CORRESPONDENCE

WEED PROBABILITY CHALLENGED

To the editor:

Your article on the risks from genetically engineering crops (*Bio/Technology* **7**:1134, Nov. '89) is liable to mislead companies that put proposals before regulatory committees in Europe. Most of Dr. Keeler's article leads to the conclusion that the risks are minimal: only on the last page does she come nearer the reality that such committees are dealing with at present. In particular, we challenge the statement that the probability of turning a crop into a weed is 10^{-10}.

Keeler points out that there are three routes by which weeds have evolved, but does not discuss selective modifications and genetic exchange with wild relatives. However, selective modification of existing weeds and other plants will undoubtedly occur if many herbicide-resistant crops are planted[1]. Similarly, companies are certainly interested in the genetic modification of crops such as oilseed rape or canola *Brassica napus* which have many closely related weeds in the European landscape. Rape itself is a minor weed.

Secondly, although Keeler contends that there is a general consensus about the plant characteristics associated with weediness, this is a consensus only in the Bellman sense[2]: "What I tell you three times is true." In our experience, most plant ecologists and weed scientists consider Baker's[3] list to have little predictive value. One reason for this is that the characters are ill-defined (e.g. "ability to compete by special means") and different scientists will produce different scores for the same plant. We regard Keeler's scoring as being biased to weediness in her list of weeds and against weediness in her list of crops, thereby exaggerating the difference. Examples are her listing of wild oats *Avena fatua* as having high seed output, but cultivated oats *A. sativa* not, and corn *Zea mays* and wheat *Triticum aestivum* as not having rapid growth to flowering.

We note too that Keeler's counts of weeds that are cultivated and crops reported as weeds both differ from ours[1,4]. In "The World's Worst Weeds"[5] it is said "Those who are not acquainted with the distribution across the world of our worst weeds often seem confused that a plant which is an important weed in one area may be a valuable crop in another place." That is, no change whatever is necessarily needed to change a crop into a weed, making the probability of a change 10^{0}—ten orders of magnitude different from Keeler's estimate. In her final section, which we regard as much better balanced, she does indeed refer to millet as being both a weed and a crop.

We also think that Keeler has used a method that would make crops and weeds appear more distinct, by using two sets that show considerable taxonomic differences. The weeds are drawn from just six families (59 percent are Poaceae, grasses), the crops from 11 families (just two in common with the weeds), and the non-weeds from 12—again, mostly different—families. Her probability estimate of 10^{-10} is, if anything, an estimate of the probability of turning a bean (Leguminosae or Fabaceae) into something like a grass (Gramineae or Poceae).

Our own studies on plant pests[6], funded by the U.K. Health & Safety Executive, indicate that no combination of characters is likely to have better than a 70 percent improvement over random chance in predicting whether a plant will become a pest. For regulatory committees that have to consider each case on its merits, the remaining 30 percent points to a need to continue case-by-case[7] review for some time yet. Companies would be well advised not to quote Keeler's work as evidence that their proposals are safe, and certainly not her probability estimate.

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1. Williamson, M. 1990. Proceedings of the 11th Long Ashton International Symposium (in press).
2. Carroll, L. 1876. *The Hunting of the Snark.* Macmillan, London.
3. Baker, H. G. 1965. *The Genetics of Colonizing Species*, p. 147. Academic Press and 1974 Ann. Rev. Ecol. Syst. **55**:1.
4. Williamson, M. 1988. Trends in Biotechnology **6**:832.
5. Holm, L. G., Plunknett, D. L., Pancho, J. V., and Herberger, H. P. 1977. *The World's Worst Weeds.* Univ. Press of Hawaii, Honolulu.
6. Perrins, J., Williamson, M., and Fitter, A. (submitted) Ann. Appl. Biol.
7. OECD 1986 *Recombinant DNA Safety Considerations.* OECD, Paris.

I am in basic agreement with Fitter et al. about the general prospects of serious new weeds. However, in my paper, I intentionally discussed only one of the three ways weeds have originated: change of a crop into a weed. Other means of weed evolution, including gene exchange with weedy wild relatives of crops, were more than could be handled within Bio/Technology's format and will be considered in subsequent papers. But as noted in the references in my article, there seems to be consensus that serious weeds could be produced by hybridization with weedy wild relatives.

While my approach may be imperfect, I recommend that those who find it superficial or suspect gather and publish their own data and analysis to test the hypothesis that agricultural selection on crops has produced plants whose genes fit them to be crops, not weeds. This discussion needs data, not undocumented assertions. I presented the bulk of my data and would be happy to supply the rest, so that the reader may draw independent conclusions. The average differences between weeds and crops are not noticeably changed by the scoring improvement recommended by Fitter et al. and others.

A serious issue raised by Fitter et al.'s comments, and on which we appear to differ, is: How similar are weedy wild races of crops to the crop itself? Fitter et al. point to conspecific weeds to say crops are weed problems. In many cases wild progenitors and derived weeds of a major crop are given the same taxonomic status as the crop, i.e. are put in the same species by taxonomists. In the cases where I am personally familiar with both members of the pair, e.g. sunflowers, Helianthus annuus, the two are quite different plants, with quite different levels of weediness. Thus, it is weedy wild sunflowers, not cultivated sunflowers of the species, that are the noxious weed[1]. Therefore I considered the traits of the crop sunflower, not the weed, in the crop analysis. In the millet example cited, the authors emphasize differences between crop and weed[2]. Would farmers plant the rape that is the minor weed referred to by Fitter et al. as oilseed rape? I assumed not, and proceeded on that basis. (Hybridization will be important, but was intentionally excluded from this paper.) Clarification of differences between crops and weeds bearing the same scientific name is clearly a critical issue for understanding if and how transgenic crops become weeds, and urgently needs thorough analysis.

Fitter et al. emphasize "We don't know." This seems to be a habit of "outdoor" biologists who, after all, study variation, not similarity[3]. While weediness cannot be predicted with certainty, the 70 percent probability Fitter et al. cite for their unpublished paper is a dramatic improve-