which 'fit' the landscape results from past farming practice but no farmer was paid to create it.

This 'accidental' occurrence of public goods does not mean that they are not economically valuable. People show that they do value such outcome by their willingness to travel to enjoy them whether as tourists or commuters. Equally the outcries surrounding planning applications which disrupt traditional patterns of landscape are evidence of the importance which is attached to a particular established use of resource. Such behaviour not only results in expenditure by the complainants but also considerable economic costs to society as a whole through the delays and redrafting of proposals which it often entails. We would not tolerate this if we did not recognise that such choices about how we use resources were of great significance. Choice of this nature is the very substance of economics. Alternative resource uses may not be measured via market mechanisms but decisions still have to be made.

It is worth spelling out some of the economic ramifications of the decisions society makes in relation to the flow of public goods. If we ignore such elements and rely wholly on the 'free' market, we risk some serious losses.

- we suffer an aggregate loss of welfare since the distribution of resources which results is inferior to that which society would choose if it were able to incorporate public goods in its decisions. A parallel would be with a man who was compelled to continue grow vegetables in his garden rather than put it down to flowers and lawn because the vegetables had a greater money value than the grass or the roses. We make him worse off by denying him the ability to create a flower garden.

- we affect the distribution of real income. If public goods are neglected factors will be rewarded only in proportion to the revenue they generate in the market place. If this criterion were applied to radio broadcasts, only pop music would be viable and opera would have to cease.
- we affect the competitiveness of our economy. Where constraints are placed on industrial activity to limit its impact on the environment, costs rise and the ability to sell competitively with other industries not so constrained is reduced. In contrast, if the defence of such public goods as are associated with health mean that products from one economy are judged to be safer than from elsewhere, then the firms operating in that environment may enjoy a competitive advantage. The recent traumas of the UK egg industry, in relation to *Salmonella* illustrate the issue.

PROBLEMS OF IDENTIFICATION AND MEASUREMENT

If the serious economic nature of public goods is recognised there exists a need to identify what they are and to attach weights to them which can be employed in order to determine how many of our resources should be applied to their production. At this stage some awkward problems arise. So far as markets are concerned we determine values through the way people spend their money. By definition this route is not open to the assessment of the value of public goods. We have to seek some other methods.

A good deal of ingenuity has been displayed in order to derive some workable procedures. It is worth exploring some of these if only to indicate their inadequacy and the need for more research. Those interested in taking a closer look at work in this area should consult the selected bibliography at the end of this paper.

One route (Marsh, 1990) has been to evaluate how much people are prepared to pay to travel to see a particular site. The implication is that the further they are prepared to travel the more they value the objects seen at that site. There are some obvious problems. For some people the process of travel is itself a 'good', if they enjoy driving they may prefer distant to local sites as giving them more opportunity to indulge their taste. For others travel may be burdensome and the shorter the time spent in the process the more they will enjoy their lives. Again, people may visit a particular location not to see that site but because it is on a journey to some other more distant target. If they stop in the area it could well be because it has amenities for eating and sleeping rather than anything to do with the landscape itself. Evidence of this type is inevitably set in the context of a particular time and place, there is no reason to suppose that public evaluation of such sites will not change. Indeed the evidence from the tourist business is that particular places enjoy periods of being 'fashionable' and 'unfashionable'. Where, as may often be

the case with public good investments, the changes intended are likely to last for many years, such ephemeral evidence may be of little interest.

Another technique which is sometimes suggested is to determine how much compensation, positive or negative, people would need in order to enjoy the same level of utility as existed before a planned change in their environment took place. This 'contingent' method has the merit of incorporating both those who gain and those who lose in a single measurement system. There are however, some severe problems. First, it is difficult to be sure that people respond to a hypothetical question in the same way that they would do an actual situation. Second, this approach almost certainly oversimplifies the circumstances which would face a consumer if the public good were to be offered to him. Third, in order to express a view the consumer has to have information about what is actually proposed. The way in which such information is provided may influence the level of compensation required. Fourth, the full range of considerations which may condition a particular consumer's evaluation will not be known to the questioner so that it may be impossible to 'ask the right questions'. Attempts to use this approach are time consuming and costly, they may even seem, to those affected, impertinent. Methods of this sort may most readily be used where a clearly defined change in the supply of public goods affects a readily specified group of people. They are much less easy to apply when the effects of a change are very widely disseminated. Many agricultural public goods are of this character. They impose considerable costs on a small part of the community who provide them. They may lead to small gains or costs for millions of people who receive them. These might, if there were a suitable system of aggregation, be judged to outweigh even large individual benefits or losses associated with their provision. In principle, in such a situation, compensation should be paid so as to place losers in no worse a situation than before the change took effect. In practice such compensation is very difficult to calculate and where the shifts in benefit or cost to the individual are small the costs of administration may well rule it out. Hard questions about fairness and equity thus remain unresolved even when such contingency valuations are made.

An approach which may be especially applicable in the agricultural sector is to examine changes in land values as an indication of the extent to which some environmental feature is preferred. In principle, if a particular environmental change is regarded as an improvement, people will be willing to pay more to enjoy it. Such additional values may affect not only the land itself but also other sites from which the 'improved' land can be seen. A major problem with this approach is its implicit *'ceteris paribus'* assumption. Land values reflect a multitude of considerations including the environmental amenity of the land. People may be willing to pay more for a piece of land because of a change in planning legislation which makes it possible to change it from agricultural to residential use. The price paid will reflect changes in the local economy which may have nothing to do with the

environmental question which is being explored. Because these other values are changing in ways which cannot be independently measured the attribution of any change in land values to specific environmental 'improvements' is likely to mislead.

A feature common to all attempts to evaluate public goods is the extent to which their recognition is related to the state of education of the population. An example helps to highlight the issue. In the absence of knowledge about the value of bio-diversity, agricultural practices which eliminate insects which bite humans, weeds which reduce yields and areas of scrub land may all be regarded as environmentally beneficial. Given more understanding of the importance of bio-diversity all these practices may, on the contrary, be regarded as environmentally degrading. A system which uses such agricultural practices may be said to lose utility because of an improvement in the level of education. In a private goods market such a change would be made effective by an autonomous reduction in demand for the product. Changes in tobacco consumption following evidence of the link between smoking and cancer, provide an example. In the market for public goods, adjustments are unlikely to be as smooth. Given continuing improvements in knowledge there should be a progressive adjustment of policies, including, from time to time, reversals in their direction. In practice the response to greater understanding is likely to encounter severe political obstacles. Any existing array of policies creates a set of clients who depend upon their continuation. Agricultural policies in all developed countries provide examples of this situation New policies are likely to be politically acceptable only when they acquire sufficient momentum in terms of public opinion to overcome these entrenched interests. This makes frequent changes in direction improbable even when knowledge itself is progressing rapidly. The political risks discourage any alteration in existing procedures until the case for change becomes overwhelming. Thus the process of incorporating public good dimensions into policy thinking is likely to be erratic, sometimes even self-contradictory and generally to lag behind the understanding of those who are most informed about the issues under consideration.

A feature of the measurement of public goods in an agricultural context is the frequency with which the costs and benefits of any particular course of action are separate. A farmer who uses nitrogen to enhance his wheat yields benefits from extra sales and is conscious only of the cost of the fertiliser and its distribution. Costs may be incurred by water authorities some years hence because of the need to reduce the nitrogen content of ground water, part of which has resulted from this application of nitrogen. It is in practice impossible to determine just how much this particular farmer's actions have contributed to this. In one season, when most of the fertiliser is used by the crop the effect may be trivial. In another, when it gets washed into acquifers before the crop has a chance to use it, the impact may be considerable. This difficulty in attributing responsibility is one of the important measurement

issues for the incorporation in agricultural policy a satisfactory 'polluter pays' policy.

The inadequacy of our methods of measuring public good costs and benefits means that actions to incorporate them in policy have to rely on the rough and tumble of political decision taking. This exposes a valid argument to the risk that it will be used simply as a pretext to defend some sectional interest. The warming of relations between 'green' parties and farmers may demonstrate such a risk. The outcome is unlikely to represent the best value so far as society is concerned but it may seem politically very convenient to policy makers.

This discussion illustrates that there is a need for better information both about the physical world and the impact of alternative human actions upon it and for the development of socio-economic techniques of assessment if we are to present more realistic and informed choices to the policy maker. The economic benefits of research cannot be assessed in market terms alone. They have to incorporate these public good elements and our current knowledge of them is seriously deficient.

THE RESEARCH AGENDA

Research agendas are determined by a mixture of push and pull factors within an overall resource constraint. Push factors emerge from past research, from the imagination of the scientist and the pressure to take further enquiries which have so far proved interesting but inconclusive. Given the limited state of our understanding the potential agenda on this basis is virtually infinite. Pull factors derive from the perceived needs of society. Some of these are represented through profit opportunities which business identify and to which they try to respond, others originate in the anxieties of governments concerning such matters as safety, security and the sensitivities of public opinion. One of the reasons for the current disarray of agricultural food research in the United Kingdom has been a perceived need to change the research agenda. Governments have felt comfortable in removing resources from what is labelled as 'production related' or 'near market' research in the context of widespread complacency about food supplies. There is, however, a need for research which illuminates some of the 'public good' debates, some of which owe more to passion than to insight. If this research is not done the probability of avoidable economic waste, as outlined in the previous parts of this paper, will increase as more resources are directed towards the public goods functioning of the economy.

At a fundamental level the sort of research required for public goods purposes and for production in the food and agricultural sector is not very different. We still have to understand the chemistry, biology and physics of the processes involved. As our methods of analysis improve and we gain fresh insight into the operation of these complex processes upon which we depend, our ability to make choices which optimise both the supply of food

and of 'public goods' is enriched. These methods may of course have to extend into new areas. Much of the work which we have attempted in the past has concentrated on the problems of businesses in the agricultural and food industries of the developed world. We now need to know more about, for example:-

- the tropical environment;
- the operation of natural 'wild' environments;
- the dynamics of global environmental change;
- the determinants of sustainability;
- the opportunities for clean technology.

The focus of interest may change but the seriousness of the pursuit of knowledge and the techniques we possess in this enterprise are unchanged. Stopping research which relates to the market sector of the economy impairs rather than enhances our ability to understand and therefore take effective action in relation to non-market public good activities.

In the decisions to be made about public goods the existence of knowledge about the physical world is not enough. Without markets to reflect consumer preference we have to rely on political action and that depends on a rather different sort of information which we broadly characterise as 'socio-economic'. For some time now we have been attempting to attach economic values to research activities in order to justify their funding. This is an important and difficult task but the range of enquiries which is relevant to choices in the public good sector go much further. They include, for example:-

- research into the ethical values held by society, the way they are formed and how they are distributed within the population;
- research into the operation of political institutions, how decisions actually get made, the role of pressure groups, the relation of different levels of government, including that of the European Community;
- research into the way in which the media derive and communicate ideas about the rural environment, the relation of comprehension to education and social background;
- research into attitudes to new technologies and the acceptability of new production methods;
- analysis of the income distribution implications of alternative public goods policies.

This short list illustrates but does not exhaust the need for research to respond to the pull factors within the community as well as to seek to advance the frontiers of the sciences involved in the agricultural and food sector. Greater appreciation of the way in which scientific progress interacts with other community values is needed both to communicate more

efficiently and to avoid a cycle of research expansion followed by cuts. If they are to be effective both the natural science and the social science research programmes need to be in touch with each other from the outset. It is no use trying to bolt on financial numbers after scientific research has been completed. It is equally absurd for social science to proceed on the basis that the alternatives open to society are those of the science developed yesterday and in action today.

Research is a costly activity. In contrast to investment in productive capacity which leads to an immediately available flow of goods and services, research yields only an uncertain return at a distant date. Other papers in this conference explore how we might measure that return. In the context of this paper it is enough to make it clear that we have to prioritise our decisions about research in ways which will leave unanswered many questions which are relevant and important but which we cannot afford to pursue. In that context the state has a special role in the support of research which is directed at public good issues. Much of the more basic research which applies to agriculture and food can only be pursued on the basis of public support. The ability of individual firms to derive revenue from its application is so limited by the competitive nature of the industry that they could not afford the investment which is implied. So far as the public good dimension of output is concerned, only the state can undertake this as an explicit target. However difficult the decisions must be about how much resource to commit to different activities, in any affluent society which intends to continue to enjoy a high standard of living, such research is essential. Without it the comfortable current levels of living of most people will be undermined by thoughtless exploitation of limited resources which, with little benefit to the current population, denies future generations choices which they could otherwise enjoy.

THE INTERNATIONAL DIMENSION OF AGRICULTURAL AND FOOD RESEARCH

Knowledge knows no frontiers. Despite the attempts of governments to limit the publication of discoveries of military significance and, via patent law, to enable inventors to acquire returns from their intellectual property, ideas escape the place of their discovery and are taken up and applied by those who have made no contribution to their development. Viewed in global terms, or indeed from the point of view of scholarship alone, this freedom to circulate information is beneficial. It helps to ensure that new ideas are identified and applied in situations to which they are relevant regardless of where the discovery takes place. It also plays a role in preventing science continually 're-inventing the wheel'. One of the most important contributions which British agricultural science has made to the world in the past two decades has been to encourage the spread of scientific ideas through training many young scientists from the developing world. Their future work

may thus build upon the intellectual capital which richer countries already possess. There are, however, some problems.

The case for being a 'free rider' must be considered by all governments, especially those of relatively modest sized economies such as the UK. The benefits are clear, costs of funding research in particular directions can be avoided whilst the benefits of the research may be acquired at no, or modest cost, by applying principles developed elsewhere or by importing high technology goods. Some delay may occur but, given the normal lag between research discoveries and their application, this may not be very significant. Indeed some past evidence suggests that research done in the UK has been taken up and applied elsewhere before it has been used in Britain.

This argument has much in common with that of companies who refuse to finance the training and education of their staff. They act essentially as predators on the remainder of society from whose resources the training which they ultimately exploit has been provided. In the context of the international community, to neglect research on the basis that others will carry it out is equally irresponsible and anti-social. It also has a further and less obvious consequence. It is the interaction between a research community and the society within which it lives which tends to alert scientists to areas of enquiry which are relevant and to identify, amidst the discoveries they make, applications which meet a perceived social need. In the public goods resulting from agricultural activity such needs and applications tend to relate to particular circumstances or locations. Problems associated with irrigation and desertification, for example, are unlikely to figure largely in the concerns of places with very high rainfall levels. A scientist who discovers some insight which might be relevant to coping with salination in soils might therefore not think it likely to receive much support from government-financed research in a 'damp' country. The same information discovered where salination was a problem could immediately be seen as central to the prosperity of many people and deserving of generous support. The same point has been recognised by the funding of some international research institutes in developing countries. It might be cheaper to locate them in developed countries where the infrastructure of science is more readily available but to do so might not encourage the same focussing of research upon issues relevant to the problems of poorer countries.

If the choice of relying on a 'free ride' to solve scientific problems is unacceptable, so, too, is the notion that every country should do every sort of research. Not only does this lead to duplication but it also neglects the economic principle of comparative advantage. That principle stresses the benefits to be derived from concentrating one's resources on those productive activities in which a country is relatively most efficient and acquiring other goods or services by trade. It shows that in such a system everyone can be better off. This applies to research activities as much as to manufacturing or the provision of financial services. The United Kingdom

has then to evaluate its scientific resources in terms of their relative merits in different areas of enquiry and its ability to continue to finance such studies. Any conclusion on such sensitive matters lies beyond the competence of this author but some observations may help to indicate the type of issues involved.

UK investment in agricultural and food research has been relatively successful judged in terms of the extent to which this industry has raised its productivity compared with many other UK industries. Much more goes into the determination of productivity improvement than research inputs but new ideas are one necessary component of the development of new technologies. It appears to be the case that there exists in Britain a relatively good system of identifying and applying research in this sector to the potential benefit of the economy as a whole.

In some of the more spectacularly expensive areas of research the UK has become a partner with other European countries in funding research – nuclear physics providing a leading example. The scope for such shared research is likely to grow and will be encouraged if political developments strengthen the sense of solidarity among European countries. In the area of public goods, where policy decisions may have to be taken on a Europe wide basis, it would seem especially important that UK research was conducted in harmony with that occurring elsewhere within the Community.

There are a growing number of areas where research must address questions which have an international 'public good' character. At the moment the most prominent of these is global warming and the steps needed to cope with and limit it. There is a range of other matters which are also beyond any individual country's research and policy making capacity. These include:-

- the use of the oceans, pollution, fish stocks etc;
- population growth and movements;
- control of animal and human diseases;
- the rate of exploitation of forests, especially tropical forest.
- biodiversity and the preservation of threatened species.

In areas such as this we need international co-operation. It may be that the development of institutions at, for example, the level of the United Nations will be required to provide a focus and means of funding major research enterprises which cannot sensibly be carried out in isolation. Recent difficulties in reaching agreement in relation to agricultural trade in GATT demonstrate that this is not likely to be an easy task. So far as trade is concerned there is an agreed economic logic which the GATT attempts to implement. In the area of public goods, whilst there is general awareness of the concept, in principle, there is no agreement about what such goods are or how, when national interests conflict, different perceptions are to be reconciled. Such problems suggest not that we should back away from the

development of appropriate institutions but rather that we should speedily seek to establish a research capacity which will make it possible to articulate issues of this nature through an agreed language. Recent debates on the law of the sea, on the process of global warming and the emergence of instruments such as the Montreal Protocol all point to the need for creating an international capital of expertise in handling such issues in a multi-national framework.

THE PROBLEMS OF COMMUNICATION

Research ideas are difficult to explain. It is of their nature that they take both their author and his audience into territory which is unfamiliar. The problem is not eased because science develops its own precise language where words are sharp edged so as to avoid ambiguity. The translation of such notions to policy makers who do not share this language is difficult, both because of the novelty of the concepts and because their expression in anything other than the language of science may easily be misunderstood. Specialist radio commentaries on scientific or economic issues make a serious contribution to bridging this gap but to the professional often fail to convey precisely the point he is attempting to make.

Unevenness of communication is one of the factors which may distort the perception of public goods. Because these cannot be valued in the market place, the policy maker has to rely upon some other indication of public opinion to steer his decision. For some public goods powerful, well organised pressure groups exist. For others representation may depend on the ability of relatively inarticulate people to attract the attention of ministers or their advisers. Issues relating to food safety provide a good example of the type of problem which may result. Imperfectly understood science communicated to a scientifically illiterate public has led to exaggerated anxiety about the risks associated with additives so that companies actually market products on the claim that they contain no "E" numbers, the very symbol which was intended to reassure the user that additives used in this food were safe. Pressure group campaigns against additives also distracted consumers from the much more serious and widespread hazard of microbiological contamination. As a result too little attention to these risks may have been paid in the production and distribution of chilled and frozen goods and their handling in the domestic kitchen. The incidence of *Salmonella* infections has increased dramatically and public confidence in the safety of food has been seriously damaged. [Central Public Health Laboratory Service: regularly published statistics.] "With *Listeria monocytogenes* the number of reported cases of listeriosis have increased from 25 in 1967 to 291 in 1988, with a near doubling between 1986 and 1987, although the increase in 1988 was much less." Waites (1990, p28-30).]

If we are to benefit from research related to public goods we need to obtain a proper sense of their relative importance and to do this the research community has to study to make its potential evident to those who form opinion and who ultimately make policy. The expenditures which are required are substantial and those who vote for them need to be able to justify their action to constituencies who may have little time for benefits they find hard to identify but are keenly aware of 'other things' which they would like to have done with the money.

The question of communication is not just a one way traffic. The research community needs too to listen to the concerns expressed by various groups within society and ensure that, where appropriate, these are translated into researchable topics. One of the strengths of research in agriculture and food has been its ability to relate to the particular concerns of an identified constituency. This may well have been punished recently by the condemnation of so called 'near market' research but the importance of the transmission of problems into research and research into action suggests that when it is politically convenient this damaging distinction will be dropped. The research community has, however, to recognise that, to an important extent, its constituency has changed. In the area of public goods, where there is no market, research must depend on government support. If that is to be secured government agencies need to be aware that support for such enquiries is a political imperative. For that to be the case the research community must be seen to be delivering goods which the ultimate sponsor, the taxpayer, recognises as value for money.

Industries which seek to persuade consumers to part with their pounds make it their business to find out what is wanted and to explain how their product meets the need. Often a substantial share of their total expenditure is devoted to such purposes. The motivation for is clear: by stimulating sales revenues are increased more than costs and profits rise. To prosper they still have to have an efficient production process which is capable of delivering the product when and where it is wanted at a competitive price. The analogy with research related to public goods is close. It has to be seen to relate to issues which the customer, in this case the taxpayer, regards as important. To achieve that we need to know what those issues are and we need to explain how research relates to them. If we fail on this score we may have the most efficient research 'production' system possible but it will still fail. Since the constituency for agricultural and food research is now changed, at least in part, the research community, if it is to meet the social needs for its services, must communicate better.

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