Lord David Sainsbury's Presidential address to the British Association.

SCIENCE AND HUMAN PROGRESS

It gives me great pleasure for three reasons to speak to you this afternoon. Firstly, as someone who has an interest in neuroscience I feel honoured in giving this address to follow in the footsteps of such great scientists as Sir Charles Sherrington, Sir Andrew Huxley and Lord Adrian.

Secondly, as an enthusiastic supporter of Science Cities, I am delighted to be making this speech in Birmingham, one of England's six science cities. And, thirdly, I am extremely pleased as part of my address on 'Science and Human Progress' to have the opportunity today to talk about 'the public engagement with science'. During the eight years I was Minister of Science and Innovation I gave speeches and wrote policy documents on practically every aspect of science policy, but I was not encouraged by my civil servants to talk about the 'public engagement with science' due to my well-known views on the genetic modification of plants, and what they regarded as my insane desire to communicate clearly my ideas to other people. I did, however, during my time as a Minister form some clear views about how the public debate about scientific issues could be improved, and I am extremely pleased to have this opportunity to talk about them today.

I first discovered the excitement of science when I was an undergraduate at Cambridge in the late 1950s and early 1960s. At that time I also formed the view that science and technology had a key role to play in reducing poverty in the developing world and solving the UK's economic problems.

I remember reading C P Snow's 'The Two Cultures and the Scientific Revolution' and being impressed not by his conception of the two cultures, which I have never found particularly helpful, but by his argument that science and technology are of vital importance for the developing world.

I remember reading and being totally convinced by the passage in which he said:

"Industrialisation is the only hope of the poor. I use the word 'hope' in a wide and prosaic sense. I have not much use for the moral sensibility of anyone who is too refined to use it so. It is all very well for us, sitting pretty, to think that material standards of living don't matter all that much. It is all very well for one, as a personal choice, to reject industrialisation – do a modern Walden, if you like, and if you go without much food, see most of your children die in infancy, despise the comforts of literacy, accept twenty years off your own life, then I respect you for

the strength of your aesthetic revulsion. But I don't respect you in the slightest if even passively, you try to impose the same choice on others who are not free to choose".

I also remember hearing Harold Wilson opening the scientific debate at the Labour Party's Annual Conference in Scarborough in 1963, when he talked about a Britain which was going to be forged in the white heat of the scientific revolution, and ignorant then of both science and industry, being nevertheless convinced that this was the way forward for the country.

This morning, looking back on those youthful views, I want to ask three questions. Firstly, am I right to still hold those views or should I have long ago abandoned them as an example of youthful idealism? Secondly, is it important that people, and particularly young people, have today a similarly optimistic view about the power of science and technology to help society solve the problems it faces? And, thirdly, if the answer to the first two questions is yes, how do we raise the level of debate about these issues and make the public engagement with science effective?

I think I can answer the first question very simply. I still hold the view that science and technology can help us solve the problems we face, and I think I have good reasons for doing so. If I look back over my working life, and look at the position in 2005 compared with 1955, what is extraordinary is the extent that the average person's life in both the developed and developing countries has improved as the result of science and technology; life expectancy has increased from a global figure at birth 50 years ago of 46 years to 64 years today, the proportion of the global population that is chronically hungry has fallen from 37% to 17% and the total numbers from 1.4 billion to 1 billion, and a mother today will bury only a third of the children that she would have done in the earlier period. More than 80% of all adults in the world today are literate, up from 73% in 1985, and the literacy rate continues to grow by about half of 1 per cent annually.

The poor have also done better than the rich. The poor in the developing world grew their consumption twice as fast as the world as a whole between 1980 and 2000. The Chinese are ten times as rich and live twenty-eight years longer than they did fifty years ago. The raw number of people living in absolute poverty, defined as less than a 1985 dollar a day, has fallen since the 1950s, and the percentage living in such absolute poverty has dropped by more than half, to less than 18%. The end result of most of these figures is still appalling but I quote them to show that progress can be made, and that if we are prepared to put in the necessary resources and effort, the situation can be greatly improved.

There are, of course, those who will say that none of this has anything to do with science and technology, that what we are seeing is simply the working of the market economy, but the progress we have seen could not have taken place without the major advances in science and technology which occurred. None of the developing countries which have grown fast in the

last fifty years have done so without introducing the basic institutions which underpin a market economy such as property rights, effective financial and labour markets and a good educational system. But if we look in detail at the economic growth of developing countries which have economically 'taken off' what is striking is that for any particular period of time the countries which have grown fastest are those which have started furthest behind the leading edge of technology. How have they been able to do this? The answer is, of course, that they have imported technology from the Developed World, and those who started furthest behind have been able to take the biggest steps forward.

Looking forward, and focusing on what must be one of the two or three most difficult problems the world faces, namely, the problem of how we feed 9 billion people in 2050, I also believe that science and technology can provide a way to meet that challenge if we are prepared to make available the necessary resources and do not put unnecessary barriers in the way of innovation.

I have two reasons for being optimistic about the ability of science and technology to play a major role in meeting this challenge. The first is that the Green Revolution in India has shown what can be done if science and technology is used forcefully to deal with a major crisis. Let me remind you of the basic facts of that remarkable story.

In the mid-1960s India seemed to be on the brink of mass famine. People were starving in growing numbers because of a drought, and the country was in the midst of a population explosion. There was little new land to bring into cultivation, and five million tonnes of food aid from America was all that prevented India from being devastated by mass starvation.

Between 1963 and 1966, however, the scientist Norman Borlaug introduced into India the varieties of dwarf wheat which he had developed in Mexico and which had already trebled the yields there. Initially he was opposed by the Indian bureaucracy, but by the summer of 1965 the famine became so acute that the government stepped in and allowed his project to go ahead. As a result of the introduction of the new varieties yields in India increased from 12.3 million tons in 1965 to 20.1 million tons in 1970.

It is also interesting to note that it was in 1968 that the environmentalist Paul Erhlich produced his bestseller 'The Population Bomb' in which he said "The battle to feed all of humanity is over. In the 1970's and 1980's hundreds of millions of people will starve to death in spite of any crash programs embarked upon now. He added, "I have yet to meet anyone familiar with the situation who thinks India will be self-sufficient in food by 1971" and "India couldn't possibly feed two hundred million more people by 1980". However, by 1974 India was a net exporter of wheat. Norman Borlaug was awarded the Nobel Peace Prize in 1970. The use of Borlaug's

wheat varieties also had a substantial effect on production in six Latin American countries and six countries in the Near and Middle East. His work also led to the development of high-yield semi-dwarf rice cultures at the International Rice Research Institute and at China's Hunan Rice Research Institute.

There are very few people who could have claimed to have saved the lives of millions of people, but I think Norman Borlaug could have if he had wanted to do so.

My second reason for optimism is that we are in the early years of what historians of science and technology call 'a new general purpose technology', biotechnology. General purpose technologies begin as fairly simple technologies with a limited number of uses, and then evolve into much more complex technologies with dramatic expansions in the range of their use across economies, and in the range of economic outputs that they help to produce. As they diffuse through the economy their efficiency improves. Another of their features is that it usually takes up to 50 years for them to reach maturity. Steam and electricity are examples of general purpose technologies, and ICT is another example, which only in the last fifteen years has begun to have a major impact across the whole economy, although, of course, the Internet traces its origins back to the 1960s.

If we brought into use large amounts of extra land, which we could do, it would not be too difficult a task to feed nine billion people by 2050. But the Royal Society has argued, rightly I think, that this would damage eco systems and biodiversity, and instead we need 'sustainable intensification'. I believe that this can be achieved to a large extent by the development and diffusion of good agricultural practice, and the provision of good extension services, an area which has been badly neglected in many countries in recent years.

What does this mean in practice? Let me give you an example from my own personal experience, the so-called push-pull system of integrated pest management in maize crops that has been developed by the International Centre for Insect Physiology and Ecology in Kenya and Rothamsted research, and which is described in the Royal Society Report 'Reaping the benefits'. This is a simple but highly effective way of dealing with stem borers, a pest which can cause yield losses of 30 – 40% in maize.

It consists of intercropping the rows of maize with a legume, Desmodium, and surrounding the maize field with Napier grass. The Desmodium releases chemicals which repel the stem borer. At the same time the Napier grass is more attractive to moths than maize for laying their eggs, but produces a gum-like substance which kills the pest when the stem borer larvae enter the stem. The Desmodium has the additional benefit of fixing atmospheric nitrogen, thereby contributing to soil nutrition and of being toxic to the Striga weed which is also a major problem for maize in East Africa. Finally, both the Napier grass and Desmodium are useful as forage crops for cattle and goats.

However, while I believe that a great deal can be achieved by improving agricultural practice, I think it would be wrong to rule out the use of GM techniques in meeting the challenge of feeding nine billion people in 2050. In areas such as dealing with abiotic stress, that is the impact of non-living factors such as drought, salinity, heat and toxic metals, and with improving disease resistance, the use of GM techniques are likely to be able to make a major contribution.

For example, a new race of wheat stem rust, UG99, was identified in Uganda in 1998. UG99 spread in 2006 to Yemen and Sudan, has now reached Iran, and is predicted to spread towards North Africa, the Middle East and West South Asia, where large areas of susceptible wheat varieties are grown under conditions favourable to the fungus. This could be a catastrophe, and it may well be that the best way to find a durable resistance to it will be through the use of G.M.

The idea that GM technology is something that could greatly benefit the Developing World and our environment is not something that I have suddenly discovered. When twenty-five yeas ago it first became clear that the new knowledge of genetics could be applied to plants, it seemed to me that with imagination it was not difficult to see ways that it could be used to benefit the Developing World and the environment.

That is why at the time I funded through my Charitable Trust the setting-up of the Sainsbury Laboratory in Norwich to do research on disease resistance in plants, and I am proud to say that this Laboratory is today one of the leading research laboratories in the world in that field.

I should also add that nothing has happened in the last twenty-five years to make me change my views on this point, and I remain amazed that the environmentalists, to me arbitrarily, and on the basis of no proper scientific evidence, decided at some point that GM was inherently a bad thing for the environment. I also find it odd that people who so strongly support climate change science so relentlessly ignore or dismiss the views of scientists about GM.

I think I should also say on this occasion that I am encouraged to take an optimistic view about the application of science and technology in the Developing World by what happened after the Presidential address of a previous President of the British Association. In 1898 the eminent British chemist, Sir William Crookes, gave his Presidential address to this association on “The Wheat Problem”. In it he argued that, given the growing population and the lack of suitable new land to cultivate in the Americas, all civilisations stood in deadly peril of not having enough to eat unless nitrogen could be chemically ‘fixed’ from the air by some scientific process. Within fifteen years, of course, Fritz Haber and Carl Bosch had invented a way of making large quantities of inorganic nitrogen fertiliser from steam, methane and air.

Having made these optimistic remarks about the application of science and technology to the problems of the Developing World, I hasten to add that I do not think that the diffusion of new

technology in the Developed or the Developing world is easy, involving as it often does the politically difficult task of reforming a country's institutions, but if there is an understanding of the issues and the necessary political will exists I think it can be done.

I also, of course, do not believe that progress advances in an unbroken straight line without reverses and deviations. If history teaches us one thing it is that civilisations rise and fall, and that progress is not continuous either in time or place. It may also be the case that a belief in progress rises and falls with civilisations. As the historian, E.H. Carr wrote "Belief in progress means belief not in any automatic or inevitable process, but in the progressive development of human potentialities".

Let me now turn to the second question I raised, 'Is it important that people, and particularly young people, have today a similarly optimistic view about the power of science and technology to help society solve the problems it faces? I think for two reasons it is extremely important.

Firstly, in both the developed and the developing world it is important that some of the brightest and best young people take up careers in science and technology. In the U.K. today we cannot compete against countries like China who have 5% of our wage costs on the basis of low costs. We have to compete on the basis of innovation, and that means upgrading our industries and going into higher-value, more knowledge-intensive areas. In the Developing World there is also a desperate need for more skilled people whether they are engineers, agricultural experts or doctors. Goodwill and enthusiasm are not enough.

Secondly, the use of new technologies to solve major social problems depends on people not blocking new technologies because of an unnecessary concern about the risks involved.

I would like to turn now to the third question I asked at the start of this address. If it is the case that science and technology can play a major role in solving the problems we face, and if it is true that to reap the benefits of new technologies we need the enthusiastic support of people, how do we raise the level of public debate on these issues and enable the public to make up their minds on the basis of the best possible scientific advice?

To be able to answer this question I think it is necessary first of all to understand people's views about science and how they deal with risk in their lives. It might be thought from reading newspapers or watching the television that people in this country are anti-science. A useful survey in 2000 reported, however, that 84% of people in Britain believe 'scientists and engineers make a valuable contribution to society, and that 68% say that 'scientists want to make life better for the average person'. However, the poll also showed that roughly half thought that the pace of current scientific advance was too fast for government to keep up with through effective oversight and regulation.

The problem we face is not that people are against science but that they are concerned about the pace of modern advance. I don't find this in any way surprising. If one looks back in history one finds that there has always been a distrust of new ideas and new technologies, whether it was the introduction of vaccinations, cars or trains.

The second point to make is that the distrust of new ideas and technologies is not due to a failure of people to understand the science. When I was first Minister of Science and Innovation there was an initiative called the 'public understanding of science'. This was in its time a very forward-looking project, and was based on the assumption that if people knew more about science they would automatically look more favourably on science. But as Lord May pointed out in his 2002 Anniversary address as President of the Royal Society, unfortunately this is not the case. A study done a number of years ago of the then 15 E U countries looked at the general level of scientific knowledge in each country. People were then asked whether they thought 'science had made life better?' Everyone said yes, but those countries scoring lowest on scientific understanding were in general the most unequivocally enthusiastic. We should not be surprised by this finding. A good education in science should lead people to ask questions about the impact of science.

A second reason that scientists give for the public's distrust of new ideas and technologies is that people do not understand risk. I have to say that I find this argument unconvincing. All my experience suggests that most people have a good understanding of risk, and I don't believe that if people know that something has a low risk of happening they immediately cease to worry about it.

So what are the factors which affect people's response to risk? I think there are three. The first is whether an activity is voluntary or not. People will, for example, respond very differently to an invitation to go mountaineering, which can be very dangerous but which is a voluntary activity, and to a nuclear power plant being built on their doorstep which is an activity where they have no choice. I think it is this factor which accounts for the curious fact that after a train crash a lot of people start using their cars more, which, of course, increases their level of risk. The reason they do it is that they feel they are more in control.

The second factor which affects people's view of new ideas and technologies is what they perceive to be the balance of risk and reward. Why, for example, have people reacted so differently to the introduction of GM foods and mobile phones? The answer is that people believe that their mobile phones bring them major benefits, and are, therefore, prepared to live with the risks. In the case of GM foods, however, the initial products had very little appeal to consumers. 5p off the price of tomato paste is not seen by most people as a good reason for taking extra risks. I remember Lord May saying at the time when the row about GM products

was at its height, “As soon as a GM product is invented, which if you take a tablespoon of it each morning, you will be slim and witty all day, this whole issue will go away.”

The third factor which affects people’s response to risk is the performance of government. People expect government to assess the risks of new technologies, and to halt them if they need to be, and to mitigate them if they need to be mitigated, and at all times to keep people properly informed. And people become very angry if they feel that the government is not doing this job properly or is in any way hiding the facts from them.

It is these factors, I think, which explain the very different reactions in recent years to the extension of the areas in which research on embryonic stem cells would be permitted and the introduction of GM foods.

In the case of embryonic stem cells there had been a long and public debate which began with the Committee of Enquiry which Mary Warnock chaired in 1982, and the essential principle, following debate about benefits against ethical concerns, had originally been settled 10 years earlier in the Warnock legislation which permitted such research directed to achieving increases in fertility. Two further reports were produced and, as a result, when the issue came to the Houses of Parliament, everyone was well informed. The debate was also strongly influenced by the fact that many of the patient groups such as the Parkinson Society pressed for the legislation to be passed on the grounds that it would bring benefits to their members. As a result the legislation was passed with clear majorities in both Houses of Parliament of 2 to 1.

In the case of GM foods on the other hand it seemed to most people that there were unknown risks involved, that GM foods were being forced on to people, and that the government was not in control of the situation. As a result of this climate of opinion, and the arrogant position taken by Monsanto, a public debate flared up which was badly informed, was carried out in an atmosphere of general distrust, and was fuelled by wild accusations. It is not something that any of us should feel proud about, and the public has every reason to feel aggrieved that they were not given a chance to consider all the evidence carefully and to come to their own judgement.

So what can scientists and governments do to improve the public debate of these issues and enable the public to make up their minds on the basis of the best possible scientific advice? The most important thing that needs to happen is that when a new technology looks as if it will produce new products, the scientific community is asked to lead an open and public debate about the ethical, health, safety and environmental issues raised.

The way that this debate is conducted is also very important. Firstly, it is important that the debate takes place upstream, that is early in the development process, because if it takes

place only when the first problems arise, the debate will already have been lost as far as the public are concerned. Secondly, it is important that the debate is open and public, that everyone has an opportunity to state their case, and that all the evidence is published. And, thirdly, it is important that everyone is clear that what the scientists are being asked to consider is the ethical, health, safety and environmental issues involved, and not whether in some way a technology is a good or bad one. It is not possible to say what impact a new technology will have over its life. If one doubts this point one has only to consider the position of a person asked this question, about computers in the 1940s, when Thomas Watson, the Chairman of IBM at that time thought that the world might only have a need for five of them. In any case, if there are no ethical, health, safety or environmental issues involved I do not think it is necessary for governments to take a position.

If these simple rules are followed, then I believe that the level of debate about new technologies can be improved, and the public engagement with science can be effective. And because I believe in the innate good sense of people I believe they will accept modern advances in sciences when they deserve to be accepted.

You may feel that, once again, I am demonstrating a youthful idealism which is not productive when debating these issues, but in 2003 the Government did show how this approach can work when it asked the Royal Society and the Royal Academy of Engineering to look at the regulatory issues raised by nanotechnology, and to do so openly and publicly. This they did, and an excellent report was produced, which said that nanotechnology did not present any problems, except in the case of free nanoparticles where there might be a health issue and where more research needed to be done. This report was widely accepted and has provided a way forward for everyone.

The way the report was produced is important. An excellent working group was set up which was chaired by Professor Ann Dowling, the Professor of Mechanical Engineering at Cambridge, and included two experts on nanotechnology, but also Professor Roland Clift, the Director of the Centre for Environmental Strategy at the University of Surrey, Baroness Onora O'Neil, a philosopher from Cambridge, Professor Anthony Seaton, the Emeritus Professor of Environmental and Occupational Medicine, University of Aberdeen and Jonathan Porrit, the Chair of the U.K. Sustainable Development Commission and Programme Director of Forum of the Future. Like all Royal Society Reports the report of the working group was also reviewed by a further panel of experts.

I have described the membership of the working group because it was, I believe, a good example of the sort of people who should be asked to be members of such a group. The working group was not made up of a narrow group of scientists concerned with the particular area of research under review, but consisted of a wide range of experts able to review it from a

number of perspectives. Equally, it was not made up of a range of people with no relevant expertise and no reason to be included other than that they represent small interest groups.

Looking back on my time as Minister of Science and Innovation I think that there were two issues in this area which went badly wrong. The first was GM foods and the second was MMR. The MMR issue has now been sorted out, but the GM food issue remains unresolved. As every year the amount of land across the world planted with GM crops expands, and today 10% of all arable land, thirty million acres, is growing genetically modified crops, without serious problems, and as it becomes increasingly clear what a contribution GM foods can make to the Developing World, I think we need to have that debate again. To improve the level of that debate I also think that the Government should now ask, say, the Royal Society and the Academy of Medical Sciences to review openly and publicly the current position on GM technology so that the Government and the public can make up their minds on this issue on the basis of the best scientific advice. And if this is done I believe it will be seen that plant biotechnology is another case of a new technology which can help the world solve one of its most difficult problems.

In most areas of my life looking back at my youthful views I often feel embarrassed, but looking back at my undergraduate view that science and technology has a key role to play in reducing poverty in the developing world and solving the U.K.'s economic problems, I find my views have altered very little. I do, however, today believe very strongly that we need to improve what the late Senator Robert Kennedy called 'the intelligence of our public debate' if we are to realise those benefits.