A talk at the Royal Society:
why science and agricultural science in particular need to be rescued and generally re-thought
By Colin Tudge

Many thanks first of all to the Royal Society for inviting me to say what I think, right here at the heart of science itself.

My thesis is that science is in a truly terrible state. For its own sake and for the sake of all of us, it needs rescuing. Scientists are losing sight of what science is for—what its role in the world as a whole should be; and indeed they seem largely to have lost sight of what it is. Above all, science is a search for things that are true, and for this it deserves our respect and gratitude. But wherever we look these days we see scientists themselves, or people ostensibly speaking on behalf of science, compromising the truth. Scientists are wont to blame all misrepresentation on some nebulous entity known as “the media”. But by far the most important misrepresentations come from within science itself.

I hate to quote Tony Blair but I think he summarised much of what needs doing with his slogan, “Education, education, education”. But I don't think education in this context means what the scientists themselves have taken it to mean. Thus about 20 years ago the Royal Society and a few other like-minded institutions began their programme for the Public Understanding of Science, known both to friends and enemies as PUS. The general notion was that people at large—known as “the public”—were mistrusting science because they did not understand it. If only “the public” knew more of the mysteries of nuclear power or of genetic engineering then surely they would see that everything that's done is for their benefit, and clamour for more public funding.

PUS has done some good things and arranged some true discussions. But on the whole the flow of information has been de haute en bas, from the scientists who are presumed to know, down to the great unwashed who are alleged to be “ignorant”. “Public ignorance” is an expression I seem to have heard all too often. But it's the scientists who need educating, and fast: not only about the realities of world politics, and the ways in which their efforts in reality affect people's lives; but also, strange though it may seem, they need educating in science itself—particularly in the philosophy of science: what science actually is, what it can do, and what its limitations are.

I will argue my case in one applied field and one “pure” field. On the “applied” front— which really means “high tech”— I will discuss the roles and the serious shortcomings of science in its efforts to help—or indeed to hinder—the production of food: which on the material front is surely humanity's most important endeavour of all. In the context of “pure” science, the world of ideas, I will look briefly at what some scientists have recently been saying in public about religion. On the whole their pronouncements in this area have been so bad, so ill-informed, that it really is not surprising that so many people at large, “the public”, express such disquiet and disillusionment.

So: let's begin with the world's food supply—and see how science has so disastrously lost its way.

I'll begin with a little slogan, which is that:

All of us, everyone in the world, could be well fed.
Indeed, everyone in the world who is ever likely to be born could be fed to the highest standards of
gastronomy as well as of nutrition, effectively forever. In doing the things that would feed everybody well
we would at the same time create environments that are beautiful to look at and are wildlife friendly, and
integrate readily with the remaining areas of true wilderness. Agriculture that fed us well and sustainably
would also be kind to livestock. Finally, and perhaps most crucially, such agriculture would again emerge
as the greatest single employer in virtually every country, providing the basis of agrarian economies that
would and should be the foundation for all other endeavours. All this—a basically sound life in a basically
sound environment—could be achieved with techniques that already exist—but especially with extra help
from science and high tech.

In reality, and in absolute contrast, as we see on television almost every night, we have created a world in
which almost a billion people are chronically undernourished; another billion are horrifically overnourished,
so that obesity and diabetes are epidemic, and rising; a billion live on less than two dollars a day; a billion
live in urban slums—a figure that is on course to double over the next half century; and that's out of a
total world population of about six billion. At the same time, other species are disappearing so fast that
biologists speak of mass extinction.

All this amounts to disaster—not in some distant future, but right now. All other setbacks that cause such
public hand-wringing are small beer by comparison. Our own government, and that of the George W
Bush, affect to see “terrorism” as the world's greatest threat, and both governments have given
themselves unprecedented powers on the back of it. Whatever terrorism is supposed to be it is nothing
compared to what is being done to the world's food supply and to the fabric of the world as a whole—not
by alleged fanatical miscreants but as a matter of official policy, supported by public money.

Yet our response is not to analyse what is really going wrong, and get to the roots of it, and put it right.
Our response—or rather the response of our governments and the corporates whose interests they
serve—is to offer more of the same—more of the same policies and methods that have caused the
disasters in the first place; that, plus occasional public orgies of grief and concern, tempered by the
wearing of red noses.

But if we really want humanity to live well—and here's another slogan—We have to design agriculture
specifically to feed people. It's that easy, and it's that obvious.

In my latest book, So Shall We Reap, I call farming that is designed to feed people, “Enlightened
Agriculture”. It is a high-fallutin' term—but in essence enlightened agriculture is irreducibly simple—
commonsensical, and in structure, traditional. The point is simply to accept the realities of climate and
water supply, and play to the strengths of the landscape, and of the physiology of livestock and crops.

In practice, this means giving the best land to horticulture (fruit and vegetables)—which needs good land
but doesn't need a lot of it. The next best land is dedicated to the staples, the crops that really feed us:
cereals and pulses and tubers—and these are grown on the large “field” scale known as “arable”.
Livestock should then fit in as and where they can—basically, the ruminants such as cattle and sheep feed
on grass and browse (meaning the leaves and branches of trees) and pigs and poultry feed on surpluses
and leftovers. When you fit livestock in this way you complement the growing of crops. You don't produce
a lot of meat, eggs, and milk by keeping livestock in subsidiary roles but what you do produce is very good indeed.

In general—not all the time, but as the default position—farms should be small (typically run by families), and they should be mixed—mixtures of different crops and livestock. In general they should produce a huge variety of good things to eat. Indeed in overall structure, the output of the farm should roughly reflect that of the surrounding landscape—and hence it should be as sustainable as the natural landscape is.

Now we come to the point that should be written in six foot letters above the heads of everyone who has anything at all to do with food policy. It is—that the principles and methods of enlightened agriculture as thus defined accord perfectly with the recommendations of modern nutritionists, and with the techniques and methods of traditional cooking—and traditional cooking is the source of all the finest cuisine. In other words, good commonsense farming, sound nutrition, and the best cooking, go hand in hand. Good nutrition doesn’t mean austerity, lentils and garlic bake. It means great traditional cooking.

How could it be otherwise? Farms with the structure I have described would produce plants in large quantities, and in enormous variety; and livestock in small quantities, with the best possible flavour and texture. Such farms would thus provide diets that are high in unrefined carbohydrate and high in fibre. The diet from such farms provides a modest amount of protein; is low in saturated fat; but provides a wide variety of plant-based unsaturated fats. Finally, the traditional produce of the traditionally structured farm is maximally various, and that takes care of micronutrients—minerals and vitamins and so on. It is exactly what modern nutritionists recommend.

And all traditional cuisine is based on what grows locally, for again, how could it be otherwise? All traditional cuisines are very heavily weighted towards staples—wheat in northern climes, rice in the wet tropics, maize in slightly warmer climes, sorghum and cassava in the dry tropics, and so on. All traditional cuisines are rich in vegetables and fruit. All make only sparing use of meat—primarily as stock, as garnish, or for the occasional feast. And whereas in the modern supermarket you can buy only chops and steaks and the occasional bit of liver, officially authorised and incised by a fully qualified vet, traditional cuisines make use of all of the beast. Two of the most memorable meals I have had in recent months were tripe in Switzerland, and the head meat of boar in Spain. Try buying those in Tesco’s.

So called haute cuisine, when it is any good at all—for often it’s just specious rubbish—is rooted in traditional cuisines. When France was at the height of its culinary reputation half of the diet even among the rich was bread—but it was very good bread. The Turks make miraculously fine meals out of cracked wheat, broad beans and chick peas, olive oil, almonds and walnuts, figs and honey, and the odd goat if one happens to have died that week. I exaggerate, but not much. I’m told that the Ancient Egyptian cuisine was much the same. In traditional village India—again I was there recently—you can eat wonderfully for pennies—and not just because of the exchange rate, but because the food is what grows easily, locally, and with minimum fuss. Modernity so called hasn’t yet caught up with much of India, thank goodness. The people so far are much better placed than in Central America for example, where modernity is poured in from the north.
Finally, enlightened agriculture—which in essence is traditional agriculture—is bound to employ a lot of people. Truly to farm well, and kindly, and sustainably, requires attention to detail—what used to be called “tender loving care”. It is also intricate—it depends on a wide variety of livestock and crops, all carefully integrated. In other words, farming that is truly designed to feed people also needs to employ a lot of people.

So everything seems in principle to be working in our favour. Sustainable farming is also kind, and it looks good, and it provides us with the best possible nutrition and cuisine, and it can provide most of the people in the world with satisfying jobs.

So what has gone wrong? Why do we have a billion undernourished and a billion overfed and rising, and a billion in slums and so on and so on?

The simple answer is that agriculture as it now stands is not designed to feed people. Still less is it designed to be sustainable—which in essence means gearing it to the realities of the environment and the climate. Still less is it intended to be kind to livestock. Least of all is it designed to employ people.

In practice we go to astonishing lengths, investing billions of pounds and dollars of taxpayers' and consumers' money, creating a system of agriculture that has absolutely nothing to do with feeding people at all, or with any of the other socially and environmentally useful things that agriculture is supposed to do. Given that the system is not designed to feed people, it really is entirely unsurprising that it fails to do so.

But if modern agriculture is not designed to feed people, then what is it designed for?

The answer to this is encapsulated in yet another slogan—indeed it has become a mantra—that I first heard in the 1970s. From the ‘80s onwards this mantra was carved above the doors of all of Britain's colleges of agriculture—most of which, not surprisingly, have since closed down, because there is very little room in modern Britain for agriculturalists. (The British economy these days is based on service industries, whatever they may be).

This all-pervasive mantra says quite simply that “Agriculture is a business like any other”.

One might immediately protest that all businesses are different, and as George Orwell might have put it, agriculture is more different than most.

But the 1970s, looking back, was still a relatively innocent time—and in the context of that time the mantra could seem innocuous enough. It had the ring of no-nonsense common sense, suggesting on the one hand that farmers ought to keep better accounts than they had sometimes done, and also suggested in a breezy kind of way that the gap between country and town should be closed somewhat. Business provides the common link between town and country. So the general advice to farmers to be more business-like, didn't at the time seem too threatening.

But much bigger changes were to come. First we had the monetarism of the 1980s, pushed by Margaret Thatcher’s government. Suddenly everything was to be expressed in cash terms—“the cost of everything and the value of nothing” as Oscar Wilde might have put it; and success of all kinds and in all fields was to
be measured in how much cash was generated. Accountants were no longer employed simply to keep count. Increasingly they dictated policy.

And hard on the heels of monetarism came the idea of the global market, with universal free trade, summarised as “neoliberalism”. Neoliberalism in turn is driven by the idea of “competition”. Those who don’t play the money game to the full will be ousted by those who do. The money game has become the only game in town.

Overall, the success of countries is now measured in GDP—the total amount of cash they generate. GDP, as John Maynard Keynes no less pointed out in the 1930s, when the idea was still new, has almost nothing to do with human wellbeing. It is not intended to measure human wellbeing. But in the modern world economy, rising GDP is taken as the measure of a society's success. The “economic growth” that Gordon Brown dangles before us as the great desideratum simply means increase in GDP. (And Gordon Brown is one of the good guys).

GDP can be increased, so the world's leading economists and politicians now assure us, by increasing trade.

A prime victim of this focus on disposable money is the concept—which should be a fine and noble concept—of “development”. Development, one feels, ought to mean increase in human wellbeing and in autonomy, both personal and of the society as a whole; increased opportunities for people to be themselves. Now it just means having more money. “Development” is now conflation with “the war on poverty”—which in truth is a disastrous over-simplification: truly a dumbing down. The “war on poverty” in turn is to be fought by trade, trade, and more trade. This trade is supposed to be “free”, and global, and all this in some mysterious way is supposed to solve everybody's problems. It is difficult to imagine that the world's leading governments and think-tanks can be quite so gross—but, apparently, they are. (I remain incredulous, but the evidence is all around).

But although trade is increasingly global it is far from free, and it is most spectacularly un-free in agriculture, where the annual subsidies paid to EU farmers and particularly to US farmers far exceed the total GDP of most countries in the world—even though those countries in theory are supposed to be competing on a level playing field. So it is that in all the rounds of trade talks, the Third World countries protest most loudly about the agricultural subsidies of the west, which indeed make a complete nonsense of the whole idea of the free global market. The inequity falls most heavily on the Third World countries precisely because agriculture is the only field in which most of them have any chance of gaining any toe-hold at all in the new global economy. But the rich countries cannot give up their farming subsidies without huge social disruption, and upsetting a lot of powerful people, and this is not on their agenda.

But there is worse. Third World countries in general cannot get anything at all out of the global market except by growing and selling commodity crops specifically for export—coffee, fruit, palm oil, and, these days, soya for European cattle, to encourage Europeans to over-eat even more than they do already. In order to produce commodity crops in worthwhile amounts and to the required (and largely arbitrary) market standards, Third World countries have to re-design their own agriculture. Furthermore, to conform to the laws of global trade, they are obliged to admit imports from others as the quid pro quo for exporting. So it is for example that Senegal now devotes half its land to ground nuts. Cost Rica (I was there
a few months ago) is a wonderful example of modernity in practice. It has given up growing maize and beans in its quaint old fashioned way, and now buys in American surpluses. It also has a brand new computer industry, which I'm told has added 25 per cent to its GDP. Gets better and better. Unfortunately, computers employ only a few thousand people while traditional farming employed millions—and although the American food is apparently cheap to import it is expensive to buy in the shops. Never mind the misery, feel the economic growth. That's progress.

So overall we have the absurd situation in which the economic system that is now so enthusiastically embraced by the world's most powerful governments and corporates cannot work in the field of agriculture, which is where it matters most: and it would very bad indeed if it did work. Meanwhile the efforts to make it work are destroying what's there, without providing any satisfactory substitute. How strange that we should have allowed such a state as this to come to pass.

But why shouldn't the new economy work in the long-term interests of humankind? We can see the answer to this just by going back to the mantra in its relatively innocent, pristine form—“agriculture is just a business like any other”. Even without the extra neoliberal trappings of monetarism and the allegedly free global market, that is enough to lead us on the road to perdition.

For in order to succeed in business—any business—you have to do three things; and all of them detract, absolutely, from the goal of providing all of humanity with good food, on a sustainable basis. In other words, the simple business mantra, even without the neoliberal elaborations, is antipathetic to the idea of enlightened agriculture. In fact for the past 30 odd years the world has been assiduously creating systems of agriculture, which are now being applied worldwide—or that at least is the intention—that are expressly not designed to feed people.

The first of the three requirements if you want to succeed in business, is to maximise turnover, meaning output. Farmers qua businesspeople qua world traders are now exhorted to produce as much as possible—maximise yields on the greatest possible area. Farming now ventures far into marginal lands, and wilderness is compromised for no good reason at all —witness all those cattle in the Mojave desert, or the wheat that's grown on the hills of Greece or to the edges of the cliffs in Cornwall. Agriculturally speaking, this is nonsense. Correspondingly, consumers are urged to eat more and more—which means, since marketing clearly works, that the epidemic of obesity and all that goes with it, is inevitable.

The second of the three requirements for a flourishing business is to add value. In food, this results in massive gratuitous waste: all that packaging; an endless catalogue of additives, largely untested (at least in their infinite combinations); allegedly “fresh”, and certainly out-of-season, fruit and vegetables whisked by jumbo jet across the world—maximally polluting, yet subsidised by tax-free aircraft fuel. (And Tony Blair now wants us to believe he is taking global warming seriously).

But above all, value adding means producing more and more meat.

Livestock production continues to increase hand over fist over all the world and despite some reforms here and there, worldwide it is becoming more and more intensive. Some “modern” pig units contain a million pigs. Received wisdom from on high has it that this is in response to “public demand”, as if human beings were out-and-out carnivores. In truth, meat is produced in greater and greater amounts in ever
more intensive systems because this is the ideal way to mop up cereals that would otherwise be in surplus. It removes the ceiling on cereal and pulse production—and the ceiling would be far too low if human beings ate the cereals and pulses in their pristine form; and it also turns food that could and should be cheap into food that is maximally expensive. Modern intensive livestock production is immensely dangerous (in the US alone 10s of thousands of tonnes of antibiotics are used each year as “growth promoters”, many of which may give rise to strains of antibiotic-resistant bacteria). It is also cruel. And it is immensely polluting.

For good measure, livestock production on such a scale is also obviously unsustainable. Traditional livestock were fed on grass (cattle and sheep) or on surpluses and leftovers (pigs and poultry). Intensively raised livestock eats staple foods that in traditional cuisines would be eaten by people. By 2050, so the UN tells us, there will be nine billion people in the world. The world’s livestock, at the present rate of increase, will consume enough to feed another four billion. But meat consumption is increasing not because human beings are frustrated polar bears, but because livestock-heavy agriculture generates more cash, which has become the point of the whole exercise, and marketing works.

The third requirement of successful business is the most damaging of all. To maximise profit the producer must minimise costs. In agriculture this means simplification of husbandry, and cheaper inputs, and generally cutting corners. With livestock in particular, cut-price husbandry is immensely dangerous. It was the direct and only cause of the epidemics of BSE and foot and mouth disease that began in Britain in recent years—and BSE, transformed into CJD, is still killing people. (We must be duly grateful that foot and mouth disease doesn’t). In fact, Britain’s livestock farming is run on a wing and a prayer—and of course we are not alone in this; and in the general cause of keeping prices down, and with proper obeisance to the ostensible ideal of free trade, we import food from countries that have even lower standards than we do, including the US.

Of course in Britain we have the much-flaunted Food Standards Agency. Its first chairman is an excellent scientist and a very nice chap but what on earth the FSA is supposed to be for is beyond me. The flaws in British agriculture are structural. If you were a virus or prion or any other kind of parasite you could hardly design a system of agriculture that was more favourable to your own propagation than the one we have designed already, in the name of good business practice. But the FSA is not concerned with structure. Probably the present chairman will be best remembered for his attack on organic farming. In truth one of the least interesting things about organic farming is the fact that it is organic. What really matters is its concern with good, basic, safe farming, environmentally and socially friendly, of the kind that is being so rigorously obliterated in the name of commerce. In a world that has so horribly lost its way, the organic movement is one of the few beacons of common sense and good practice. That the FSA should single it out for particular criticism is, to put the matter mildly, regrettable. It is also typical of allegedly independent government-appointed bodies which deal officiously with detail, but have no brief to look at anything that really matters. And we, taxpayers, of course foot the bill.

But the main way to cut costs, as you have to do in this frenetically competitive world, is to cut labour. Thomas Jefferson at the end of the 18th century conceived the newly emerging United States as “a nation of small farmers”. So it was, until well into the 20th century. Now only about one per cent of Americans
work full time on the land—there are more people in prison in the US, than are working full time on the land. Two million is the actual figure—by far the biggest in the world. Britain is much the same. So far to be sure we have fewer people in jail—but we’re getting there. The mantra has it that labour-intensive farming is just too expensive. (We bear the cost of prisons with admirable fortitude. They after all are a growth industry and therefore good for the GDP, especially when privatised).

This frantic cutting of labour is held to be “efficient”—since efficiency is measured only in cash. The biological efficiency is very low indeed, as all the subtleties of husbandry must go by the board. It is also a fake. The US has always propped up its agriculture with outside labour, first with African slaves and then when this became illegal, with Mexicans and Puerto Ricans and others who are virtually deprived of rights and so can be deported at will. (In fact they have lower status than the slaves). Britain is now following suit—propping up its threadbare farming with Brazilians, Roumanians and Poles (although the Poles often take one look and go home again). They again have dubious legal status and so are virtually without rights. So it is that 200 years of social reform has been undone at a stroke.

Actually, Britain’s whole economy is a fake. It seems to work in the short term only because the British as a whole are richer than most of the world, and we so can entice battalions of foreigners to do our dirty work for us, and buy from them at rock-bottom prices because we are richer than they are. But we are richer only because of our history—first we had our Empire, and then we were on the winning side in World War II, and then again in the Cold War. But the imbalance cannot last, even if it was morally acceptable. It is precarious and it is vile. And farming has become part of the vileness.

The world at large is being encouraged by the powers that be—western governments, corporates, and their attendant experts—to follow the western lead in all things. It is coarse to equate “development” with increase in disposable wealth. It is equally coarse to equate development with westernisation—but that, too, is what is happening. But if Third World countries follow our lead in agriculture, as they are under immense pressure to do, then we will see disaster on a scale that will make the present seem like the good times.

For in the Third World as a whole—which is most of the world—about 60 per cent of the people work on the land. In India alone, this is 600 million people. If India followed the ways of British farming, then at least half a billion people would be out of work. This is far more than the total population of the newly expanded EU and almost twice the total population of the US. Yet this is perceived as “progress”. Advocates of such “progress” speak of alternative industries. The alternatives in India are said to be IT and tourism. IT employs only tens of thousands of people—not hundreds of millions—and most of them are graduates. For most people, tourism at best offers employment as taxi drivers (you can earn £8 driving a taxi in Delhi for a mere 80 hours) or as hotel cleaners (bussed in from the suburbs or the slums before dawn, and then decorously tidied away again). Most disenfranchised farmers and their families finish up in slums. In Africa, prostitution and mercenary soldiering have been the great growth industries (although they don’t actually do much for the GDP). The girls in the bars of Bangkok are the daughters of farmers, and they send money home. They are good girls, and they love their families. That’s progress.

In truth, if you take a sober overview of the ways in which most people live, and of the alternatives, you conclude that the future economy for most of the world for the foreseeable future has got to be agrarian.
If and when urban industries can or actually do provide realistic alternatives, then might be the time to leave the land. To abandon agrarian ways before those alternative urban industries are in place, or even remotely on the horizon, is madness. To encourage mass urbanisation before the cities are ready to accommodate people seems very like wickedness. But that is what is being done. That's development. That's progress. That's neoliberalism in all its glory.

But what has all this got to with science?

Absolutely everything. The modern world is inveterately a high tech world. The global economy is inconceivable, it could not get off the ground, without IT.

More specifically, globalised agriculture means mass monoculture of crops in places where they happen to grow easily—and/or where the labour is particularly cheap, which means where the society is particularly disadvantaged. High tech alone—the application of very fancy science—enables the million-head pig unit, or the prairies of maize and rice or indeed of peaches or of cut flowers, that stretch from horizon to horizon, each bred and fertilised to give maximum yield, each employing a few day-labourers at most.

All this requires the highest of high tech—industrial chemistry, massive machinery, and now, biotechnology, which in particular means genetic engineering: endless inputs of fertilisers, pesticides, and drugs of all kinds; and then, for good measure, fleets of jumbo jets and refrigerated trucks to take it all, such as it is, to western supermarkets.

Science ought to be the world's great free spirit. It is innately radical, innately challenging. In reality, over the past few decades, it has in effect become the handmaiden of corporates. This is not entirely the fault of scientists. Since the early 1970s, beginning with Lord Rothschild's report in Britain, the notion has come about that applied science at least should be financed by the people who want to make most of use of it, which in the modern world means those who stand to make most profit from it.

As neoliberalism has come into vogue, this has meant that applied science has become locked into a positive feedback loop. Big industry supports those aspects of science that will provide the high technologies that will produce more profit for big industry which in turn is used in part to finance research, and so on and so on, round and round. Research that would produce technologies that would not be profitable to the corporates does not get financed at all.

This means that to a significant extent, scientists cannot work at all unless they take the corporate shilling. I have been assured that the purity of science is not affected by this. Pure research is still carried out in universities and government research institutions, independently of the ambitions of big business. To what extent this is true of food science is highly questionable. More to the point, what this really means is that public money finances basic ideas—but as soon as those ideas look as if they could be profitable, the opportunity to make something of them is handed over to private enterprise. So we have yet another example of taxpayers subsidising the private sector—which in turn feels no obligation to do anything that is not in its own direct interests. Indeed in this maximally competitive world economy the corporates cannot do anything that is not in their own direct financial interests, except as a piece of PR, under the heading of “corporate social responsibility” (known as “CSR”).
In fact, the principal outcome of agricultural science this past 30 years has not been significantly to increase the world's food security, but to transfer power: from millions upon millions of small farmers, into the hands of a remarkably few corporates, and of the countries in which those corporates are mainly based. It has been a massive exercise in what we might call neo-imperialism. This is vaunted as “progress”, but it might reasonably be seen as the antithesis of what “progress” and “development” ought to mean.

In fact the transfer of power from the many to the few goes well beyond agriculture. In its pristine state human society as a whole has the structure of the neural net—no one single centre of power; just the interaction of what in effect is an infinite number of quasi-independent centres. It was in such a world that Adam Smith outlined his economic vision, of everyone doing their own thing while an “invisible hand” ensured an agreeable outcome. The modern world increasingly has the structure of a steep pyramid, with a few corporates and powerful western governments at the top, and all the rest—at best—as employees and day-labourers. Apologists for this modern monolith are wont to claim that it is indeed rooted in the economics and politics of Adam Smith but again, in truth, it is the precise antithesis. The truth is again a victim.

To a significant extent scientists have been forced into their present economic-political role. If they don’t work for Monsanto or Tesco or some such, they don’t have a job at all, and they have families to feed, like all of us. But I reckon, too, that scientists have been altogether too complaisant. They have not protested enough. In the field of food production, the most important material enterprise of all, they have become principal apologists for the system itself. Either they are cynical, or they are seriously misinformed.

There is a particular irony in all this. Scientists tell us, repeatedly, often from public platforms including this one, that they should be trusted not necessarily because they are always right—no-one can guarantee such a thing—but because their thinking is rigorous. Science we are told is ultimately rational, indeed is the embodiment of rationality. The modern expression is “evidence based”. The pronouncements of science may be not be perfect, but they are the best that humanity can provide.

Yet it seems that when it comes to the application of science—the things that affect humanity most directly—this rigour largely goes out of the window. Where is the evidence that the new, high-tech, industrialised, competitive, neoliberal agriculture does or indeed ever could feed the world? To be sure, the yields of some crops have been increased here and there, in the short term—but increased yield in any one time or place has remarkably little to do with feeding the world well and forever. Bigger and bigger yields in the short term simply lead to glut—and we already have bumper world gluts in commodity crops such as coffee, which is why the world price has fallen seven-fold this past 20 years. But still Third World farmers are encouraged to grow more—because it suits the powers that be if prices go on falling. So it is that East Timor and Vietnam are now drawn in to the coffee boom, to see if they can undercut the Brazilians and Kenyans and Costa Ricans. That’s the global market that is supposed to solve all our problems.

Yet there is plenty of reason to suppose that present-day, high-tech food production cannot feed everybody well. It is bound to fail—clearly is failing—precisely because to a significant extent it obliterates the very means by which long-term security might be achieved—that is, through labour-
intensive husbandry with attention to detail, and through traditional cuisine, geared to what the local
land is best able to produce. In fact there is no evidence at all to support the idea that the new systems
can achieve what is claimed for them. It is nothing more than dogma, an idée fixe, that drives the whole
sorry system. Yet the scientists who cling to the system and are essential to it, continue to tell us how
rational they are, and how much further they can see than the rest of us.

But actually the position is even worse than that. In order to make the case for modern, high-tech
industrialised agriculture, scientists have actively to misrepresent the traditional systems that it is
replacing. They do this both on the grand scale, and in particular contexts.

Thus we have statistics—evidence, in fact—give us a quite different picture. Agriculture probably began at
least 30,000 years ago, and was practiced on a scale big enough to show up in the archaeological record
by about 10,000 years ago—the period that is commonly called the “Neolithic Revolution”.

At the time of the Neolithic Revolution, around 10,000 years ago, the world population stood at around
10 millions. Without agriculture, total human numbers probably would not have grown much beyond this.
By the time of Christ, around 8,000 years later, world numbers stood at between 100 and 300 million.
Traditional, craft farming had brought about a rise in population of 10 to 30 times.

Science itself has been told time and again this past 20 years of the pressing need to introduce the highest of
high tech the world over. In particular, we have been told over and over of the huge benefits that genetic
engineering, GMOs, will bring to Asia and the hungry millions of Africa. Those who oppose these
innovations are, we are given to understand, effete and nostalgic, in love with a golden past that never
existed. I have heard modern economists actually state that history in effect began in 1980—and many
scientists talk as if the same was true of farming. The impression is given that traditional methods are
simply inadequate, and that humanity was dying on its feet until modern agricultural science came on the
scene like the US cavalry in the fifth reel of a western.

But the rawelf in modern, recognisable form is commonly taken to have got off the ground in the 17th
century AD. The findings that underpin modern agricultural science—the beginning of soil chemistry, of
animal and plant physiology, of germ theory, of nutritional theory, and of the Mendelian genetics that
underpins modern breeding—were all laid down in the 19th century.

Nonetheless, high tech—science based tech—did not begin to make a serious impact on world farming at
least until the 1930s. Then, artificial nitrogen fertiliser became significant—it emerged from the industrial
chemistry of World War I. Tractors were becoming common by the 1930s, although horses and oxen still
provided most of the draft power over most of the world (including Britain and the US). Breeding of crops
and livestock began to incorporate Mendelian principles, and towards the end of the 1930s the world saw
the first large-scale industrial pesticides, notably DDT.

But by the time all this science came on board, in the 1930s, the world population already stood at around
3000 million—three billion. In other words it had increased 300 times since the Neolithic revolution. All of
that increase had been achieved by pre-scientific methods: by craft. World numbers have doubled again
since the 1930s and some of that increase can be ascribed to modern agricultural science. We cannot say
exactly how much, because the land under the plough has also increased significantly, and craft itself has
improved since the 1930s, just as it always did.

So craft alone—which essentially was organic farming—took the world from a state of hunting and
gathering into modern times, with big cities and all the trappings of civilisation. Craft did that. Agricultural
science has not been the saviour. It has been the gilt on the gingerbread, the Johnny come lately. Again,
anyone with any feel at all for the history of farming knows what an astonishing range of crops and
livestock were available in the 19th century, and even in the 18th, before there was any bona fide
agricultural science at all. Indeed, modern agricultural science has succeeded as well as it has only
because it was able to build on the astonishing achievements of traditional farmers, who had done all the
hard work. Isaac Newton claimed to have succeeded only because he had “stood on the shoulders of
giants”. Modern agricultural scientists should be saying the same in spades. Except that, unlike Newton,
they don’t seem to know any history. They, unlike Newton, are far more concerned to exult their own
achievements, and that of their employers. But in order to do this, they have systematically to denigrate,
which is to say to misrepresent what was there before—some of which, mercifully, has so far survived.

Particular cases are misrepresented, too. The most blatant and shocking example is surely that of so-
called “golden rice”.

Golden rice is genetically engineered to contain vitamin A. Lack of vitamin A leads to blindness—indeed it
is the commonest cause of childhood blindness in the tropics, and is said to affect 40 million children.
Many of those children live in regions where the diet is based on rice. Put all those facts together and the
tremendous effort over the past decade or so to produce a rice that is rich in vitamin A seems something
akin to a Godsend. It seems to illustrate at a stroke the incomparable value of genetic engineering, and
the waywardness and stupidity of all those critics, including people like me of course, who at least want
some kind of moratorium. How dare we stand by while children go blind!

But wait a minute. The pigment that makes golden rice golden, or more accurately yellow, is carotene, the
pre-cursor of vitamin A, which indeed becomes vitamin A when it's consumed. Fair enough. But carotene
is one of the commonest organic molecules in nature. It is abundant in all dark green leaves, its colour
masked by the green chlorophyll. It is the stuff that makes carrots orange, and some strains of cassava,
and gives that lovely rich glow to mangoes and papaya. Mangoes and papaya seem exotic to us, but they
grow like weeds in the tropics. I have stood under a bus shelter in Panama while they thudded on the
roof, during a rainstorm. A taxi-driver the other day told me that when he was a boy in Grenada, in the
1970s, mangoes grew everywhere. They were free. Precisely because they were free, they grow no more.
They are now plantation crops, making money for somebody—contributing to GDP.

More to the point, any society that practices horticulture of any kind—growing spinach, fruit, carrots, or
whatever—has all the vitamin A it could possibly want. And all traditional agriculture includes
horticulture. The kitchen garden is the first thing the family farmer establishes.

In fact, people are deficient in vitamin A for precisely the same reason that they are often deficient in
food in general (while others are vastly over-stuffed); that traditional agriculture has been systematically
undermined, to make way for high-tech monoculture of commodity crops, which make money for
 corporates and feeds the great God of GDP.
Again we see that the kind of technologies, and the kind of economics that are now being flaunted as the only possible saviour of humankind, with all the power of modern politics and scientific academe behind them, are the prime cause of the problems they affect to solve.

“The public”, who apparently need educating, may not know the details of vitamin A, but people at large are very well able to smell a rat. And again we see that the politicians and the captains of industry and the scientists who are flogging golden rice, as the symbol of modern high-tech beneficence, either are misrepresenting the situation deliberately, or else are themselves profoundly ignorant. Either way it is not good. Either way, public mistrust is absolutely justified. People who are either ignorant or cynical cannot occupy the high ground, either moral or intellectual.

Just as an aside, too: It is a key feature of neoliberal economics that people work best, and therefore that systems operate most efficiently, when driven by competition.

But traditional agriculture was not, and is not, innately competitive. Above all it is collaborative—co-operative.

We see this very clearly in Angola, which sometimes features as a disaster area. The farmers of Angola grow about 600 different varieties of beans. They know the strengths and weaknesses of each one—some are particularly flavoursome, but delicate; some yield more reliably, but are less esculent, and so on. No one farmer grows all 600 varieties at any one time. Of course not. Instead there is a country-wide informal trade—largely conducted by women. The farmers (who themselves are largely women) vary what they grow from year to year, exchanging different varieties with their neighbours—or indeed with other farmers miles away. This is one of the best ways to control pests—grow a wide range of varieties so that no one pest can wipe out the whole lot. So this trade is a marvellous exercise in pest control. But it depends absolutely on co-operation. Competition, forced on to the farmers by neoliberalism, would kill the prime means by which food security is assured.

Or take another example. My wife and I have a friend called Alejandro who is native to the Peruvian Andes and is setting up small businesses for growing medicinal herbs among his local people. Again, as is usual in traditional farming, this enterprise depends absolutely on cooperation. Alejandro tells us that if different Andean communities were set against each other—which is what competition means—then this would lead to violence. He knows his own people. One wonders in a general way how many of the wars that make modern Africa so intolerable result directly from the modern economy, which depends on setting neighbour against neighbour, and makes a virtue of it, in the name of “efficiency”.

In fact when we look carefully at traditional agriculture—when we do the thing that scientists advocate, and look for real evidence—we do not find universal disaster, waiting for science and corporates to come and put things right. We find immense subtlety and knowledge. We find systems that generally work brilliantly, albeit with occasional set-backs. For all but the last few gasps of the past 30,000 years agriculture has been a craft industry; and the more we look at its past and still present achievements, the more our respect for craft increases. To denigrate that achievement with such carelessness displays the most extraordinary ignorance. To sweep aside these systems that have served us so well in favour of a spurious modernity that is mostly untested looks very like wickedness. That the zealots of modernity can do this and yet claim the moral and intellectual high ground, takes the breath away.
Does all this mean that there is no room for science in agriculture?

Of course not. The wonderful thing about science is that it can, in principle, help us to do anything we may choose to do. It can in principle improve on all human endeavours. Agriculture is craft, and should be craft. The mistake is to conceive it as something else—as just another engine for making money. Science has a great deal to offer to the craft.

It has been my privilege and good fortune this past 30 years to travel at the expense of organisations like New Scientist and the BBC and talk to farmers and scientists and economists the world over, in fact in all the habitable continents. For several years at the end of the 1980s I helped to write the annual scientific reports of what was then the Agricultural and Food Research Council. During this time I have seen science truly working in the service of good farming and hence in the service of humankind—not seeking to replace traditional agriculture with some new, industrialised, neoliberal substitute, but to abet and enhance the craft. This is the proper role of science.

Examples that come to mind are again both small-scale and large-scale. On the small scale I recall internationally-sponsored research in India to produce mildew-resistant millet by crash programmes of mass selection. This is relatively low-tech. Definitely high-tech were attempts to produce vaccines against foot and mouth disease in tropical cattle—vaccines that were genetically engineered not only to induce immunity safely, but also to be extremely robust—so they would still be of use even if the refrigerators failed. I have seen and written about various excellent attempts to improve the efficiency of nitrogen fixation, as carried out by bacteria in the roots of pulse crops and acacia trees, and in the leaves of floating ferns in rice paddies.

More broadly, there are some marvellous programmes afoot to explore the possibilities of biological pest control. Or again, the international institutions set up under the auspices of the CGIAR were established in the 1970s and have largely focused on conserving and exploring the many thousands of traditional varieties—including Angola's 600 beans—that are vital to produce secure yields in difficult and changing circumstances. Most exciting of all are the efforts, not least in Asia and Costa Rica but also for example in Oxfordshire, to explore the wondrous possibilities of agroforestry—combining various forms of farming with the growing of trees, for a wide range of purposes.

All this work is out there and to a significant extent is still pursued. But it is no longer mainstream. The main endeavour these days is to turn the labour-intensive craft of farming into agri-business, in the causes of progress and development—causes that are now sadly debased.

But at this point you may well be asking, “And who is Tudge to be pronouncing in this way? How dare he criticise scientists, when he himself is neither a professional scientist, nor a farmer?”

Well, let me just say that when I was an undergraduate way back in the 1960s I believed the propaganda of the day, which in some important respects was not so different from the present—the propaganda which said that traditional farming is bad, anachronistic, and generally defunct, and that traditional farmers are—that word again—“ignorant”. Nowadays the zealots are pushing biotech (I see our government is preparing to invest another billion pounds of our money on it) while in the 1960s, before
Rachel Carson’s Silent Spring became widely known, salvation was supposed to lie in DDT and more and more fertiliser, courtesy of ICI. Le plus ca change.

The people who changed my mind were scientists—not the modern kind who rush from bench to boardroom but the kind who spent decades in the field, looking at what traditional farmers do, and learning from them. Those scientists—and other scholars, including sociologists, economists, and indeed the old colonial administrators—had looked closely at what people really do, and why they do it; and they invariably expressed enormous respect for the traditional ways. Many still emphasise that the proper role of science is to abet the craft of agriculture—or indeed craft of all kinds—and are at least as dismayed as I am by the turn of modern events. These are the voices of true rationality, people who actually know something. They, nowadays, are largely sidelined. They are not the policy makers.

Indeed I want to conclude this section of my talk with a quote not from some wild radical, but from one of the most respected figures of late 20th century agricultural research—Sir Kenneth Blaxter, who for many years was director of the Rowett Research Institute, Aberdeen. Sir Kenneth was a Fellow of the Royal Society. In a Royal Society document on farm economics he wrote: “It seems wrong that ... the science related to producing food has to be used in a competitive fashion: the essence of science is its universality, and freedom from hunger should be the birthright of all humankind.”

Sir Kenneth wrote this in 1977. It’s only 30 years ago, but it sounds like a voice from another era. It isn’t gratuitous nostalgia to suggest that in many of the most important ways it was a much more enlightened era.

I should end this talk here. All perorations of all kinds should contain just one big idea. But actually this lecture is about science—not specifically about food. And I want at least briefly to point out that the dereliction of scholarship and good thinking in the field of applied science, as manifest in agriculture, is also evident in the field of pure ideas as well.

I hate to single out any one individual for criticism but for lack of time one example will have to do—and I'll pick on Jonathan Miller. He is not a professional scientist, to be sure, but he is a professional intellectual educated in science, and has often appeared as its champion. Recently he wrote and presented three 50-minute programmes on BBC television, titled “A Brief History of Unbelief”. Basically it was an apologia for atheism, making the point that has been made so often this past 300 years or so, that the superstitions of religion have simply been blasted out of the water by the incontrovertible rationality of science. Again, as is so typical of such presentations, Miller displayed an astonishing lack of scholarship. In one instance—and one must serve to illustrate the whole—he gazed at a mural which if memory serves was by Giotto, painted in the 14th century; and while admitting that it was pretty, he mused: “Yet one can’t help thinking, looking at this painting, how astonishingly closed the Mediaeval mind really was”.

The truth is quite different. Indeed I am inclined to suggest that Mediaeval thinkers wrestled with issues that are still with us—universal issues that will never go away—with far greater subtlety than is usual nowadays. For instance, just a few decades before Giotto—and two centuries before Copernicus—Nicole Oresme of Paris was questioning the astronomy of Ptolemy and Aristotle, who said that the stars spin around the world in a succession of spheres. Might it not be, said Oresme, that the Earth itself is spinning?
He concluded that observation alone could not decide such a point. The stars would appear to revolve around the globe whether they were indeed fixed in spheres, or whether the world itself was spinning. Thus in a stroke he identified the key shortcoming of empirical evidence—that it invariably lends itself to more than one and sometimes to many different interpretations. Any particular conclusion—that the Earth spins, or the universe revolves—must be, as a modern philosopher of science would say, “underdetermined” by the data. Such musings are not indicative of a closed mind. Oresme was echoing the theme that roars through all Mediaeval philosophy—how we know what’s true? He did not, as modern scientists so often presume to do, pre-empt the answer.

Oresme, in fact, showed the humility that is appropriate to everyone who seeks to understand nature. So for that matter did Newton. Newton’s letters to colleagues do not suggest that he was personally a humble man but he was humble about his work. He spent as much time on theology as on science and he said of all his musings, “to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding another pebble or a prettier shell than ordinary”.

Many great scientists share Newton’s humility in the face of nature. Alas, what too often comes across to the world at large is arrogance. Arrogance together with obvious misinformation and political naivety is surely the most dangerous combination imaginable. The mistrust that attaches to science and scientists is entirely in proportion to its performance.

So what is to be done? Actually I think the world as a whole needs to embark on programmes of re-thinking from first principles, on just about everything.

On the moral and political front we must never stop asking as a species what we are trying to achieve, and why; and the proper meanings of what should be grand concepts such as “development” and “progress”. Beyond doubt the Churches have key roles to play in this discussion.

More practically we need to devise systems of economics—probably though not necessarily, variations on a theme of capitalism—that are specifically geared to human wellbeing. The algorithms of neoliberalism and economic growth just will not do. I know people who are working on such models, and some that are already up and running.

In science we need of course to identify the things that really need doing—that really will benefit humanity, and are not destined simply to make rich people richer. At the same time we need to find ways of supporting the things that really need doing. Again, slavish adherence to the algorithm of neoliberalism, and to the corporate cause that lies behind it, does not and cannot meet the case.

And on an important point of detail—and really this is the point of this lecture—we need new curricula of science that on the one hand will produce good scientists, who know how to do good research; but which also ensure that they have some conception of what it is that they are actually doing.

Thank you.