COTTON IMPROVEMENT: A PARTNERSHIP WITH PRODUCERS 3. MANIPULATING USEFUL TRAITS/GENETIC ENGINEERING ARE TRANSGENIC PLANTS "RISKY BUSINESS"??

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Transgenic organisms have become the unfortunate media targets of the 90's, generating articles in the popular press and resistance to their appearance in the European marketplace. A rational discussion of the risks of transgenic plants (or animals or bacteria, etc.) has become clouded by emotion and misinformation. What I hope to do here is to try to balance legitimate concerns and questions with scientific knowledge (or lack of) so that we can objectively determine the risks of transgenic plants now and in the future.

Producer/consumer confidence has not been helped by the sometimes polyannaish advertising and attitudes of some of the seed and chemical companies. The checkered history of industry-funded research, such as on tobacco, has given rise to a strong public perception of distortion leading to a distrust of industry reports. Frank discussions of the risks associated with transgenic plants are necessary so that consumer confidence can be regained such that intelligent, **informed** decisions can be made about transgenics in their lives.

Four major concerns exist with the present generation of transgenics – allergies, "Super Weeds", "Super Insects" and "Super Bacteria", to put it simply.

The concern over allergies is problematic, either the transgenic contains allergens or it doesn't. What is important is that **all** the introduced gene products (selectable marker, etc.) must be tested for allergic responses, especially if a promoter that is active in most cells is used. Gene products of the current generation of selectable marker genes – *nptII* and *bar* – have been shown to be nonallergenic but new selection schemes mean new testing. The experience with the Brazil nut protein construct illustrates the absolute requirement for human testing as animal models indicated no allergenic response. Transgenic soybeans were developed by Pioneer using a Brazil nut protein gene to increase methionine levels. Although there was no reaction when tested in an animal system, exposure to several human volunteers triggered an allergic response. Pioneer subsequently dropped plans for marketing the soybeans, a refreshingly ethical decision.

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Discussions on the "threat" of transgenics to the environment have conveniently ignored the existing archive of past introductions of "exotic genes", namely the spread of new cultivars by agriculture into areas that were not ancestral locales. Although some crops have become problems (=weeds) in some countries, the ecological impact of new cultivars has been relatively benign. That is not to say that introductions of exotic species are not ecologically risky; kudzu, zebra mussels and starlings were all introduced and all epitomize the term "pest." However, the evaluation of the growth characteristics of various field-grown transgenics (especially rapeseed) have shown no indication of increased(super) weediness. This does not justify a blanket approval for all transgenics but should ease concerns over the validity of the testing which should be continued for each transgenic. We are woefully ignorant of the environmental effects when genes cross kingdom barriers.

"Super Weediness" was troubling to some when the first herbicide-resistant (and to some degree, the antibiotic-resistant) transgenics appeared. Again, testing has so far shown little evidence of increased competition by the transgenics and, unless the herbicide is used outside the field, selective pressure does not exist. Whether or not spread to wild relatives will compromise herbicide treatments depends on the presence of the relatives in the first place. In addition, herbicide resistance is used ONLY during the production of some transgenics; the herbicide may not even be used or licensed for the crop and so, again no selective pressure exists.

"Super Weediness" may prove to be more of a concern when the genes introduced improve the physiology (=ability to grow) of a plant. In this scenario, a plant could have a selective advantage and may outcompete the native vegetation if it escaped from cultivation. Again, adequate testing should answer this concern. The spread of these genes to wild relatives is only of consequence if the wild relatives 1) are present and 2) can breed/cross with the transgenic.

The development of Bt-resistant plants was also accompanied by a media barrage on "Super Insects." The discussion completely overlooked the fact that the Bt powder has been indiscriminately sold over-the-counter for many years and resistance to Bt in some insects has already been detected. Although enomologists are concerned about the development of resistance to the biodegradable "Bt powder", no concrete rules have been in force to regulate access and use of this insecticide. There is no doubt that Bt transgenics are a selection pressure and no doubt insects will overcome the resistance. The relevant question is when. The current "solution" for resistance management has been to establish refugia so that high numbers of susceptible insects are always present. Refugia are supposed to keep the population levels of resistant individuals low but this has been mainly evaluated through computer models and not field testing. The question is whether or not the refugia concept is truly a practical solution for delaying the onset of insect resistance to pesticides.

Again, the spread of Bt-resistant genes to wild relatives is of great concern **IF** they are present and can be crossed with the transgenic. Anything that alters the selection pressure will alter the frequency of the resistant individuals as well as probably compromise the refugia effect. The growing of two different Bt transgenics side by side also complicates the Bt resistance scenario especially for insects, like the cotton bollworm/corn earworm, that can feed and reproduce on both plants. Hence the current ban on growing Bt corn and Bt cotton in the same region.

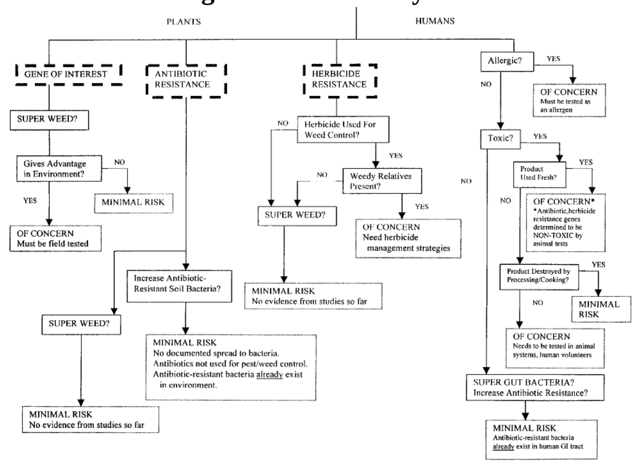
That not all pests are controlled, that full control is not always possible and that not all spraying is eliminated have sometimes been underplayed by the marketing advertising. However, the reduction of certain very destructive primary pests has been spectacular using transgenics and most farmers have been very happy with the results.

The concern over "Super Bacteria" takes on added publicity with the reports of "killer bacteria" resistant to most major antibiotics. People have become extremely sensitive to any possibility that may compromise antibiotic therapy. The *nptII* gene, used in the production of many transgenics, provides resistance to alpha-amino glycoside antibiotics, the most common of which is kanamycin. Kanamycin is also used for treatment of animals and humans and the concern was voiced that for those transgenics which are generated by antibiotic selection, would the presence of antibiotic resistance genes compromise antibiotic therapy?

Despite the difficulties of transferring a gene from a eukaryotic to a prokaryotic organism there is still the problem of expressing a gene, modified for the eukaryotic messenger RNA and protein production machinery, in a prokaryote. The simplest response is that antibiotic-resistant bacteria, particularly to kanamycin and its relatives, are ALREADY present in the environment (not to mention you or me at this very moment). Since antibiotics are not commonly used as weed or insect control in farming (the only plant industry that uses antibiotics is floriculture where individual plants can have great value) there would be no selective pressure for the development of antibiotic resistance and the risk of Super Bacteria would be less so than in our own body.

Since it is not possible to come up with a blanket means to evaluate the risks of transgenic plants, it then implies that there has to be continued bench and field testing, much like for new drugs. Each transgenic will have to be judged on an individual basis and probably by each nation or region, depending on the genes introduced and the wild relatives present. However, the rewards and potential benefits of transgenics far outweigh the disadvantages from not using them. Crops that are environmentally friendly, crops that provide maximum return, crops that can be factories for new medicines (including pharmaceuticals, antibiologicals, antibodies or even vaccines) can **ONLY** be produced via the transgenic route. Transgenics are here to stay; how well they're used ultimately comes down to an intelligent decision making process that should be practiced with every new technology.

Are Transgenic Plants "Risky Business"?



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