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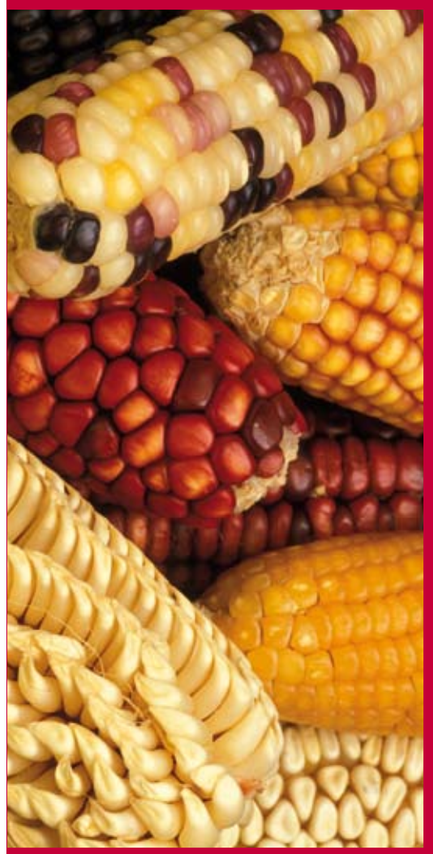
Food Security and Sustainability

Report of a seminar organised by the Royal Society of Chemistry



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Food Security and Sustainability

Food Security and Sustainability

Food is moving towards the top of the political agenda, with issues such as obesity, sustainability, and security of supply now impossible to avoid. Farmers, policy makers, consumers, and the big businesses involved in our food chain, stand alongside economists and environmentalists debating the balance between food production, the challenges and value of waste, and the growing use of crops for fuel.

Since the beginning of the 1960s, world food production has grown by 145%. The trend is most apparent in developing countries, but even industrialised regions, such as the USA and Western Europe, have seen significant increases in the last 40 years. However, over 800 million people remain malnourished and without adequate access to food in the 21st century.

As global population is predicted to reach 9 billion by 2050, food production will have to increase in the coming years to accommodate increased demand. As diets change, food production will also have to provide different types of food. Sustainable agriculture offers signposts towards intelligent strategies to make the most of finite resources during this unique period in history.

To understand how science and technology can contribute to environmentally sustainable and socially responsible food production, the Royal Society of Chemistry held a seminar to discuss the evidence on 9 October 2007. **Dame Deirdre Hutton CBE**, Chair of the UK's Food Standards Agency, chaired the meeting.

Dr Les Firbank, Head of North Wyke Research Station, at the Institute of Grassland and Environmental Research, gave an account of sustainable agriculture in the light of increasing demands on the landscape. **Professor Peter J Lillford CBE** is Director of the National Non-Food Crop Centre (NNFCC). He focused on the food supply chain, suggesting a number of scenarios for future sustainability. **Peter Jones**, Director of External Relations at BIFFA explored technological and economic drivers influencing food waste exploitation. **Dr. Jonathan Scurlock**, Chief Policy Adviser, Renewable Energy, Climate Change and Non-food Crops for the National Farmers' Union, explored some of the perennial myths that recur in the food versus fuel debate.

Agricultural land use

Society makes many demands upon the landscape. In addition to food, land is increasingly needed for energy production, and science provides new techniques to use crops for materials too, as a substitute for oil-based products. Land is now viewed as a potential carbon sink.

Following World War II, policies emphasised increased production to meet food shortages, with considerable success. But by the 1960s the push from science and technology in the agricultural arena was very much balanced by a growing realisation of the costs to wildlife and the environment through products such as the pesticide DDT. Just a few decades later, food production was no longer the key driver, land was set aside and food mountains grew. In Europe, the focus shifted to the social and environmental benefits of supporting farmers through the Common Agricultural Policy.

Today the situation has shifted once more, according to Les Firbank. Society wants it all: increased production for food and energy; environmental quality; and an even greater social use of land for leisure and health. To realise the most potential from a given piece of land, Firbank suggests, a multifunctional approach is needed.

A multifunctional approach

Multifunctional agriculture provides food products for consumers, livelihoods and incomes for producers, and a range of public and private goods and services for citizens and the environment, including ecosystem functions. This approach goes beyond viewing agriculture solely in economic terms, and incorporates a broad and global view of agriculture.[1]

Managing resources such as soil and water associated with the land will be a crucial requirement for sustainability in years to come, and to date these ecosystem services have tended to be undervalued. The landscape also has its own intrinsic value for other species and fostering biodiversity as well as for leisure and tourism.

Agriculture and forestry has a role to play in several pressing issues for global development, including climate change, renewable energy supplies, human and animal health and the quality of ecosystems. Pollution from the poor management of nitrogen, from fertilizers and manures, has a major environmental impact arguably second only to climate change in the UK.

Hunger and human health

There is an increasing demand for food, reflected by increases this year in commodity prices for basic foodstuffs, such as milling wheat, oilseed rape and milk. The increase is global, and not just a result of population growth but also of changes in diet, leading to increasing markets for meat and dairy products in some parts of the world. Other recent pressures include poor harvests around the world, and a switch from some food crops to bioenergy production.

However, Jonathan Scurlock suggests that the present worldwide hunger is mainly a result of conflict, economic mismanagement and under-investment, rather than limited supply. *"The world is not short of agricultural land,"* he said, *"the world is short of agricultural investment."*

Issues of food safety also place certain limitations on the food chain: cooking, chilling and appropriate transportation under strict guidelines are not up for negotiation, because consumer safety is at stake. In addition constant vigilance is necessary to guard against food-borne pathogens, and dietary issues have risen to prominence due to the burden on individual health and on healthcare services.

The food chain

The food chain today is a high technology, global concern. Science and technology have contributed significantly to high farm yields, large scale continuous processing, sophisticated preservation methods and global distribution of finished products. However, this model is based on assumptions that the Earth performs as a limitless energy supply and waste disposal sink. These assumptions are now changing.

Players in the food chain are aware of, and share the need to reduce energy and water use, and by-product waste, not least because these will help reduce costs. The food chain is a profit-driven enterprise, but as well as a drive to optimise individual processes' efficiency, sustainability should be measured in terms of the entire food chain, including the consumer, Peter Lillford argues.

The food chain as a whole, from farm to plate, which includes domestic energy use from storing and cooking, is responsible for around 111 million tonnes of carbon dioxide or approximately 17% of the UK's greenhouse gas emissions .[1]

Agricultural efficiency will increasingly need to be viewed in terms of *"yield versus emissions,"* Lillford suggests. Farming has a relatively low carbon footprint when compared to subsequent processing and transport. However, fertilisers, soil nitrogen and manure management are all significant issues, since they give rise to nitrous oxide and methane emissions, which are greenhouse gases. This is an area where scientific research could make a considerable contribution.

"There's no single right solution for everything. And the consumer wants everything. What are you prepared to give up?"

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"The world is not short of agricultural land - the world is short of agricultural investment."

Our food spends longer on the road than it does in the supermarket

There's a long tradition of farmers bringing fresh produce to the marketplace. However, the situation has changed markedly to become global and energy-intensive now that retailers are able to transport fresh produce long distances to meet consumer demand. Despite the increased awareness of food transportation by air, this only accounts for about 1% of the total vehicle kilometres our food travels. Transport by sea is particularly efficient: this represents around 65% of all food movements but accounts for only 12% of total external costs.

Figures from the Department for Environment, Food and Rural Affairs (DEFRA) show that our food spends longer on the road than it does in the supermarket. Food in the UK travels 30 billion kilometres through transport, 82% of which is transport within the UK. From supplier to shelf, the total costs are £1 billion each year, comprising congestion (£680m), infrastructure (£164m) and accidents (£194m).[2]

A significant proportion of our food is processed. Due to technological capabilities in process engineering, many food manufacturers have become successful globally. Accordingly they manage their supply chains and manufacturing capabilities on a global level. Multinational food corporations are not bound by national loyalty, and wield considerable economic and marketing power.

Ingredient suppliers are a less visible but nonetheless significant contributor to the food chain. Providing flavours or additives to modify and improve food, these chemical manufacturers inject considerable 'added value' to products on the shelves. In developed countries, people are increasingly dining out or eating takeaways. Catering is growing rapidly as a result. As food is prepared in bulk, this makes economic sense and is profitable.

Increasingly 'sustainability,' in terms of emissions or food miles for instance, is quoted as a selling point, for all parts in the chain, including retailers. These claims must be examined carefully to assess the real costs and benefits, which are complex and not always transparent to consumers.

Using a process engineering model, the food chain can be viewed as a 'biorefinery'. Farming provides the raw materials, and some of the outputs include food, food ingredients and renewable materials. Location is a big issue, and one where society cannot afford to have a 'not in my back yard' attitude. These biorefineries should either be scaled up to a global level, or down to a local level to optimise the balance between emissions and yield.

A local model incorporates production close to the farm with integrated waste management and recycling, to supply regional markets. A global model involves optimising production of a chosen crop, with large scale biorefineries at the source, coupled with efficient bulk transport and measures to minimise waste. Which route is chosen will depend on the crop in question and how it is retailed.

Consumers

Consumers today want it all: maximum choice coupled with sustainable and ecologically sound food production. The public is increasingly aware of pollution, climate change and finite fossil fuel reserves, evidenced by concerns relating to chemicals used in farming, additives in food and the 'food miles' involved in distribution. On the other hand, consumers generate 5.2 million tonnes of food related packaging waste and 6.7 million tonnes of food waste in the home each year in the UK.

Food versus fuel?

Biofuels are a more sustainable alternative to fossil fuels, but concerns have been raised over the true cost of these alternative fuels in terms of land, raw materials and energy. Critics suggest that growing trees on marginal or set aside land would bring greater benefits in terms of carbon absorbed. Others suggest that policy makers' primary interest in biofuels pertains to national energy security, ahead of environmental gains. [3]

Jonathan Scurlock backs biofuels, arguing that the 'food versus fuel' debate is an old argument that refuses to move on, is itself ill founded, and is based on a number of misconceptions. He notes that of the 47 poorest countries worldwide, 25 import all their oil, and are held back in a state of perpetual extractive primary production. Protracted debate in place of embarking on the new biofuels economy maintains the status quo, and with it continued underdevelopment in less wealthy nations.

Among other market forces, biofuels are contributing to an increase in the price of cereals and oilseeds, and therefore will have an impact on food prices. However, the EU anticipates its biofuels target of a 10% inclusion rate by 2020 might lead to a rise of 3 to 6% in raw material prices, with a knock on effect of increasing the price of a loaf of bread by less than a %.

Europe's farmers have been accused during the last few decades of dumping surplus production with the aid of massive export subsidies on over-supplied world markets, depressing prices and contributing to poverty and hunger in less developed countries. The charge today is that biofuels will contribute to poverty in developing countries by driving food prices up. The true outcome depends on how farmers, particularly in the developing world, respond to the new situation. Higher prices may lead to investment in agricultural infrastructure and more extensive and intensive production, possibly providing such farmers with a better deal, assuming a beneficial balance between food and fuel crops is found.

At the UK level, there is sufficient capability to produce enough bio-ethanol and bio-diesel to meet the Renewable Transport Fuel Obligation (RTFO) of a 5% inclusion rate by 2010. During the 2003-05 period, UK wheat exports have averaged 2.8 million tonnes, enough for 1.2 billion litres of bio-ethanol, equivalent to 5% of future estimated petrol demand. Further capacity is available from sugar beet production, and our considerable reserves of set-aside and fallow land.

The European Environment Agency Report *"How much bio-energy can Europe produce without damaging the environment?"* [4] estimates that to meet current energy targets the EU needs 150 million tonnes oil equivalent from biomass by 2010. On very conservative estimates Europe's potential, environmentally friendly, production is 190 million tonnes in 2010, rising to 295 million tonnes by 2030. The UK is one of 7 countries where the potential is greatest alongside Spain, France, Germany, Italy, Lithuania & Poland. Although there is a risk that biofuel production may cause environmental damage, through the destruction of rain forest to make way for crops like palm oil and sugar cane, this is an avoidable danger. The biofuels industry is in

"Landfill taxes provide the economic green light for companies to install waste disposal technologies"

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the process of establishing new standards for international commodity trade, such as the sustainability criteria underpinning the RTFO in the UK, and the Roundtable on Sustainable Palm Oil. By "raising the bar" for standards of production for renewable natural resources, biofuels could become a major driver for sustainable development.

Scurlock argues that suggestions of biofuels creating a negative energy balance (cost more in energy terms to make than they yield) are not backed up by science: looking at the entire lifecycle, biofuels are actually unique compared to fossil fuels in having a positive balance. [5] The US Department of Energy's Argonne National Laboratory calculates that 1 unit of energy at the pump requires 0.76 units to produce from American corn ethanol (and considerably less for other crops or regions of the world), compared to 1.22 for regular gasoline.

'Next generation' biofuel feedstocks such as ligno-cellulosic ethanol, made from the whole wheat or maize crop, or from perennial grasses or trees, do offer genuine promise. But Scurlock notes that commercial production using these is about 10 years away, and the UK must act now using existing technology.

Biofuels will initially be reliant on subsidies, but all forms of energy, including coal and nuclear energy, receive subsidies too. Subsidies may provide a bridge until the carbon trading market becomes properly established.

Waste

Estimating and forecasting the scale of materials used and waste produced has been a major project championed by the waste industry, which can see the future benefits of reusing waste to create energy or nutrient resources. Peter Jones suggests that we will see a major shift in this direction when the increasing taxes on landfill mean that other waste options become viable competitors. He suggests that this transition will happen in the next 4 to 5 years.
Jones calls for a holistic material flow analysis to convert the full lifecycle impact of goods, including food, and waste, into units of carbon. This measure of carbon footprints will help with carbon pricing and trading systems. In our current economy, each tonne of goods consumed costs 20 tonnes of embedded materials to produce. Economics, technology and socio-political attitude are three systems available that we might harness to improve this 20:1 ratio and make our resources go further.

According to Jones, proven technology exists to deal with and benefit from waste via mechanical, biomechanical, biochemical or thermochemical routes without the need for extensive investment in R&D. In addition to methods that yield energy, such as thermochemical or biochemical routes, another alternative is to compost biomass to create nutrient-rich soil. The cost-effectiveness and revenue yield of these various exit options will drive technology choice.

In terms of economic instruments for change, government has been slow to put up landfill taxes. This is now taking place, and provides the economic green light for waste companies to install relatively costly new technologies, which are more capital and labour intensive. Waste companies are increasingly moving away from landfill as taxes are ramped up. Economic factors will drive which technological route companies choose for waste disposal.

Indeed, in future, waste companies may be paying for waste as a feedstock for energy or soil manufacture, or to meet recycling requirements. Waste may increasingly become a valuable resource in response to real price rises in global commodities and demand side pressures. The looming shortfall in electrical energy supply emerging in the UK as ageing capacity is shut down is another factor. As coal and oil dwindle there will be a switch to gas, but a chronic energy shortage is likely around 2015, in part because any potential nuclear facilities would not be commissioned before 2020. Early adoption of supplementary distributed energy approaches, some of it fuelled from scrap carbon in the waste stream is thus desirable, even if the latter is unlikely to provide more than 3-5% of baseload electrical capacity at present.

In summary, Jones calls on government to implement a National Resource Flow mapping/data capture system in parallel with a transparent audit framework to convert those mass flows to some form of carbon equivalence within a single International Organization for Standardization (ISO).
As the value of carbon /carbon dioxide becomes monetised within convergence of international trading systems, government, business and private citizens can thus more easily shift their consumption and production decisions based on prices and costs which incorporate carbon externalities. In the food supply chain accounting as it does for around 20% of UK carbon dioxide, 67% of nitrous oxide and 40% of UK methane, that revaluation could engender significant production and consumption shifts.

Summary

It is clear that issues of food production, economics, agriculture, waste and energy are closely linked. Shifts in policy or practice in any one of these areas will exert an influence on others. Society is in the midst of a paradigm shift, where our fossil fuel-based hydrocarbon economy increasingly gives way to a carbohydrate economy, in which intelligent and sustainable use of our plant- and land-based resources is key. The shift towards biofuels is one such example, and the UK is very much leading Europe with the introduction of the Renewable Transport Fuels Obligation that comes into effect in April 2008.

There is a cautious optimism that both socio-political and technological solutions to sustainable food production are possible in the 21st century. However, it is unlikely that any single approach or technology will hold the answer, nor are we likely to reach a consensus that would allow this in any case. Against a backdrop of national and regional policy, the business of food production – from the farmer to the retailer – is one where international businesses and market forces hold considerable sway.

As goods on our supermarket shelves are increasingly marketed by 'selling sustainability' to the consumer, it becomes vitally important that policy makers and the public have access to the right information to make meaningful judgements about these claims.
On a global scale, fair access to the infrastructure and opportunity to develop land for agriculture is necessary if farmers in less developed nations are to make the most of these resources and benefit economically. A shifting balance in agricultural markets and the introduction of new crops for fuel, coupled with political will, may offer a window of opportunity for such farmers and a greater possibility for increased fair trade in agricultural commodities.

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