TOWARDS ENVIRONMENTAL SUSTAINABILITY AND INNOVATION
by
WAYNE MARTINDALE

Food Innovation Centre, Sheffield Hallam University, Surrey Building, Howard Street, Sheffield S1 1WB.
T: 0114 2253451 E: w.martindale@shu.ac.uk

My notes are included here with some of my analysis supporting the statements and caveats I present for the continued innovation and sustainability in the food system. If further references and data are required they can be provided on request.

Presentation notes

Firstly, my presentation today will not use forecasts and predictions to define sustainability. Today's food system tells us much about what is achievable and what is sustainable. My research, and that of many others, has utilised over 150 years of food system data from long-term experiments and this will continue to drive innovations in the food supply chain. However, assertions based on experimental evidence are likely to be perturbed by a continued miss-matching of pleasure and quality of life with the requirements of sustainable development. This is beginning to create sensational outcomes, for the first time global urban populations outnumber rural populations and the impact of the 'Brazil, Russia, China, India- or BRIC' nations is being felt on the global food system.

Clearly, food production capacities are not limitless but significant yield gaps still exist and low yielding agricultural systems are not the answer for 9 billion people (see figure 1). However, limits are a clear certainty for energy where all current oil production estimates suggest supply in 2050 will be 90-100 M Barrels per day, falling short of the 120 M Barrels demanded even when we include extraction from shales and tar-sands. Naturally, such limitations will incite intense innovation.

The health factor will also continue to drive much innovation because it is clearly associated with enhanced pleasure and quality of life. Emergent technologies are providing nutritional solutions to obesity, malnutrition and calorific deficiency. For example, there is intense interest in providing ready-made ingredients from the field with biofortified crops that are now on the cusp of market entry to provide enhanced mineral, vitamin and fatty acid nutrition. Such developments will change our current innovation and NPD environments beyond recognition.

Sustainability is a 'now' issue the food and beverage industry has responded to. For example, 'waste' is not a word used lightly in the ingredients sector and there has always been intense activity to divert 'waste' streams to valuable co-products. Such actions generate new ideas, increased wealth and continued regulatory compliance. Co-product markets are proven with many of the supporting technologies coming from the ingredients industry. They include starch by-products, biofuels, fibres, novel oils, waxes, cellulosics and a range of fine chemicals from biorefinery systems. It is not going to be easy to attain sustainability, it may not be pleasurable – which makes it even more difficult to achieve in a food and drink environment that thrives on enjoyment. There are three specific areas of our industry I want to highlight as critical for future success.

The first is water use efficiency. Globally, irrigation of agricultural systems is highest where water-scarcity is most intense. The UK itself will experience a more Mediterranean climate in the future representing a challenge for food manufacturers. For example, 4 to 5 litres of water are required to produce the ingredients for a slice of bread, to make those ingredients into a slice of bread requires 40 litres of water. The 36 litres of water utilised from farm to fork will be increasingly visible in terms of cost and regulation.

The second is energy production where we have already identified a clear shortfall in supply initiating much innovation. For example, much current interest is focussed on the termite gut, these insects digest cellulose into sugar that can be fermented into ethanol. Such seemingly abstract chemistry can yield significant quantities of ethanol, methane and hydrogen fuel. The

USA has initiated a billion tonne biomass project based on cellulosic technologies. A co-product of our industry is cellulose and fermentation is clearly in our folio of expertise. The EC is currently precautionary about the use of biofuels and estimate 150 million tonnes of biomass is available for cellulosic technologies. Are they leaving someone and something out of the equation?

The third and final area I want to highlight is supply chain efficiency, which relates to my own specific research over the past two years. Supply chain efficiency can be defined by the 'carbon footprint'. A typical 200 g mixed sandwich will have 80 g of CO_2 emissions associated with growing and processing its ingredients. Transport and packaging can add 10-20 g CO_2 emissions, so half the product weight. However, including the other greenhouse gas emissions such as methane (from livestock production) and nitrous oxide (from organic and mineral nitrogenous fertiliser use) can double these emissions as carbon dioxide ‘equivalents’. The highest emission intensity tends to be pre-farm gate, not the same as the water supply chain. However, do not assume it is of lesser importance in food manufacturing. The carbon footprint and life-cycle methodologies offer us a toolbox to analyse our supply chain and formalise much innovative development. It could also provide smarter consumer communications that relate environment, health and lifestyle (see Figure 2).

Additional analysis supporting presentation notes

The application of agronomic technologies in 19th and 20th Century have dramatically increased food yield per unit agricultural area. The limits in regional agricultural product supply have been traditionally ameliorated by efficient food logistical infrastructure, preservation and packaging. We are now beginning to account for these limits. Indeed, they are driving the development of much innovation and regulation. Supply chain resource efficiency, managing natural resources, accounting for energy, water and waste will become more critical to the success of the sustainable business model. Global food production statistics suggest a dramatic change in the requirement for products that improve flavour and taste (Table 1). Food staples have remained relatively constant in these terms with palm oil production providing an exception where production area and yield per hectare has increased globally 279% and 193% respectively between 1980 and 2004.

Table 1. Trends in production for selected agricultural products obtained from FAOSTAT (2008) data that provide key ingredients in the food production system

Crop	Production (Mt)		Increase (%)
	1990	2005	
Spinach	4.087	13.778	337
Garlic	6.600	15.184	230
Chillies	12.845	28.693	223
Sugar crops	1363.207	1649.669	21
Wheat	592.372	605.946	2

The global food system must operate in a robust regulatory system that ensures safety of products but this should not stifle innovation and the application of new technologies. Innovative technologies will be applied to enhance nutritional quality of food using novel ingredients, nano-encapsulation of nutrients, biofortification and individual (genomic or metabolomic) nutrient profiling. Crop breeding and agronomic management have a central role in closing yield gaps and increasing nutritive quality (Figure 1). The changing global food trade dynamic must not overlook consumer influences, precautionary attitudes and new regulations. Indeed, technologies and innovations are being deployed in a new bias that does not reflect how things happened in the 19th and 20th Centuries.

Conclusion

The attainment of sustainability and innovation will follow three caveats:

1. The ability to deploy new and established technologies in the agri-food arena
2. Sensing regulatory environments that enable and stimulate innovation
3. Delivery of innovative multidisciplinary approaches to product development that provide consumers with high impact health and ethical information

Figure 1. The wheat yield (t/ha) gap potential

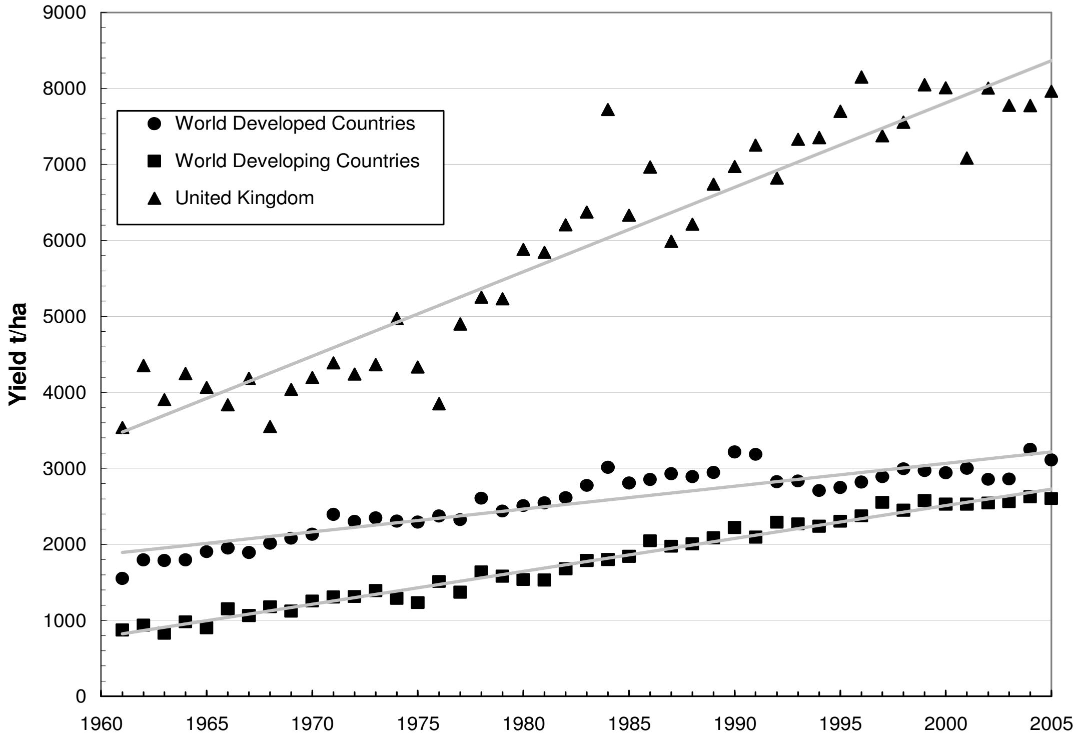

Figure 2. The relationship between Global Warming Potential (GWP) associated with the production, manufacture, retailing and distribution of food and beverage products and, the energy content of the food product.