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Research on diet and nutrition at a conference organised by the Scottish NGO Nourish in June 2014 revealed a swathe of problems in Scotland associated with modern industrial farming and industrial food procurement procedures. These include the prospect of the population being 80% obese or medically overweight by 2030 from eating an inappropriate diet, growing ground water and atmospheric pollution, reduced animal welfare in planned larger animal factories, dramatic declines in native species on farmland, and a broader cultural disconnect between food consumers and farmers (Nourish 2014). The conference outcomes revealed a preference among the delegates – who included smallholder farmers, small food business people, academics and public health experts – for kinds of foods and farming that are less dependent on agrochemicals and large machinery, and for greater availability to people of wholesome foods in the form of whole grains, vegetables, pulses and reduced protein of animal origin.

In the closing panel of the conference Iain Gordon, a crop scientist from the James Hutton Institute, made the claims that GM crops are essential for feeding the world, including Scotland; that they are a form of 'natural selection'; that the scientific case for them is based on 'evidence'; and that the alternative case -as set out in the conference outcomes -– for reducing use of agrochemicals, improving animal welfare, reducing reliance on large industrial and mechanised farming, and recovering a more localised food supply which produces more fresh food for human consumption and less for animal feeds – was merely 'advocacy' with no basis in 'science'. The conference had reviewed unambiguous scientific evidence on the negative outcomes, in terms of the environment and human health of the present food system. But for the crop scientist, to resist technological innovations in crop science and food manufacture was represented as 'anti-scientific'.

Mutual incomprehension between crop scientists and an informed lay food-eating public is a frequent feature of the public debate around Genetically Modified (GM) crops and foods. I first encountered this mutual incomprehension as a member of a research project on the ethics of GMOs by a team of researchers who included crop scientists, social scientists, philosophers and theologians. The outcomes of our deliberations took the form of a collaboratively written book which was published just as the controversy over GMOs spilled over into a major public campaign against them (Bruce and Bruce 1999). The very fraught and public debate led to the widespread banning of GMOs in human foods in Europe. GMOs were viewed by European regulators as novel organisms because the mix of genes the new methods made possible - such as the insertion of a fish derived anti-freeze gene into a strawberry plant - could not occur under natural selection, or in conventional plant breeding techniques. But in North America GM foods were widely introduced into the human food chain without public debate. This was because the United States Food and Drug Administration adopted the claim of some of those involved in patenting GMOs that food crops derived from these patents were 'substantially equivalent' to non-GM foods and therefore required no special licensing, labelling or regulation (Herrick 2005).

The claim that GMOs were substantially equivalent to conventional crop hybrids rested upon laboratory investigation by crop scientists, who might be said to have an interest in the outcomeof the chemical

composition of GMOs (Novak and Halsberger 2000). But no investigations of the effects of these new substances on mammals beyond 30 days were undertaken before the claim was made, although long-term mammalian tests are mandated by the US FDA for novel substances created in pharmaceutical laboratories using what can be claimed to be analogous biochemical technologies to those used in the creation of GMOs. Subsequent efforts by public scientists to investigate the long-term effects of GMOs on mammals were resisted by public and private agencies, and there remains a paucity of such studies (Pusztai and Bardocz 2006). Two published peer reviewed studies of the effects of GMOs on the mammalian gut beyond 30 days of dietary introduction found significant toxic effects, including the production of cancerous cells in rats fed Roundup Ready maize for 90 days (Seralini et al 2007, Seralini et al 2012). However Seralini's results were contested and, amid claims that his laboratory's methods were 'unscientific', the journal editors retracted the 2012 article.

Despite the suppression of scientific efforts to investigate the effects of a GM diet on mammals, there is growing controversy in the United States and other countries where GM foods have been introduced, concerning their effects on human health. Growing anecdotal evidence from farmers and consumers, some of it published in grey literature, indicates increasing concern about the effects of GMOs in foods (Smith 2005). There is also scientific evidence of environmental and reproductive health problems in humans associated with glyphosate, which is the most widely used herbicide on GM crops engineered for herbicide tolerance (Richard and Moslemi 2005). Hence a number of state legislators in the United States have begun the process of attempting to pass state laws requiring the labelling of GMOs in foods in their states. The first state assembly to pass such a law was that of Vermont, and this state assembly is, at the time of writing, being sued by a coalition of American food processors (Hallenbeck 2014). The contested background of GMOs in the developed world has been of concern to food corporations, governments and venture capital investors who see biotechnology as representing significant economic benefit to private corporations and to public science laboratories.

Against the background of growing controversy over GM crops and foods in the developed world, the GMFuturos project was funded by the John Templeton Foundation to investigate whether the widespread adoption of GM crops in developing nations provided any lessons for understanding (and potentially overcoming) the controversy in North America and Europe. However, the project research outcomes reveal precisely the same disconnect between crop scientists and the lay food-eating public that characterise the GM crop controversy in Europe and in North America. They also indicate that the disconnect between agricultural science and sustainable farming is not unique to GM crops but a broader feature of the science-food relationship. One of the first and best known discussions of this disconnect is a collection of essays by the Kansas farmer and essayist Wendell Berry. In *The Unsettling of America* Berry described the demise of the family farm in North America, and argues that it was the result of efforts to increase crop outputs using novel technologies as promoted by the Federal Government funded Land Grant Universities. The mechanised, chemically dependent, and monocrop agriculture these universities researched and commended was responsible for the destruction of the old settler culture of small farms in the American Midwest and South (Berry 1977). For Berry, food and farming are about human culture and ecological community, and when they are treated as being purely about maximising economic production of a small number of favoured crops, the

richness and resilience of human communities as well as ecological diversity and resilience are diminished.

The GMFuturos research data reveals how percipient is Berry's analysis for the unfolding saga of GM foods in Mexico. Mexico is the origin of the largest social movement in human history - La Via Campesina (Redclift 1980). This movement originated in the 1980s among peasant farmers and urban food growers and consumers who saw that the mechanisation, chemicalisation, and hybridisation of corn, and other staple foods, threatened both the ability of Mexicans to feed themselves in the future, and put at risk the enduring cultural pattern of food growing on small plots which for many Mexicans (those not living in big cities) remains central to a good life (Montoya 2010). Montoya's research on the symbolism of food in Mexico reveals that cultural meanings around maize growing and meal preparation are ontological, sociolinguistic, moral, politico-economic and cultural (Montoya 2010). They are situated in embodied relationships between peasant farmers, cooks and householders, and hence between people and land. When an agricultural system that neglects these is imposed on a people it inevitably courts political controversy, including contestation over GM foods. The laboratory interviews, as well as the interviews with farmers, in the GMFuturos project reveal that this relationality between people and land, culture and agriculture, is missed by crop scientists whose primary training is focused on maximising production of an individual crop in a laboratory or on a university or crop institute plot (Thompson 1995). In other words when agricultural science is primarily about what is done in a food laboratory, absent of considerations of what impacts what is done in the laboratory will have on farmers, food consumers or other species, then the likely outcome will be a growing disconnect between science-informed farming and the health of farming communities, of farming ecosystems and of food consumers. Hence science is not neutral for those interviewed for our project in Brazil. Instead they perceive GM crops, and the advocacy of them by multinational corporations, as a value laden and politically and economically portentous project which was locking farmers into dependence on expensive hybrid seeds, and into an expensive and polluting chemical arms race against increasingly herbicide resistant weeds.

The reflexive nature of the nature-culture relationship in agriculture is at odds with the perception of science-society relationships held by many in the scientific community, and among the corporate funders of much scientific research. That laboratory science and physical reality are reflexive was first proposed by Walter Heisenberg who argued that laboratory instruments such as electron microscopes are capable of modifying the behaviour of the physical subjects their users investigate, and this finding is now called the 'uncertainty principle' or the Heisenberg principle (Heisenberg 1958). The Heisenberg principle was brought into popular culture by an influential United States TV series called *Breaking Bad.* The main protagonist of the series, Walter White, is a chemistry teacher in Albuquerque, New Mexico who develops lung cancer, treatment for which his health insurance does not cover. To meet the costs of treatment, and to provide financial security for his family on his death, he sets up a mobile methamphetamine laboratory with a junky who has contacts with drug sellers. He makes exceptionally pure crystal meth and the product acquires a mythic reputation, and White then acquires the market name 'Heisenberg'. And as the name becomes established so the bodies start piling up. White/Heisenberg fails to insulate himself or his laboratory from the death-dealing drugs market, and becomes caught up in successive acts of violence among those he chooses as partners in crime.

Breaking Bad works well as a metaphor for GM crops. GM crops are more 'pure' from a scientific

perspective than a Mexican farmers' inherited seeds. They are designed for a specific purpose and with laboratory instruments: each gene has been charted, counted and inserted at a level of microbiological precision that is unavailable outside of a highly insulated and 'clean' laboratory. But this 'clean' lab underwrites the belief that a laboratory made crop will not influence the environment, the farmers, the eaters and other species who interact with it. And hence GMOs manifest even more deeply than non-GM crop science the mechanistic and reductionist frame of scientific epistemology. But this frame is subject to reflexive uncertainty: as Heisenberg observed, the scientist who studies atoms using an electron microscope influences their behaviour and so her findings are influenced by her interrogative practices. Insulation does not work. *Breaking Bad* is also a critique of economic neoliberalism (Pierson 2013). For Vandana Shiva, the most influential Indian campaigner against GM crops in the third GMFuturos study area, GMOs are products that are deeply intertwined with neoliberal economics (Shiva 2005). This is because GM crops offer private corporations such as Monsanto the ability to privatise gene races and hence the fundamentals of human food cultures on every continent, and Monsanto in particular have pursued that corporate goal with considerable success, and despite extensive resistance from civil society.

Poesis is the word given by classical Greek philosophers to the unique capacity of humans to generate and sustain aesthetic and ethical ideals through their creative powers. For Plato, makers such as craftsmen and cooks, when they combine knowledge of the ideals with their practices of making, become exponents of the 'liberal arts' just as do philosophers or sculptors (Plato 2005). This same conception of *poesis* is found in other ancient stories, including those of Jews and Christians, about the cultural powers involved in making, including the making of food (Northcott 2005). In the origin story of the Jewish people their ability to grow food on their own plots of heritable land is seen as the source of their freedom from the slavery of collectivised agriculture in Egypt. Similarly in Christian history, cultures of farming, and of crafts and workshops, become sources of freedom when they are mediated by communitarian craft Guilds, and land distribution patterns that enabled yeomen farmers to flourish and restrained the powers of nobles and princes.

The gradual neoliberal collectivisation of agriculture by private corporations repeats earlier collectivising projects from ancient Egypt to Maoist China, and it threatens the same losses of freedom and sovereignty that these earlier collectivisation projects imposed on the peoples subjected to them. The contemporary neoliberal collectivisation project in the spheres of food growing and making is underwritten by scientific agriculture, and GM crops in particular, because the expert knowledge which creates them, and the high cost inputs required to grow them, are in the vanguard of this new collectivisation project in the developing world which transfers power and deliberation over the growing and making of food from farmers and householders to private corporations (Northcott 2003). Resistance to GM crops in the developed, and developing, world reflects not only uncertainty about the risks of GM foods to the environment or to human health. It also resonates with the reflexive relationships between culture and agriculture, and between political freedom and distributed powers over land and making. Neither the walls of the science laboratory, nor the biota free environment of the petri dish, can isolate the products created therein from contestation over these relationships.

References

Belloc, H. (1913) *The Servile State.* London: T N Foulis.

Berry, W. (1977) *The Unsettling of America: Culture and Agriculture.* San Francisco: Sierra Club Books.

Bruce, D. and Bruce ,A. (eds.) (1999) *Engineering Genesis: Ethics of Genetic Engineering in Non-Human Species.* London: Earthscan.

Flannery, K. and Marcus, J. (2012) *The Creation of Inequality: How Our Prehistoric Ancestors Set the Stage for Monarchy, Slavery, and Empire.* Cambridge, MA: Harvard University Press.

Hallenbeck, T. (2014) Vermont defends GMO labelling law. *Burlington Free Press* 8 August 2014.

Heisenberg, W. (1958) *Physics and Philosophy.* New York: Harper.

Herrick, C. (2005) 'Cultures of GM': Discourses of risk and labelling of GMOs in the UK and EU, *Area* 37: 286–94.

Montoya, A. (2010) *The Theology of Food: Eating and the Eucharist.* Oxford: Wiley-Blackwell.

Northcott, M. (2003) Behold I have set the land before you (Deut 1. 8): Christian Ethics, GM Foods and the Culture of Modern Farming. In Deane-Drummond, C. and Szerszynski, B. with Grove-White B (eds.) *Re-Ordering Nature: Theology, Society and the New Genetics.* London: T and T Clark, pp. 85–106.

Northcott, M. (2005) Concept art, clones and co-creators: the theology of making, *Modern Theology* 21: 219–36.

Novak, W. and Haslberger, A. (2000) Substantial equivalence of antinutrients and inherent plant toxins in Genetically Modified Novel Foods, *Food and Chemical Toxicology* 38: 473–83.

Nourish (2014) True cost accounting: how can we pay for sustainable food? 4 June 2014, Edinburgh Centre for Carbon Innovation, Edinburgh, Scotland.

Plato (2005) *Statesman,* trans. Waterfield R. Cambridge: Cambridge University Press.

Pusztai, A. and Bardocz, S. (2006) GMO in animal nutrition: potential benefits and risks. In Mosenthin, R., Zentek, J. and Żebrowska, T. (eds.) *Biology of nutrition in growing animals Vol. 4*, Amsterdam: Elsevier, pp. 513-40.

Redclift, M. (1980) Agrarian populism in Mexico - the 'via campesina', *The Journal of Peasant Studies* 7: 492–502.

Richard, S., Moslemi, S., Séralini, G-E. et al. (2005) Differential effects of glyphosate and roundup on human placental cells and aromatase, *Environmental Health Perspectives* 113: 716–20.

Séralini, G-E., Cellier, D. and de Vendemois, J. (2007) New analysis of a rat feeding study with a genetically modified maize reveals signs of hepatorenal toxicity, *Archives of Environmental Contamination and Toxicology* 52: 596-602.

Séralini G-E, Chair, E., Mesnage, R. et al. (2012) Long term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize, *Food and Chemical Toxicology* 50: 4221-31

Shiva, V. (2006) *Earth Democracy: Justice, Sustainability and Peace.* London: Zed Books.

Smith, J. (2005) *Seeds of Deception: Exposing Industry and Government Lies about the Safety of Genetically Engineered Foods You're Eating.* White River Junction VT: Chelsea Green.

Thompson, P. (1995) *The Spirit of the Soil: Agriculture and Environmental Ethics.* New York: Routledge.