Comment on Stefan Flothmann and Jan van Aken's article 'Of maize and men' in *EMBO reports*, August 2001

Stefan Flothmann and Jan Van Aken, in a reply to our article in *EMBO reports*, 2, 455–459, raise issues about our objectivity and our concern for ensuring that sufficient food is available for an increasing population. We clearly cannot address those criticisms 'objectively'. But their article contains a number of quite serious biological errors, and more seriously, provides a selective representation of the scientific information available on the benefit/risk assessment of genetically modified (GM) crops. Here we would like to address some of their allegations.

Transgenic plants contain genes and traits that are completely new to the species and its environmental context. In the case of GA21 corn—a GM crop resistant to Roundup herbicide—the modified EPSPS protein, which confers resistance to the herbicide, is only 3 amino acids different from EPSPS in normal corn. In fact, GA21-EPSPS is closer to wild-type EPSPS than to EPSPS from other plants. On another note, is Bt protein really completely new to the human diet, considering that it has been used in farming for the last 40 years?

The process of genetic engineering is neither targeted nor precise, but rather a crude intervention. Current 'traditional' plant breeding actually uses adventitiously and randomly generated mutants to produce disease and insect resistance. According to the Atomic Energy Agency in Vienna, 2252 types of crop plants have been artificially bombarded with radiation to induce mutations. Unlike genetic modification, the effects of radiation are completely random and totally unpredictable. This form of genetic engineering (GE) alters both chromosome structure and genome sequence alike, in ways no other technology can, but has been used by breeders for 50 years mainly to obtain pest-resistant crops. Ironically, organic farming specifically chooses to use pest-resistant varieties in order to reduce pesticide use without due regard

to variety yield. Of all the forms of farming, the organic approach is the most dependent on varieties generated by radiation. Greenpeace espouse organic farming, and organic farmers reject standard GM crops. In so doing, they accept a form of GE that has never been assessed for safety, and is less predictable and more random than GM, which they claim to be hazardous. But Greenpeace clearly support these plants as 'traditionally' bred.

A conventional maize insect resistance—be it a toxin, a feed deterrent or a structural component—evolved together with maize and its environment. Maize is a domesticated plant and the only environment it has ever seen has been the cultivated field. The only evolution maize has experienced has been in the hands of plant breeders. If indeed Greenpeace has classified this 'intervention' as evolution, at what point does man's intervention no longer represent their 'classification' of evolutionary progress? Teosinte, the wild plant from which maize may have been domesticated, is not a primary or even secondary source of genes for maize breeders. However, the original teosinte individuals that were evolved into maize represent only a tiny part of the genetic diversity in wild teosinte. For better or worse, the only pest resistance that came with them were the genes in those few individuals.

We did warn readers of our article that activist groups constantly confuse pollen movement with real pollination. The paper by Timmons *et al.*, 1995, quoted by Flothmann and van Aken as evidence of pollination at 1.5 km, actually used pollen traps—some others have used male sterile plants—and not measurements of pollination. Our figure of 99.9% purity maintenance for rape at distances of 100 m comes from a report prepared for the UK government, which examined all the assessments of pollen distribution but recognised the obvious flaws in confusing pollen detection with real fertilisation.

The senior author of Timmons *et al.*, Mike Wilkinson, provides real estimates of introgression in a paper whose title '*Transgene risk is low*' says it all. Extensive experience has been obtained over many decades in the production of high-purity seed samples, and crop isolation distances have been laid down to achieve this. Long distance pollination or seed transfer is very rare but has undoubtedly occurred. However, Flothmann and van Aken provide no evidence other than unreal possibilities that, somehow, an engineered crop will march across the countryside destroying everything in its wake. Declines in biodiversity or species number have resulted largely from habitat loss, change in land usage or hybridisation, and were rarely due to displacement from other species, especially domesticated ones. Such stories should be confined to the pages of science fiction.

Gene flow has always occurred and will continue until breeding results in complete separation of crop and weed. Some weed individuals may briefly benefit from gene flow but a weed population has to rely on enormous individual genomic variation to exploit its environments. A single transgene is far less likely to be beneficial than a trait from a traditionally bred crop. At the end of the day every farmer can resort to the plough to eliminate unwanted plants, and newer methods of soil UV and heat treatment can eliminate seed banks; that is in addition to the 100 or so herbicides.

Rhododendron ponticum, which we offered as an example of a nuisance plant, was not introduced but arose naturally as a result of unusual hybridisation. In fact, as our climate changes so will population numbers and species distributions. To try to set the world in aspic so that nothing can change is far more dangerous, as it means setting ourselves in opposition to the flow of nature. Mankind is part of this world, and as populations burgeon, he will continue to modify where he lives. He should do so with sensitivity. Human

population numbers are the basic problem; not technology designed to react to common humanity.

We referred only briefly to the Monarch Bt corn experiments because they have been discussed at length, and their significance largely rejected by both ecologists and entomologists. Their conclusions can be quoted: 'the effect on survival of butterfly populations of Bt corn pollen dusting their larval food appears to be relatively insignificant compared with other facts, insecticides, herbicides and fungicides, and habitat destruction'. The Hansen and Obrycki study quoted is again not a proper field study and is no more useful than the Losey study that started this particular discussion. Bringing leaves with pollen on them into a laboratory and forcing larvae to feed on them is akin to forcing humans to consume 50 kg of popcorn. Death would result from salt stress. Flothmann and van Aken conceal the assessment already made by many researchers and contribute to the mistrust of scientists and science of all kinds. Furthermore, they did not refer to the report on black swallowtail larvae, which showed no effect of Bt pollen.

Claiming that GM crops induce some subtle change in field populations of insects is true, but Flothmann and van Aken compare GM crops to a scenario of no insect control and ignore the fact that very few data on current field insects are available. We agree that it is likely that Bt-crops will impact insects differently than current agricultural practice. But of more importance is the positive balance of benefit/detriment to various species when adopting a Bt crop. As any farmer will confirm, each different crop in a rotation

changes the field balance of insects radically.

Finally, Greenpeace do not like our disqualification of laboratory tests as relevant claiming that 'risk assessment of hazardous chemicals is based on the concept of acute toxicity and that we (Trewavas and Leaver) would not argue for the safety of benzene or other carcinogens on the grounds that their hazardous nature was only tested in the laboratory and in worst case scenarios'. There are about 10 000 natural substances in both organic and conventional fruits and vegetables which when extracted, concentrated and injected into rodents will induce cancer and benzene is one of them. On this basis, should we stop eating fruits and vegetables because benzene is a natural constituent of many of them? This point illustrates the old adage 'it is the dosage that makes the poison'. Laboratory data on carcinogenic effects of benzene indicate only that benzene is a carcinogen at extreme dosage, and so we will continue happily to eat fruits and vegetables.

The hallmark of scientific objectivity is to change your view when the science shows it to be wrong; the hallmark of politics is to save face by all means possible and pick up on any selected information that can be twisted into shape to maintain a predetermined position. If we find evidence that indicates GM crops to be dangerous, we will say so but we will wait for Greenpeace to retract their requirement of absolute safety since there is no doubt that it is scientifically unsound. The nub of the Greenpeace article is simple. Because some hypothesised difficulties with a new technology

can be imagined, ban it forever. If we had taken this attitude throughout history we would never have developed farming—including fertilisers and crop protection with pesticides—electricity, computers, aeroplanes, drugs or even built houses. We would still be neolithic lumpen waving clubs at each other. Some members of Greenpeace would actually prefer that scenario since they frequently elevate the environment above the survival of mankind rather than recognising the mutual interdependence. There will always be problems with any new technology; the key is not to reject the benefits but to improve safety, avoid difficulties and reap the rewards. We believe that every citizen has the right to benefit from the advances of science but that those rights also involve responsibilities. Indeed, we have confidence in the ability of mankind to solve problems by the application of knowledge. We agree with the detailed testing of GM products as we previously stated but believe that other agricultural production systems, organic and conventional, should likewise receive the same rigorous degree of inspection so we can all make an informed comparison.

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