

# Diet and Diseases: Facts and Fantasies

*A discussion paper for the Academy of Medical Sciences meeting on 20 October 1999*

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1. It is not at all surprising that, since BSE was described in 1986; and its human form - variant Creutzfeldt-Jakob disease (vCJD) - in 1996, there has arisen a widespread preoccupation with the safety of the food supply in the UK. BSE has been a huge disaster for cattle and the scale of its impact on humans is still unknown. There have so far been 43 deaths from vCJD. There have also been a number of outbreaks of severe bacterial food poisoning during this time which have caused rather more deaths - showing that problems of food safety are not all novel.
2. What is surprising is that this preoccupation should now have become transformed into an obsession with the health risks of genetically modified food crops, which have been widely eaten in particularly in the USA and the Far East and are not known to have caused any health problems at all.

## **The origin of BSE**

3. The origin of the BSE outbreak cannot be attributed to scientific meddling with food. Meat and bone meal made from dead cattle and sheep has been fed to farm animals for a long time - certainly since the end of the First World War - and this practice became common in large parts of the world after the Second World War. It was certainly not peculiar to the United Kingdom. The meat and bone meal itself is a side product of the production of tallow, which was widely used. At that time there was really no reason to be concerned about the practice. Scrapie was not known to be transmissible until 1936 and the remarkable resistance of the scrapie agent to inactivation by heat, ultraviolet light and radiation was not shown until the mid-1950s. If the animal food industry was aware of this work they could reasonably have reassured themselves with the thought that they had forty years or more experience of feeding this material without ill effect.
4. Shortly after BSE was recognised in 1986, it was shown on epidemiological grounds to be the result of feeding meat and bone meal. It was proposed that changes in the rendering industry introduced in the 1960s and '70s (when a continuous extraction process was substituted for a batch process which had included higher temperatures and a solvent extraction step) had allowed the scrapie agent to survive in meat and bone meal and to infect cattle, thereby producing BSE. Although highly plausible, newer work has cast substantial doubt on both the latter suppositions. BSE is not any common form of sheep scrapie transferred to cows. Experimental attempts to transmit scrapie to cows do not give rise to BSE. Furthermore attempts to inactivate the BSE agent by the batch rendering processes have been unsuccessful. It is therefore probably wrong to blame changes in rendering technology for the outbreak of BSE although it may have facilitated its spread [1]. It really does seem to have been an extremely rare misadventure. It is likely that BSE is a very rare spontaneous spongiform encephalopathy in either a cow or in a sheep, which has been spread through the cattle food chain as meat and bone meal. This is probably analogous to what happened to the Fore people in New Guinea. The New Guinea highlanders have probably engaged in cannibalism for a very long time. The misfortune of the Fore was, sometime around the turn of the century, to eat someone who was incubating sporadic Creutzfeldt-Jakob

- disease. In this way the agent of CJD entered the human food chain of this tribe and gave rise rapidly to a severe epidemic.
9. With the benefit of hindsight what morals can be drawn from the origin of the BSE epidemic? One is that it is necessary that all practises in food production - established as well as novel - be kept under review by competent regulatory bodies who keep abreast of new scientific findings. A second possible conclusion is that one should be respectful of ancient taboos. The taboo against cannibalism is very strong and, whatever its origin, it may have survived because those who indulge in cannibalism eventually leave less progeny!
  10. The BSE enquiry is still investigating the actions that were taken to respond to the outbreak of BSE. But there is little dispute that, after the first cases of vCJD appeared in 1985, rigorous and well thought out precautions were put in place to minimise the risk of further infected material entering the human food chain. It is still impossible to predict with any accuracy the extent of the outbreak of vCJD that is to be expected. It is not certainly known when and from precisely what source people were infected. We do not know the mean length of the incubation period of vCJD or its variability and so far there is no satisfactory way of making the diagnosis before the clinical onset of the disease. Because of these limitations the best models now available (from Professor Anderson's unit in Oxford) cannot be more precise than estimating a range from between 500-500,000 cases by the year 2025. While diagnosis is possible only after the onset of the disease it will be difficult to predict the extent of the outbreak until its peak is passed. However, if the early diagnostic procedures now being introduced based on the detection of prions in tonsils and appendix turn out to be robust and if they are applied on a large scale then much more accurate modelling will become possible. In the meantime, it really must be sensible to take all reasonable precautions to keep the food supply free of infection, especially for the generation who were not eating potentially infected food in the 1980s. It is puzzling therefore that there has been such widespread rejection of measures like the ban on beef on the bone (which contains dorsal root ganglia - a possible source of infection). One plausible explanation is that there is a strong wish to deny all that is known about the spongiform encephalopathies because it would be more comfortable if it were not true. Many would like to believe that BSE is not a contagious disease spread by an unusual resistant agent although this is established beyond all conceivable doubt. Because the precise nature of the infectious agent - whether it is wholly protein (which is the more likely) or contains a very small amount of nucleic acid - still excites some discussion, there is a view that the well-established fact that there is an infectious agent can be ignored. This view is deeply irrational and is exactly comparable to the belief that, because some of the finer points of evolutionary theory still excite discussion, creationism remains as tenable as evolution. Both represent the desire to reject uncomfortable fact in favour of more comfortable fiction. Thus wide public attention has been given to theories about organophosphate intoxication as a cause of BSE. It is absolutely clear that organophosphates can be neither a necessary nor a sufficient cause of BSE (although it is conceivable that they increase susceptibility to the infective agent). Similarly, the autoimmune hypothesis for BSE - which can be confidently rejected on experiments already done - is still attracting public research funds.
  11. In an essay on fairy stories Tolkien points out that it is always the youngest son, the one who is neither industrious nor clever, who gets the girl or the treasure by virtue of being nice to an old lady; and that this pattern represents a common wish fulfilment. In just the same way, not just the tabloid press but others who should know better, would love to show that the scientists who study BSE, who do experiments and who read the scientific literature are all wholly wrong and that some maverick scientist or, preferably, someone with no scientific training at all turns out to have dreamed up the correct solution. This is however just a fairy story and not a rational basis for public policy.

13. In the case of BSE therefore there is undoubtedly some danger to public health which may affect small numbers or may still turn out to be a substantial epidemic. Prudent measures to minimise possible contamination of the food chain have therefore been put in place but, surprisingly, they have been largely rejected by public opinion at least in so far as this is reflected by the media.

### **Genetically modified food**

14. This is in striking and startling contrast to the situation with regard genetically modified food crops where the hostility expressed is as intense as it is lacking in any underpinning science. The genetic modification of food crops by selective breeding goes back to the beginning of agriculture and, with increasing knowledge of plant cell and molecular biology, has become more scientific and much more efficient. Large parts of the world's crops are now grown from conventionally bred, F1 hybrid plants. Because F1 hybrid plants do not give rise to F1 progeny this means that new seeds have to be used on each occasion. This applies to a large part of the vegetable crops grown in the developed world and increasingly to cereal crops grown in the third world. Because the yield is so much higher, there is usually financial advantage to the farmer in using F1 hybrid crops. The need to use fresh seed has nothing to do with the introduction of genetic manipulation, accounts in the press notwithstanding. The transfer of genetic material between bacteria and plants, which is the basis of much plant genetic engineering, also occurs in nature, albeit at a slow rate. Genetic modification is a discovery and not really an invention. It is just a new phase in the improvement of crops and it has great potential for human benefit. At the present time almost all discussion attaches to the introduction either of herbicide resistance which allows crops to be sprayed with a particular herbicide which will kill the weeds but not the crop, or the introduction of a bacterial gene that makes a plant resistant to stem-boring insects and therefore avoids the use of insecticides against such pests. Although these are useful innovations, they do represent the 'horse-less carriage' phase of the development of genetic manipulation of crops. There are in the middle distance far more important goals [2]. For instance, a great deal of agricultural land is lost to saline pollution, often due to the over-extraction of water. There are plants that can grow in saline polluted soil but they are not crop plants and the possibility of using genetic manipulation to allow crop plants to grow in saline polluted soil would be an enormous benefit to world agriculture and to the feeding of the poor. Water supplies are increasingly critical and it may be possible to engineer plants so that they have an increased resistance to drought. Perhaps the most ambitious goal of all is to increase the efficiency of the photosynthetic process. This is very inefficient and if it were possible by manipulating the genes to increase the efficiency from 1% to 5%, it has been calculated by Lord Porter [3] that agriculture could meet not only the food but also the energy needs of the planet with all the environmental advantages that this would bring. Not least it would mean that nuclear power generation would become unnecessary. It is therefore particularly odd that the very pressure groups who so strongly oppose nuclear power should now be equally opposed to the genetic modification of plants!
15. Beyond its use for improving food crops, plant biotechnology is already used for making pharmaceutical agents and may be used for producing biodegradable substitutes for plastic. It is difficult therefore to understand why this technology, which carries so much promise for the public good, should be so vociferously condemned as a moral evil.
16. The moral arguments used are frequently contradictory and sometimes shameful. One set of arguments concerns human health. This is particularly puzzling since there is no experimental, or even anecdotal, evidence that genetic manipulation of plants as a process carries any hazard to human health at all, nor has anyone suggested any plausible mechanisms by which it could do so. Of course every novel crop product

requires careful evaluation and there will be a need to re-assess some of the practices in the light of developing knowledge and experience. It is probably not a good idea to introduce proteins from brazil nuts into cereals to improve the protein quality since this provides a hazard to those who are allergic to nuts. However, this hazard is no different than if the brazil nut protein were simply mixed with the cereal crop. It is also not a good idea to leave antibiotic resistance markers in crops because of the hypothetical possibility that this could transfer to gut bacteria.

20. It is a habit of media interviewers to ask whether a process is absolutely safe. This is not a meaningful question since risk is a quantitative concept. With regard to GMOs it would be more reasonable to ask whether they carry greater risks than similar crops grown without genetic modification. There are no data to suggest that a genetically modified crop as such carries any greater risk than a crop grown by conventional agricultural procedures; and particular introduced genes may reduce certain hazards. For example, if it is no longer necessary to spray a crop with an insecticide that carries some safety advantage. Furthermore, genetically modified crops are likely to be safer than organically grown crops and it is, again, curious that the same people who are so passionately opposed to genetic modification on safety grounds seem happy to eat organic foods richly manured with animal dung and not sprayed with fungicide. There are substantiated outbreaks of E.coli food poisoning traced to the use of animal dung as fertilisers (particularly in unpasteurised apple juice) [4] and the danger of poisoning by fungal toxins is unjustifiably ignored by the general public. These were in previous generations a serious cause of food-borne disease. In northern Europe ergot poisoning from fungus contaminated rye - St. Anthony's Fire - was a much-feared disease and outbreaks have occurred this century. Another fungal toxin, aflatoxin, is widely found in cereal crops grown under moist conditions - not just in mouldy peanuts - and is a major cause of liver disease, especially in carriers of hepatitis viruses. Personally I would be happy to be reassured that the cereals used to make my bread do not contain any that have not been treated with fungicides. However, all these dangers are quite small and the safety of our food supply is not a serious concern. Major problems with bacterial food poisoning come from unhygienic practices between farm and consumer.
21. The other concerns about genetic modification of food concern the effects on biodiversity and ecology. While such concerns need to be carefully considered in each case, reduction in biodiversity is not peculiarly related to genetic modification. Modern high intensity agriculture has greatly reduced the number of crops that are grown for food and has led to large tracts of land being virtually monoculture. It is, however, at least arguable that the intelligent use of genetic modification may make this problem better rather than worse. It should not be forgotten that real ecological disasters have been brought about both in the distant and the recent past by the ill-considered introduction of plants into novel environments. The introduction of ground elder into United Kingdom as a salad vegetable is one good example and the introduction of the water hyacinth from South America to Africa and India is another. The latter was done with the entirely laudable aim of allowing these plants to help clean up the water. It was not foreseen that they would grow as rampant weeds in the affected areas. It is, however, no solution to this problem to conclude that plants should never be moved from their native habitat. Native food plants in the British Isles were very limited and we should have a very poor diet subsisting on them alone. There would, for example, be no wheat (which was derived in the eastern Mediterranean) and no potatoes or tomatoes (both from the New World). The Australians would be even worse off since there is no native cereal crop there at all.
22. What explanations can be given for this extraordinary difference in the handling of the real dangers of BSE and the imaginary ones from genetic modification? It has been partly due to the agenda of well-organised single interest groups. Their arguments are particularly shameful. The same people who have for years opposed the development of the green revolution and of intensive agriculture now argue that because we have

enough food grown in this way we no longer need further improvements. Another, perhaps more widely, felt view is that genetic manipulation is somehow unnatural and an unsuitable activity for humans to indulge in. It is interesting that this view has no large following when applied to medical biotechnology. We manipulate bacteria and yeast to produce pharmaceutical agents and these are used on a world-wide scale without opposition and with enormous benefit. Hepatitis B vaccine is an excellent example. Growth hormone is another and indeed recombinant growth hormone is free from the risk of transmitting Creutzfeldt-Jakob disease which unfortunately happened with growth hormone extracted from human pituitaries. There is also no substantial opposition to the attempts to cure disease by modifying the somatic cells in disease sufferers. It has been widely discussed in many ethical fora and by theologians and the majority view is that it provides no new ethical problems. The third argument, more often voiced in private than in public, is that the real problem is world over-population and that increasing the food supply will just move this ratchet further and simply delay some final day of reckoning. This argument, besides being morally repellent, is also demonstrably false. There is now strong evidence that the 'demographic transition' that is required for a population to lower its birth rate and to concentrate on improving the quality of life of its people is achieved only when there is a secure and adequate food supply and proper investment in education, particularly of women. It is only by achieving an adequate and stable food supply for the existing world population that one is likely to achieve a substantial reduction in population growth.

15. On a more parochial note, it is clear enough that while 300 million Americans and a billion Chinese are happy to consume genetically modified food and to develop its production, the resistance to the technology in the United Kingdom is unlikely to be of huge significance on a world scale. The damage that this opposition is likely to do to science base in the United Kingdom and to our national wealth is however substantial and is a self-inflicted wound which we would do well to avoid.
16. The Royal Society [5] and the Nuffield Council on Bioethics [6] have both produced serious, well-argued papers on genetically modified foods, as has the Government's chief scientific adviser [7]. They have received little public attention and are ignored by the single-issue groups. It could be helpful if more opinion formers in science and in medicine and in agriculture were prepared to speak out with enthusiasm than has recently been the case. Fear of public opinion is really no less reprehensible than fear of official disapproval as a reason for keeping a low profile. It is not just genetically modified food or indeed agricultural science that is under threat but all scholarship and rational debate.

### References

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[3] *The Rajiv Gandhi Science and Technology Lecture: Life under the sun.* Lord Porter. January 9 1995.

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This paper was discussed at the regional meeting of the Academy in Edinburgh on 20 October.

1. The public are very much more sensitive to risks that are imposed on them compared to risks that they choose to take themselves. This may be one reason why they are more tolerant to eating beef on the bone than genetically modified commodity crops where they have not been able to avoid eating them. It would seem that adequate labelling should therefore eliminate this particular problem.
2. There was general agreement that the quality of the scientific debate on these topics in the public media was low.
3. It was felt that worries about GM food were driven more by environmental considerations than by consideration for human health, though it is clear that the BSE episode had greatly diminished the public's confidence in the government reassurances.
4. There was agreement that the Academy should take a positive stand in upholding good science in controversial matters and it was agreed that the Academy's role in controversial science would form the topic of a discussion at the Annual Meeting in November.