Considerations for conducting research in agricultural biotechnology

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Abstract

Science has shown its increased vulnerability because of two recent high-profile articles published in major journals on corn produced through biotechnology: a laboratory report suggesting profound consequences to monarch butterfly populations due to Bt corn pollen and a report suggesting transgenic introgression into Mexican maize. While both studies have been widely regarded as having flawed methodology, publishing these studies has created great consternation in the scientific community, regulatory agencies and the general public. There are roles and responsibilities of scientists, scientific journals, the public media, public agencies, and those who oppose or advocate a specific technology, and serious consequences when those roles and responsibilities go awry. Modern communication may exacerbate the flow of misinformation and easily lead to a decline in public confidence about biotechnology and science. However, common sense tells us that scientific inquiry and the publication and reporting of results should be performed with high standards of ethical behavior, regardless of one’s personal perspective on agricultural biotechnology.

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Recent controversial articles on agricultural biotechnology published in major journals have caused great consternation within the scientific community, and have led to a decline in public confidence about the use of agricultural biotechnology, and perhaps science in general. Controversies in science can be healthy if they lead to questions that can be investigated, thereby advancing knowledge. However, some of the recent controversies have also involved questions about the integrity of scientific conduct, policies of scientific journal publication, and the proper role of the media in educating the general public about the important issues involving agricultural biotechnology.

As scientists we play a central role in determining the future of agricultural biotechnology. We select the areas to be investigated based on our intellectual curiosity, position responsibility and available resources. Because agricultural biotechnology is a “hot topic,” it has attracted considerable attention by regulatory agencies, funding agencies, the general public and scientists. Scientists are interested in this area for a multitude of personal or professional reasons. Science is done by people, each with his and her own prejudices and view of the world, and this can affect how experiments are performed and reported. Furthermore, because many of us depend on competitive funding and recognition to advance our careers, some may also feel an unhealthy pressure to publish their work before it is solid. While perhaps the best science is done by people with passion, that passion must be balanced with ethical behaviors not injurious to science in the long run.

Aside from personal and professional reason(s) for selecting a particular aspect of science (such as biotechnology) to work on, how research is performed is fundamental to a project’s eventual outcome. Two examples of recent controversies in agricultural biotechnology involve corn engineered to produce proteins from the bacterium, Bacillus thuringiensis, for insect control. While much has been written about the motivation of the authors for selecting these projects (Anonymous, 2002; Knight, 2000), the central consideration should be about whether the science was conducted soundly and reported accurately in the scientific and lay press. I believe these two examples failed in these areas and have damaged the credibility of science and,
particularly, the credibility of agricultural biotechnology. The first example is what can only be considered preliminary findings on the effect of monarch butterfly larvae to be negatively impacted when they consumed milkweed on which pollen from Bt corn had been applied (Losey et al., 1999). This study was strongly criticized in the scientific community because of its poor quality including the unspecified dose of pollen used and the unspecified endotoxin concentration in the pollen, the lack of a choice test, the use of inappropriate controls and the lack of information on the potential for a temporal and spatial overlap of pollen shed, milkweed plants, and monarchs under natural field conditions (Gatehouse et al., 2002; Hodgson, 1999; Shelton and Roush, 1999; Shelton and Sears, 2001). However, for those opposed to agricultural biotechnology, this study became a rallying cry, not justified by the science, but by their personal feelings about agricultural biotechnology. More detailed laboratory studies and a series of field studies have shown the risk to monarch butterfly populations in the field is “negligible” (Gatehouse et al., 2002; Sears et al., 2001).

In 2001, another highly controversial paper was published in the same journal (Nature) as the monarch story. In this paper the authors claimed that native Mexican corn had become contaminated by DNA from genetically modified varieties that were banned in Mexico (Quist and Chapela, 2001). This paper caused a furor in the scientific community because of the techniques used by the researchers. Once it was published in Nature the editorial board of the journal Transgenic Research stated that “no credible scientific evidence is presented to support claims that transgenic DNA was introgressed into traditional maize landraces in Oaxaca, Mexico” (Christou, 2002). Furthermore, the board argued that an analysis of the procedures used “demonstrate that the data presented in the published article are mere artifacts resulting from poor experimental design and practices.” These concerns led to Nature publishing a statement concluding that the evidence available was not sufficient to justify the publication of the original paper. A “retraction” of a paper about such a highly controversial topic is very unusual, and begs the question of why more rigor and caution was not exercised prior to publication (and the same question should also be asked about the monarch butterfly paper). While it is clear that no conclusions can be drawn from the Nature article on Mexican corn, this does not mean that transgenes will not be detected in Mexican landraces in the future or what those consequences might be. The retraction meant that the experimental protocol used by the researchers lacked the rigor to back up their claims. But it is impossible to “un-ring a bell.” Greenpeace used the article to petition FAO for a global ban of the production of all transgenic plants (Piña, 2002).

The impact of conducting flawed experiments in agricultural biotechnology can be tremendous and lead to professional discredit within the scientific community. On the other hand, it may lead those who are against this technology to see the authors of the flawed work as being persecuted by the scientific community. The latter did in fact occur when Food First (Oakland CA) released a statement (Food First, 2002) in which they interpreted the criticisms of the study as “intimidatory tactics” and stated, “Pro-industry academics are engaged in a highly unethical mud-slinging campaign.” As noted by Metz (2002), these and other claims by Food First, including a call to “censor those academics and institutions that slander the competence or integrity of those who publish peer-reviewed studies,” misinterpret the scientific process in which peer review is the beginning of a critical process of scientific investigation and that criticism is not slander.

Perhaps high-profile journals such as Nature have lost some credibility for publishing flawed articles, but I doubt the number of articles submitted to Nature has declined because of the controversy about publishing these two studies. Still, one should be aware of the nature of journal publications. There are about 2000 academic journals of consequence, and most of them are published by non-profit organizations. However, Nature and Science, two of the most prestigious journals, are published commercially, supported by advertising (Knight, 2000). Whether for good or bad, Nature now has more “name recognition” than it had previously. Publication of any flawed article, whether in a journal with relatively high or low “impact” has even further consequences. It presents difficulties to regulatory agencies charged with making decisions for the public good. Furthermore, it corrupts the scientific literature with faulty information. Even articles that are retracted continue to be cited frequently in the scientific literature (Campanario, 2000), as well as in the public memory.

News reports involving biological sciences are more common than ever and the public quickly hears about scientific controversies. Controversies about the monarch and the potential for spread of Bt pollen have been highlighted in the media and have influenced public opinion and may influence public policy. As noted by Abbott (2001), the reporting of biotechnology issues has changed markedly since 1997 and “moved from being a scientific issue to being a social issue.” The media coverage has exploded and the sources of information have changed. In late 1999 the New York Times was running “almost one article per day on this (biotech) topic” (Abbott, 2001).

In a world made smaller by our modern communication methods, more care is needed since misinformation or partial information can easily influence public policy (Shelton and Roush, 2000). When working in agricultural biotechnology, scientists should be
thorough in conducting their experiments and deliberate when reporting on them and base conclusions on “appropriate methods of investigation and sound risk-assessment procedures” (Gatehouse et al., 2002). As scientists working in the highly controversial area of biotechnology, we should consider the comments of Foster (1999) that “the emerging trend toward publishing little scientific studies... causes big problems for scientific credibility” and that these flawed but highly controversial studies have changed the research agenda of many scientists. Although the scientific community has an obligation to examine the effect of biotechnology on the complex environment in which it can influence, the initial studies on the monarch (Losey et al., 1999) and gene flow in Mexican corn (Quist and Chapela, 2001) do not seem a proper beginning to this worthy exercise.

Scientists may feel they are left out of the discussion on these controversies and missing the opportunity to correct scientific misrepresentations. As noted by Abbott (2001) in the media coverage of GMOs in England and the US from 1997–2000, the New York Times and the Times of London were using scientists less and less as sources for stories and, by Sept. 2000, only 12% of the news stories quoted scientists. In contrast, Abbott (2001) stated that environmental activist groups such as Greenpeace, the Environmental Defense Fund and the Union of Concerned Scientists were used increasingly as sources of news and that the newspapers noted were more than twice as likely to use a quote from one of these sources as compared to scientists.

In agricultural biotechnology there are roles and responsibilities of scientists, scientific journals, the public media, public agencies, and those who oppose or advocate a specific technology, and serious consequences for science in general when those roles and responsibilities go awry. Scientists may feel the pressure of competition, especially in an academic setting. Personal views may continue to decide which issues one will work on, but the quality of science must back up those personal opinions. Common sense tells us that scientific inquiry and the publication and reporting of results to the scientific community and general population should be performed with high standards of ethical behavior, regardless of one’s personal perspective on agricultural biotechnology.

References

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