

ATTACHMENT II

COMPILATION OF RESEARCH BEARING ON ROUNDUP-READY SUGAR BEETS

Boulder County Food and Agricultural Policy Council, Research Subcommittee

When the BCFAPC's officers initially raised questions about the extent to which viewpoints or literature *not* supporting the Roundup-Ready sugar-beet proposal were being solicited or compiled, they were told that if such additional viewpoints or literature were desired they could be solicited or compiled by the Council. Accordingly, believing that it would be advantageous for the Council to consider a broad spectrum of views bearing on the proposal, the BCFAPC's Chair asked the Council's Research Committee to prepare this compilation of publications concerning Roundup-Ready Sugar Beets (or, in some cases, genetically-modified plants in general) which advance viewpoints other than one advocating for their production. The Research Committee emphatically views this compilation as a non-exhaustive sampling of the literature. Given the way these efforts developed, the Committee has deliberately not included pro-production literature excerpts in this compilation. Additionally, some of this information concerns issues which, although not expressly raised by the beet-growers' proposal, might be appropriate for the Council to consider in analyzing that proposal. Finally, the Committee is not presenting this compilation as reflecting a position it has adopted, nor asking the Council to adopt any particular position. Instead this information is being presented for whatever consideration by individual Council members that they deem appropriate in their decision-making process.

CONTENTS

- I. Introduction: Process.
- II. Weed Resistance.
- III. Impact on Herbicide Use.
- IV. Plant Disease Impact.
- V. Crop Yield.
- VI. Gene Transfer.
- VII. Compliance with Planting or Herbicide Requirements.
- VIII. Human and Environmental Impact.
- IX. Ethical Issues.

I. Introduction: Process.

- A. T. MacMillan, “GM Foods: The Wrong Debate,” 3 *Food Ethics* (Autumn 2008) at 1:

“We should have learned – from the previous decade of wrangling over GM foods – that to have meaningful debate about innovation we need to ask not ‘Do we need GM?’, rather ‘What do we need?’ It all comes down to logic. Ask whether we need any specific new technology – a crop, computer or medicine – and the honest answer is that we don’t. We can’t be sure it would do what we want and there could always be another way – new technology is uncertain by nature. Ask whether it could help and the answer is that it could, however outlandish the example, for just the same reason. Because the question determines the answer, it can’t help anyone decide anything. Calling for debate about a technology is just nice way of telling people to like or loathe it, depending how you ask. So yes, let’s have a fresh debate about innovation in agriculture. But we must ensure that it is open and wide-ranging, not a narrow, dead-end discussion about one set of technologies. To devote our attention to GM, whether through accident or opportunism, is to ignore tough lessons from a decade of controversy.”

- B. R. Bratspies, “Some Thoughts on the American Approach to Regulating Genetically Modified Organisms, 16 *Kan. J. of Law & Public Policy* 393, 394 (2007):

“Opponents of [GM] technology are often accused of being obstructionists – of creating impossible demands for certainty before approving of those new technologies. The clear implication is that these demands are wholly strategic: as this threshold of certainty cannot be reached, opponents really intend to block deployment of the technology. This criticism has often been used in attempts to discredit opponents of agricultural biotechnology. There are certainly those voices within the broader debate. However, biotechnology’s advocates are often too quick to label any questioning of their claims of safety and benefit as a reactionary blocking strategy. By lumping those who want to question the process by which safety and risk are assessed with those determined to perceive risk at all costs, any questioning of the technology can easily be relegated to the Luddite margins.

“There is a difference between a demand for certainty and a demand that appropriate questions be explored. The former focuses on results – whether the fruits of exploration point so conclusively to a particular outcome that no other

explanation is tenable. The latter addresses process – whether the exploration has been structured in a fashion likely to uncover relevant information. Both sets of demands can be obstructionist; the Tobacco Institute’s insistence that the link between cigarettes and cancer was ‘not proven’ is perhaps the best example of how a demand for certainty can be wielded to prevent otherwise reasonable social actions. Similarly, a common tactic to delay or prevent social activity is to ‘send it back for more study.’ However, to suggest that demands for more – or more appropriate – study are always or even predominately obstructionist is to caricature wholly legitimate and important public participation in public decision making.

“A healthy society needs room for genuine dialogue, particularly around the process of evaluating and weighing risks to public safety. Many of the most significant questions concerning agricultural biotechnology raise structural issues, in particular whether we have created an appropriate framework within which to make decisions about safety and efficacy.”

- C. J. A. Roberts, “Who Needs GMOS? Technology, Democracy and the Case of GM Crops,” 16 *Kan. J. Law & Public Policy*, 451, 452-53, 454-55, 457 (2007):

“...I want to explore the tensions highlighted here between the science/technology (or ‘technoscience’) of GM or transgenic organisms, legal concerns arising from the production of the new artifacts, and the varying ethical concerns raised by groups in opposition. (1) how does technoscience trump debate on ethical concerns, and (2) how might we incorporate these concerns into our discussions *before* the creation of the artifact rather than waiting to argue about it *after* it has been created?

“[U]nderstandings of how science works vary, especially as we move from ‘within’ science to ‘outside’ of science. If you are looking at science from the perspective of its actual practice, uncertainty is an inherent characteristic of the scientific enterprise. However, outside of these bounds, science becomes locked into the dichotomies that characterize so much of our political sphere: the science is either certain, or it is not, and if it is not, do we dare act on it?

“There are ways to handle these instances of uncertainty and its relationship to the regulatory and legal frameworks within societies; the most visible of these has been the ‘precautionary principle’ ... [which] states quite simply that if we do not have enough information about the possible consequences of the development, or use, of a specific technology or class of technologies, then we should assume a precautionary posture until more information is available. That is to say, the burden of proof is placed upon those seeking development or use to demonstrate that no harm will result.

....

“[The precautionary principle] is symptomatic of the more pervasive problem that allows science – not just “uncertain” science – to trump all other modes or reasons for objection and disagreement. That is, using the precautionary principle reinforces the idea that only science can save us from technologies we do not want and that only risks to our health and safety ought or need to be considered in decisions about the acceptance or refusal or specific lines of technoscientific inquiry. How did things end up this way, and is there a way out of this narrowly defined debate?

“...I want to argue for a more democratic process of science that could help inform and involve our debates on issues such as the research, production, and use of GM technologies. This is not an argument for or against these technologies,

although admittedly, I have serious reservations about them. This is instead, a plea to initiate a discussion preliminary to the debates currently taking place. As I see it, the question that still needs an answer is this: ‘Why do we need GMOs?’ What are these technologies designed to do, and why should I agree to these specific technologies as a solution to these specific problems?

“To help us get out of the tangled mess of polemical debates currently at work, we need to change our focal point. ...I suggest moving our focus away from arguments over matters of fact, and instead towards thinking and engaging at the level of matters of concern, from a philosophy of science towards a philosophy of research. That is to say, for our purposes here, what are the concerns raised by these groups? Are they concerns upon which we can agree, that we share? From here, can we begin thinking about how we want our various scientific and technological tools to address these concerns? The focus shifts away from a debate about transgenic crops and towards the issues and concerns that transgenic crops are supposed to address. We can ask the questions, ‘Do we want to use this specific set of technologies to address these concerns?’ ‘Are there other ways of addressing these then?’ ‘What is entailed in the selection of one set of technologies over the other?’ ‘If we decide to accept transgenic crops, what else are we implicitly accepting?’ Technologies are not stand-alone entities or artifacts: they come packaged with other technologies of the physical and social kind. Thus, the question I am really interested in provoking ... is: ‘How do we go about making both our technologies and our choice of technologies more democratic in nature?’ A correlative question might be: ‘How do we make sure that the technologies we choose are not only chosen in a democratic way but also enhance and support democratic systems, themselves?’”

D. P. Andree, *Genetically Modified Diplomacy: The Global Politics of Agricultural Biotechnology and the Environment* (2007) at 238-39:

“An interesting dimension of [the work of the International Project on GMO Environmental Risk Assessment Methodology (“GMO ERA”)] is the way a precautionary approach is infused in all the steps of its risk assessment and management framework. Precaution ... is ... found in the emphasis GMO ERA places on identifying and prioritizing knowledge gaps as a critical step in the assessment process. Most important, however, is the way GMO ERA conceptualizes the initial steps in the process. Rather than see risk assessment simply as part of the environmental safety of the GMO itself, the GMO ERA approach begins with a problem formulation and options assessment (PFOA).

“GMO ERA sees PFOA as a process that should be undertaken by a multi-stakeholder group. The first step, problem formulation, requires the group to clearly define the problem, or unmet basic need, needing change. The second step, options assessment, involves considering the various options that exist other than, or complementary to the GEO [genetically engineered organism] in question that might enable the need to be met. Any subsequent assessment of the GEO takes place in the context of this broader discussion of needs and alternatives. As GMO ERA notes, the goal of systematically comparing alternative technological futures is to encourage ‘the option or options that meet the needs and values of a given society.’ Needless to say, this process may lead to the conclusion that there are

better approaches to meeting the identified need than the GEO that prompted the analysis.” [citations omitted]

- E. T. Wakefield, “Democracy: The GM Controversy Took the UK a Step Forward But We Now Risk Going Backwards,” 3 *Food Ethics* (Autumn 2008) at 12:

“[T]he GM experience underlines the need for counterbalances - or what the political analyst Archon Fung calls "countervailing forces" - to be built into the running of any public participation. The point is to offset the weight of the body sponsoring the process. Unless you build some dissent into participation at that level, experience shows you are likely to design a process that tells you what you want or, if the people involved say something uncomfortable, you won't be held to account if you ignore it.”

- F. International Assessment of Agricultural Knowledge, Science and Technology for Development, *Executive Summary of the Synthesis Report* (2008) at 10:

“Biotechnology has always been on the cutting edge of change. Change is rapid, the domains involved are numerous, and there is a significant lack of transparent communication among actors. Hence assessment of modern biotechnology is lagging behind development; information can be anecdotal and contradictory, and uncertainty on benefits and harms is unavoidable. There is a wide range of perspectives on the environmental, human health and economic risks and benefits of modern biotechnology; many of these risks are as yet unknown.”

II. WEED RESISTANCE.

- A. United States District Court, Northern District of California, *Geertson Seed Farms v. Johanss*, 2007 Westlaw 518624 (Feb. 13, 2007 Order granting summary judgment) (Roundup-Ready alfalfa case):

“[USDA’s] APHIS acknowledges that the use of Roundup Ready alfalfa may result in the development of Roundup-tolerant weeds. The resistance develops because of the increased use of Roundup on the crops. APHIS found that such a possible impact nevertheless does not warrant the preparation of an EIS [Environmental Impact Statement] because weed species often develop resistance to herbicides and the agricultural community is addressing the issue. ‘Alternative herbicides and strategies are available that may minimize the problem. Based on the comments, the alfalfa growers and weed scientists understand that good stewardship may be the only defense against this potential problem.’

“APHIS’s reasons for finding the development of glyphosate resistant weeds not to be significant are not convincing. Reasoning that weed species often develop resistance to herbicides is tantamount to concluding that because this environmental impact has occurred in other contexts it cannot be significant. Nothing in NEPA [National Environmental Policy Act], the relevant regulations, or the caselaw supports such a cavalier response.

“The assertion that ‘good stewardship’ may be the only defense against such weeds is equally unconvincing. Such a conclusion is not the same as a finding that the development of the weeds is not a significant environmental impact. This is especially so given that neither the FONSI [Finding of No Significant Impact] nor the EA [Environmental Assessment] contain any analysis as to what exactly constitutes good stewardship and how likely it is to be practiced successfully. There may be ways to reduce the proliferation of weeds, but if farmers are not engaging (or cannot engage) in those practices, then the availability of those practices does not ameliorate the potential environmental impact.

“Finally, APHIS failed to evaluate the cumulative impact of the deregulation of Roundup Ready alfalfa. While alfalfa is the first large scale perennial Roundup Ready crop, APHIS has deregulated other Roundup Ready crops, including corn and soybeans, and other deregulation petitions are pending. While the deregulation of one crop in and of itself might not pose a significant risk for the development of glyphosate resistant weeds, when all the crops are considered cumulatively such a risk may become apparent. There is nothing in the FONSI or EA that suggests APHIS even considered how much Roundup use will increase, or even how much such use has increased since the introduction of the other Roundup Ready crops; to the contrary, the EA specifically states that it ‘does not address the separate issue of the potential use of the herbicide glyphosate in conjunction with these plants.’ APHIS’s failure to consider in the context of the development of Roundup resistant weeds that there are already other Roundup Ready crops on the market, and more crops seeking to enter the market, means that it did not take the ‘hard look’ NEPA requires.” [citations to court record and cases omitted]

- B. Center for Food Safety, *Comments to USDA on Environmental Assessment for the Determination of Nonregulated Status for ... Roundup Ready Sugar Beet* at 12-15 (2004):

“[T]here are now seven known glyphosate resistant weeds, and at least one other with significant tolerance, and several more that are problematic and may be developing resistance or tolerance. Most of these tolerant or resistant weeds have developed in just the last four years. In the four years since it was identified, glyphosate resistant horseweed has reportedly spread to over 600,000 acres and has moved westward at least to Indiana and Arkansas.

....

“Weeds in the U.S. that are so far known to be resistant to glyphosate are not considered to be important weeds of sugarbeet. However, there have been several reports of important sugarbeet weeds that have become difficult to control with glyphosate in some areas. These weeds include several pigweeds (*Amaranthus* spp.), tall waterhemp (*Amaranthus tuberculatus*), and lambsquarter (*Chenopodium album*). Resistance or tolerance has not been confirmed but weed control specialists are concerned. Even if these weeds are not currently tolerant or resistant to glyphosate, difficulty in controlling them may give them an advantage in developing resistance. Pigweeds, along with kochia (*Kochia scoparia*) are often considered some of the most troublesome weeds in the most important sugarbeet growing areas.

“Monsanto discusses the importance of crop rotation as a sound agronomic practice, such as a means of facilitating disease and weed control, but not for preventing resistance. Another important implication for sugarbeet crop rotations is how they affect glyphosate use, because continuous use of an herbicide or herbicide mode of action increases the likelihood of resistance. The vast majority of sugarbeet are rotated to other crops, typically for at least two years. Rotation to other RR crops will prolong and thereby increase selection pressure on weeds to develop resistance, providing the weeds can survive in the rotation crop(s). Significantly, according to Monsanto’s data, soybeans are the most important rotation crop for sugarbeet, especially in the most important sugarbeet production states. Because over 80% of soybeans are glyphosate resistant, most of these rotation acres are expected to be RR varieties.

....

“Finally, voluntary resistance management approaches, such as suggested by Monsanto, are currently applied to many pesticides with little evidence of success. On the other hand, the mandatory resistance management program applied to Bt crops has so far prevented resistance to a valuable insecticide and prolonged its use. Therefore, we recommend that [USDA] design a mandatory resistance management program for RR sugarbeet, with the help of sugarbeet growers and independent scientists. Such a program would likely employ mandatory rotation of herbicide modes of action.” [citations omitted]

- C. Chris Boerboom, UW-Madison weed scientist and Extension agent; summary of telephone communication 4/2709:

There are already many cases of weeds developing Roundup resistance, especially in corn and soybean areas. UW-Madison Extension is working on practices to decrease the selection pressure for Roundup resistance. There is no formal monitoring; when a grower notices a weed that appears to be resistant, he contacts the state university for testing. Wisconsin has been relatively successful at avoiding weed resistance; they have no confirmed cases of Roundup resistance at this point. Most states have fields or counties with documented resistant weeds; some have multiple resistant species in the state. The 3 worst thus far: Palmer amaranth in the southeast, waterhemp in Missouri/Illinois, giant ragweed in Ohio, Indiana, and Minnesota.

To decrease glyphosate resistance: 1) limit use 2) use other herbicides or methods in combination. Example of rotation: RR soybeans, then RR corn but use conventional herbicides.

“Resistance is going to happen”; the timing is based on probabilities—increased frequency of use results in an increased probability of resistance. One year of no use extends the utility that far into the future; responsible use extends the time for resistance to develop and build up to the point where it’s a problem. Example of combination: recommended use of a preemergent to get rid of 90% of the weeds, then use Roundup.

In fields of RR soybeans, resistant weeds have been seen for 8 years.

Sugarbeets are a concern because they are sensitive to the herbicides which may remain in the soil after the previous season’s application; Roundup is one of the herbicides that can be used before a sugarbeet crop, thus encouraging use of Roundup in sequential seasons.

See <http://glyphosateweeds crops.org/Pubs.html> (publications on glyphosate use.) and attached White Paper on Glyphosate Stewardship: <http://www.uwex.edu/ces/ag/teams/grains/documents/ipmworkgroup3.pdf>.

- D. Kniss, A.R., S.D. Miller, P.H. Westra, and R.G. Wilson, "Glyphosate susceptibility in common lambsquarters (*Chenopodium album*) is influenced by parental exposure." *55 Weed Science* 572-577 (2007):

"Field studies were carried out at two sites in 2005 using common lambsquarters seed collected from long-term research plots near Scottsbluff, NE; Fort Collins, CO; and Torrington, WY, to determine the effect of herbicide selection pressure on glyphosate susceptibility. Parental herbicide exposure influenced the level of glyphosate susceptibility exhibited by a subsequent generation. Common lambsquarters selected from historical plots receiving continuous and exclusive use of glyphosate exhibited lower mortality in response to 420 g ae ha⁻¹ glyphosate compared with selections from nonglyphosate treatment histories. Selections from rotating glyphosate treatment histories demonstrated an intermediate tolerance response. Differences in response were also influenced by environmental conditions."

- E. Purdue University (2009, April 16). "Farmers Relying On Herbicide Roundup Lose Some Of Its Benefit." *ScienceDaily*. Retrieved May 3, 2009, from <http://www.sciencedaily.com/releases/2009/04/090414153529.htm>:

"Roundup Ready crops have made weed control much easier for farmers, but a new study shows their reliance on the technology may be weakening the herbicide's ability to control weeds.

"Bill Johnson, a Purdue University associate professor of weed science, said farmers who plant Roundup Ready crops and spray Roundup or glyphosate-based herbicides almost exclusively are finding that weeds have developed resistance. It is only a matter of time, Johnson said, before there are so many resistant weeds that the use of glyphosate products would become much less effective in some places.

" 'We have weeds that have developed resistance, including giant ragweed, which is one of the weeds that drove the adoption of Roundup,' Johnson said. 'It's a pretty major issue in the Eastern Corn Belt. That weed can cause up to 100 percent yield loss.'

"Johnson was part of a team, including Steve Weller, a Purdue professor of horticulture and landscape architecture, that surveyed farmers in Indiana, Illinois, Iowa, Mississippi, Nebraska and North Carolina about their views on the ability of Roundup Ready crops to help control problematic weeds. A paper on the survey was published in the most recent edition of the journal *Weed Technology*. Researchers from Iowa State University, Mississippi State University, North Carolina State University, the University of Nebraska and Southern Illinois University Carbondale also contributed.

"Roundup Ready crops are resistant to glyphosate, the active ingredient in Roundup. So, if a farm uses Roundup Ready crops, the herbicide can be sprayed on crops to kill weeds without damaging those crops.

"Johnson said the problem has become farmers' overreliance on Roundup and Roundup Ready crops. Those who saw the most benefit from using Roundup,

according to the survey, rotated between types of crops and those that were Roundup Ready and conventional crop varieties.

“Johnson said this shows that subjecting weeds to different herbicides is important to keeping them from developing resistance to any particular herbicide.

“ ‘Farmers do not think resistance is a problem until they actually have it,’ Johnson said. ‘And they think the chemical companies can turn on the spigots and produce a new herbicide whenever they want. The problem is, since Roundup is so effective, there’s not been any money for new herbicide discovery.’

“Johnson said farmers should treat Roundup and Roundup Ready crops as an investment and work to protect the technology. Rotating crops consistently and using various herbicides will slow the development of glyphosate-resistant weeds.

“ ‘Go after weeds with two different herbicides. That’s the best short-term solution,’ Johnson said. ‘We want to minimize the number of weeds resistant to Roundup. To do that, you want to minimize the exposure that a weed population has to Roundup. If you diversify a little bit, you’ll extend the life of the technology.’

“Monsanto, the maker of Roundup, funded the survey. Johnson said the next step is studying the differences among management strategies in grower fields to see which will slow the build-up of glyphosate resistance.”

- F. J. Bremer, “Corn Growers Have New Weed Management Challenges,” *High Plains Journal* (April 6, 2009) at 2-B:

“Glyphosate-resistant weeds are becoming more of a problem for farmers, also. This problem is not determined until a field is sprayed and the farmer reports the herbicide did not control the weeds.

“ ‘The ability of glyphosate to be stand-alone herbicide for weed management will continue to decline,’ said [University of Illinois assistant professor of weed science Aaron] Hager.

“Continual studies are being conducted to better understand glyphosate-resistant weeds and how they spread – through seed or pollen or both. Hager said nuclear inherited traits move in both seed and pollen and since these can affect a lot of crops in a short amount of time, he feels it is very important to find the answers.

“Hager also warns that weed problems seen in one crop could move over to cause the same problem with weeds in other crops.

“ ‘Farmers seem to be very responsive to making changes in their systems to control weeds,’ he said. ‘There are many problem weeds out there and, most importantly, farmers need to keep control of their weed situations in order to prevent yield losses’.”

III. IMPACT ON HERBICIDE USE.

- A. C.M. Benbrook, *Genetically Engineered Crops and Pesticide Use in the United States: The First Nine Years* (2004) at 6-9:

“[B]iotech proponents have claimed repeatedly that today’s GE crop technologies are reducing pesticide use. A comprehensive accounting of the impacts of HT [“herbicide tolerant”] and *Bt* transgenic varieties on total pesticide use demonstrates unequivocally that in the first three years of commercial use, this claim was justified. But since 1999 it has not been. GE corn, soybeans and cotton

have led to a 122 million pound increase in pesticide use since 1996. While *Bt* crops have reduced insecticide use by about 15.6 million pounds over this period, HT crops have increased herbicide use 138 million pounds.

“The increase in herbicide use on GT crops should come as no surprise. Weed scientists have warned for about a decade that heavy reliance on HT crops would trigger changes in weed communities and resistance, in turn forcing farmers to apply additional herbicides and/or increase herbicide rates of application. The ecological adaptations predicted by scientists have been occurring in the case of Roundup Ready crops for three or four years and appear to be accelerating.

“Reliance on a single herbicide, glyphosate, as the primary method for managing weeds on millions of acres planted to HT varieties remains the primary factor that has led to the need to apply more herbicides per acre to achieve the same level of weed control.

“Average application rates of glyphosate in HT weed management systems have jumped sharply in the last few years as a result of the spread of glyphosate-tolerant or resistant marestail ..., shifts in the composition of weed communities, and substantial price reductions and volume-based marketing incentives from competing manufacturers of glyphosate-based herbicides.

“For the foreseeable future, HT crops will increase pesticide use more than *Bt* transgenic crops reduce it.”

- B. Colorado State University, Department of Soil and Crop Sciences, Website: “Reductions in chemical spraying--Are they real?” *Transgenic Crops: An Introduction and Resource Guide* at <http://cls.casa.colostate.edu/TransgenicCrops/spray.html>. (accessed 4-20-09, but page last updated 3-11-04):

“Although transgenic technology may result in the reduction of chemical spraying in some cases, it does not always do so. Bt cotton is the only crop for which claims of reduced spraying are clear.”

- C. Center for Food Safety, *Comments to USDA on Environmental Assessment for the Determination of Nonregulated Status for ... Roundup Ready Sugar Beet* at 9 (2004):

“[H]erbicide use is projected to increase with RR sugarbeet based on projections, from 0.89 pounds/[acre] with conventional varieties and herbicide, to 1.50 pounds/[acre] with RR sugarbeet, for an overall increase of about 931,000 pounds/year.

“It is also instructive to examine ... herbicide use trends ... in RR soybeans, because weed control is not a static process, but changes over time. The trends in RR soybeans therefore may provide some foreshadowing of events with RR sugarbeet if they are deregulated. The efficacy of glyphosate herbicides is likely to be highest for the first several years after commercialization, prior to weed shifts that favor the most recalcitrant weeds, and the development of resistance. [R]ecent data suggest that as of the past several years, more glyphosate is used on RR soybeans than herbicides on conventional soybeans. The report attributes this increase to weed shifts, glyphosate resistant weed, and other trends such as lower herbicide costs ...” [citations omitted]

- D. United States District Court, Northern District of California, *Geertson Seed Farms v. Johanss*, 2007 Westlaw 518624 (Feb. 13, 2007 Order granting summary judgment) (Roundup-Ready alfalfa case):

“[P]laintiffs assert that – even apart from the development of glyphosate-resistant weeds – APHIS failed to consider that the deregulation of Roundup Ready alfalfa will result in the increased use of Roundup, and likewise failed to consider how that increased use of Roundup, perhaps doubling its use on alfalfa fields alone, will impact the environment. And, argue Plaintiffs, APHIS should have considered this increased use in the context of its deregulation of other Roundup Ready crops; in other words, APHIS must inquire whether the introduction of the many Roundup Ready crops will together increase the use of Roundup and impact the environment.

“APHIS responds that there are other federal agencies, primarily the Environmental Protection Agency (“EPA”), that are responsible for regulating herbicides and tolerance levels in crops for such chemicals. It also contends that there is no evidence that farmers will misuse Roundup, that is, use it contrary to the manufacturer’s instructions and it notes that Roundup use will replace more toxic herbicides.

“Since the Court has concluded that APHIS must consider the cumulative impact of increased glyphosate use with respect to the development of glyphosate-resistant weeds, APHIS will have to examine the increased use of glyphosate; thus the Court declines to specifically rule on this claim. The Court notes, however, that it is unclear from the record whether any federal agency is considering the cumulative impact of the introduction of so many glyphosate resistant crops; one would expect that some federal agency is considering whether there is some risk to engineering all of America’s crops to include the gene that confers resistance to glyphosate.”

IV. PLANT DISEASE IMPACT.

- A. R.L. Larsen, A.R. Kniss, et al., “Influence of Glyphosate on Rhizoctonia and Fusarium Root Rot in Sugar Beet,” *62 Pest Management Sci.* 1182 (2006):

“This study tests the effect of glyphosate application on disease severity in glyphosate-resistant sugar beet, and examines whether the increase in disease is fungal or plant mediated. In greenhouse studies of glyphosate-resistant sugar beet, increased disease severity was observed following glyphosate application and inoculation with certain isolates of *Rhizoctonia* ... and *Fusarium* Significant increases in disease severity were noted for [*Rhizoctonia*] and moderately virulent [*Fusarium*] on both cultivars tested, regardless of the duration between glyphosate application and pathogen challenge, but not with highly virulent [*Fusarium*] or an isolate of [*Rhizoctonia*]. Studies of glyphosate impact on sugar beet physiology showed that shikimic acid accumulation is tissue specific and the rate of accumulation is greatly reduced in resistant cultivars when compared with a susceptible cultivar. The results indicate that precautions need to be taken when certain soil-borne diseases are present if weed management for sugar beet is to include post-emergence glyphosate treatments.”

- B. Center for Food Safety, *Comments to USDA on Environmental Assessment for the Determination of Nonregulated Status for ... Roundup Ready Sugar Beet* (2004) at 5:

“Increased disease is important for several reasons. First, the increased disease, if not adequately controlled, may reduce yields. Second, the increased use of fungicide for controlling the diseases would cause human and environmental harm. Several fungicides used to control sugarbeet diseases may cause substantial risk. In particular, triphenyltin is highly toxic to humans and other organisms, and was the most widely used fungicide on sugarbeet in 2000, with 1.4 applications on 44% of sugarbeet acres. Triphenyltin has been considered the most efficacious fungicide for *Cercospora* control where tolerance has not occurred, and alternative fungicides such as benomyl also have undesirable environmental and human health profiles.”

- C. Montana State University News Service, website: “Pathologist Urges Considering Sugarbeet Disease Resistance Before Ordering Seed,” at <http://www.montana.edu/cpa/news/nwview.php?article=5427> (2007):

“Sugarbeet growers will be considering the potential of relatively new options like Round Up Ready varieties as well as traditional concerns like disease resistance,” said Barry Jacobsen, MSU plant pathologist. “One of those considerations should be that we have limited control of some diseases other than the resistance bred into sugarbeet varieties.

“ ‘Fusarium yellows’ is another disease that should be a priority for growers anywhere in Montana, Jacobsen added. There are no controls for this disease other than variety resistance. Screening trials in 2006 and 2007 indicated that some newly approved Round Up Ready varieties are very susceptible to this disease.

“Fusarium yellows is caused by a soilborne fungus. Once the fungus infests soil, even long term rotations are of little help, he said.”

- D. R. Kremer, N. Means, “Rhizosphere ecology is altered in glyphosate resistant soybean” (2006) Weed Science Society of America Meeting paper (abstract) at http://www.ars.usda.gov/research/publications/publications.htm?seq_no_115=189068:

“The environmental assessment of glyphosate-resistant (GR) soybean on soil- and root-associated microbial communities is not well understood. Glyphosate applied to GR soybean consistently affected root-associated *Fusarium*. Populations often increased 2-5 times within five days after glyphosate application and continued to increase during the growing season. Consequences of increased *Fusarium* may include alteration in soil microbially-mediated processes such as decomposition and increases in potential pathogenic effects of certain *Fusarium* spp. on soybean and other rotation crops. We subsequently found that glyphosate released in root exudates of glyphosate-treated GR soybean coupled with increased exudation of carbohydrates and amino acids from GR roots stimulated growth and colonization of *Fusarium* spp. in the GR soybean rhizosphere. Results suggest that analyses of selected indicator groups of microorganisms (i.e., *Fusarium* spp.) provide the most reliable and relevant information on GR soybean effects on the soil ecosystem. Effects of GR soybean on other components of the soil and

rhizosphere microbial communities and the linkage to microbial functions are other areas that need to be investigated.”

V. **CROP YIELD.**

- A. Center for Food Safety, *Comments to USDA on Environmental Assessment for the Determination of Nonregulated Status for ... Roundup Ready Sugar Beet* at 8 (2004):

“Monsanto cites sugar beet yield data in support of its claim that RR sugarbeet is beneficial. Such data are important in part because yield will impact grower profits. [Monsanto’s] petition selectively cites data indicating a 15% increase in sugar yield, with two Roundup applications compared to three for conventional herbicide applications. However, other reports show much smaller, often insignificant gains, or higher yields for conventional varieties. For example, Kaffka and Peterson show only a one percent increase in sugar yield with RR sugarbeet compared to the conventional counterpart, with only a single application of Roundup or conventional herbicides. These researchers also believed that the slightly higher RR sugarbeet yields were likely an artifact. Similarly, in 2001, researchers in Oregon reported only a 2% increased sugar yield compared to the conventional progenitor. And in many cases the conventional varieties yielded more than the RR variety. In Idaho field trials some RR sugarbeet varieties yielded more sugar than some conventional varieties, but the highest yielding varieties were conventional.” [citations omitted]

- B. D. Gurian-Sherman, *Failure to Yield: Evaluating the Performance of Genetically Engineered Crops* (Union Of Concerned Scientists) (2009) at 1 http://www.ucsusa.org/food_and_agriculture/science_and_impacts/science/failure-to-yield.html.

“[A] close examination of numerous studies of corn and soybean crop yields since the early 1990s gives us a good gauge of how well GE crops are living up to their promise for increasing those yields.

“Bottom line: They are largely failing to do so. GE soybeans have not increased yields, and GE corn has increased yield only marginally on a crop-wide basis. Overall, corn and soybean yields have risen substantially over the last 15 years, but largely not as a result of the GE traits. Most of the gains are due to traditional breeding or improvement of other agricultural practices.”

- C. P. Lund, “The Science: We Have More Answers But Not Enough,” 3 *Food Ethics* (Autumn 2008) at 3:

“In the USA at least, this increased adoption is driven by the farmers’ expectation of improved yield, or at least greater profits. Are these being realized? A report from the Soil Association suggested not, although several of the papers

and reports cited in this study are quoted selectively or out of context, and do indeed provide what appears to be robust evidence of increased yields or higher profits, at least in the short term. One thing that has not changed in the GM debate, however, is the difficulty in obtaining reliable data from an unbiased source, and given the enormous complexity of the issues involved, it is probably still too early to state whether GM crops represent, overall, a net long term economic benefit for farmers who plant them.” [citations omitted]

VI. GENE TRANSFER.

- A. Center for Food Safety, *Comments to USDA on Environmental Assessment for the Determination of Nonregulated Status for ... Roundup Ready Sugar Beet* at 7-8, 9-10 (2004):

“Data presented by Monsanto ... indicate that its [Roundup Ready sugarbeets] may bolt at higher rates than varieties used for comparison. In particular, variety Beta 991 RR bolted at over three times the rate of the next varieties (another RR variety and a control) in 2001 field trials. Bolting is significant because bolters lower yield and, more importantly, may allow gene flow to occur in sugarbeet production fields. This is a concern in California sugarbeet production areas, where the wild sugarbeet relative *Beta macrocarpa* is found, and is a weed problem in sugarbeet and rotation crops.” [citations omitted]

VII. COMPLIANCE WITH PLANTING OR HERBICIDE REQUIREMENTS.

- A. R. Bratspies, “Some Thoughts on the American Approach to Regulating Genetically Modified Organisms, 16 *Kan. J. of Law & Public Policy* 393, 414 (2007):

“[T]he primary strategy for preventing cross-contamination between GM crops and conventional or organic crops are physical containment measures [which] involve using planting distances or timing to prevent contamination of conventional crops with GM crops. Unfortunately, for existing GM crops, physical containment measures have largely been ineffectual, either because the requirements are too lenient or because they are not being fully implemented. Indeed, a 2003 USDA survey found that approximately 20% of farms growing GM crops failed to comply with planting regulations intended to ensure physical containment.” [Citing E. Gerseney, “USDA Survey Shows Biotech Rules Breaches,” *Washington Post* Sept. 10, 2003; http://www.nass.usda.gov/Publications/Corn_and_Biotechnology_Special_Analyses/bioc0703.pdf.

- B. T. Sellen, "Herbicide-Resistant Weeds Force Change in Agriculture," Dow Jones Newswires, Feb. 2, 2007;
<http://www.cattlenetwork.com/content.asp?contentid=104080>.

"A couple of reasons weeds are becoming resistant to glyphosate are that farmers are not all applying the weed-killer at recommended rates or are waiting too long before application to high-density, large weeds, according to [Bill] Johnson [associate professor of weed science at Purdue University].

" 'They misuse the technology, that's where we're starting to see the cracks first. But for the guys that are good managers, the technology is sustainable for quite some time,' he said."

VIII. HUMAN AND ENVIRONMENTAL IMPACT.

- A. From *GM Science Review Panel Second Report*, Jan 2004 [The GM Science Review was requested by the United Kingdom's Secretary of State for Environment, Food and Rural Affairs with the agreement of Ministers in the devolved administrations. The Public Debate "GM Nation?" and the Strategy Unit report on the costs and benefits of GM crops have been the other strands in the GM dialogue aimed at engaging the public and assisting the Government with future GM policy decisions. Complete report at www.gmsciencedebate.org.uk.] :

"If all else remains constant and the three crops are introduced and managed in the way they were in the trials, then for GMHT beet and spring oilseed rape a significant reduction would be expected in weed biomass and weed seed return resulting in fewer nectar resources for pollinators and fewer weed seed resources for granivorous birds.

"For GMHT maize the opposite is expected."

- B. University of Pittsburgh (2005, August 4). "Even Small Doses of Popular Weed Killer Fatal to Frogs, Scientist Finds." *ScienceDaily*. Retrieved May 3, 2009, from <http://www.sciencedaily.com/releases/2005/08/050804053212.htm>:

"In two articles published in the August 1 issue of the journal *Ecological Applications*, [University of Pittsburgh assistant professor of biological sciences Rick] Relyea and his doctoral students Nancy Schoeppner and Jason Hoverman found that even when applied at concentrations that are one-third of the maximum concentrations expected in nature, Roundup(r) still killed up to 71 percent of tadpoles raised in outdoor tanks.

"Relyea also examined whether adding soil to the tanks would absorb the Roundup(r) and make it less deadly to tadpoles. The soil made no difference: After exposure to the maximum concentration expected in nature, nearly all of the tadpoles from three species died.

"Although Roundup(r) is not approved for use in water, scientists have found that the herbicide can wind up in small wetlands where tadpoles live due to inadvertent spraying during the application of Roundup(r).

"Studying how Roundup(r) affected frogs after metamorphosis, Relyea found that the recommended application of Roundup(r) Weed and Grass Killer, a

formulation marketed to homeowners and gardeners, killed up to 86 percent of terrestrial frogs after only one day.

“ ‘The most striking result from the experiments was that a chemical designed to kill plants killed 98 percent of all tadpoles within three weeks and 79 percent of all frogs within one day,’ Relyea wrote. ... This research was funded by the National Science Foundation, Pitt’s McKinley Fund, and the Pennsylvania Academy of Science.”

- C. “Invertebrate responses to the management of genetically modified herbicide-tolerant and conventional spring crops. I. Soil-surface-active invertebrates.” **The American Association for Research into Nervous and Mental Diseases**, R. Brooks, D. A. Bohan, et al. *Phil. Trans. R. Soc. Lond. B* 29 November 2003 vol. 358 no. 1439 1847-1862:

“The effects of herbicide management of genetically modified herbicide-tolerant (GMHT) beet, maize and spring oilseed rape on the abundance and diversity of soil-surface-active invertebrates were assessed. Most effects did not differ between years, environmental zones or initial seedbanks or between sugar and fodder beet. This suggests that the results may be treated as generally applicable to agricultural situations throughout the UK for these crops. The direction of the effects was evenly balanced between increases and decreases in counts in the GMHT compared with the conventional treatment. Most effects involving a greater capture in the GMHT treatments occurred in maize, whereas most effects involving a smaller capture were in beet and spring oilseed rape. Differences between GMHT and conventional crop herbicide management had a significant effect on the capture of most surface-active invertebrate species and higher taxa tested in at least one crop, and these differences reflected the phenology and ecology of the invertebrates. Counts of carabids that feed on weed seeds were smaller in GMHT beet and spring oilseed rape but larger in GMHT maize. In contrast, collembolan detritivore counts were significantly larger under GMHT crop management.”

- D. “Warning: The Most Widely Used Herbicide in Argentina Causes Birth Defects,” 04/14/2009 12:11 PM EDT, *The Latin American Herald Tribune*, <http://www.dialogo-americas.com/index.php/article/461/>:

“The herbicide used in transgenic soybeans, Argentina’s main crop, can cause neuronal, intestinal, and heart malformations, according to scientific research released today.

“While the study ‘used amphibian embryos,’ the results ‘are fully comparable to what would happen with the development of the human embryo,’ professor of embryology Andres Carrasco, one of the authors of the paper, told *Efe*.

“ ‘What is remarkable is that there are no studies on embryos at the global level, and much less in injecting glyphosate into embryos,’ said the researcher of the National Scientific and Technical Research Council (CONICET) and director of the Laboratory of Molecular Embryology.

“The doses of herbicide used in the study ‘were far below levels used in spraying,’ so the situation ‘is much more serious’ because ‘glyphosate does not decompose,’ he warned. ...

Carrasco said that the investigation found that ‘pure glyphosate at doses lower than those used in fumigation generates malformations’ and ‘could interfere with various normal mechanisms of embryonic development that control how the cells divide and die.’ ... Due to the barrage of legal claims related to the disproportionate use of agrochemicals in the cultivation of GM soybeans, in February the Ministry of Health established a group to investigate the problem in four Argentine provinces.”

- E. N. Benachour, G. Seralini, “Glyphosate Formulations Induce Apoptosis and Necrosis in Human Umbilical, Embryonic, and Placental Cells,” 22 Chem. Res. Toxicol. (2009) at 97, at <http://pubs.acs.org/doi/abs/10.1021/tx800218n>:

“We have evaluated the toxicity of four glyphosate (G)-based herbicides in Roundup (R) formulations, from 10⁵ times dilutions, on three different human cell types. This dilution level is far below agricultural recommendations and corresponds to low levels of residues in food or feed....All R formulations cause total cell death within 24 h, through an inhibition of the mitochondrial succinate dehydrogenase activity, and necrosis, by release of cytosolic adenylate kinase measuring membrane damage....Moreover, the proprietary mixtures available on the market could cause cell damage and even death around residual levels to be expected, especially in food and feed derived from R formulation-treated crops.”

- F. 64 Fed. Reg. 18360-18367 (April 14, 1999) [The U.S. Environmental Protection Agency increased the maximum allowable residues of the herbicide, glyphosate, on sugar beet roots from just 0.2 parts per million (ppm) to 10 ppm. EPA’s policy change represents a 5,000% increase in allowable residues, some of which could end up in sugar]:

“This notice included a summary of the petition prepared by Monsanto Company, the registrant. ... The petition requested that 40 CFR 180.364 be amended by establishing tolerances for residues of the herbicide (*N*-(phosphonomethyl)glycine), in or on the imported raw agricultural commodities barley, grain at 20 parts per million (ppm); barley bran and pearled barley at 60 ppm; cereal grains group (except wheat, corn, oats, grain sorghum, and barley) at 0.1 ppm; canola, seed at 10 ppm; canola, meal at 25 ppm; legume vegetables (succulent or dried) group (except soybeans) at 5 ppm (PP 2E4118) and in or on the commodities beets, sugar, tops (leaves) at 10 ppm; beets, sugar, roots at 10 ppm; and beets, sugar, pulp, dried at 25 ppm (PP 7F4886)....The Agency is amending the proposal to read that 40 CFR 180.364 be amended by establishing tolerances for residues of the herbicide glyphosate (*N*-(phosphonomethyl)glycine) resulting from the application of the isopropylamine salt of glyphosate and/ or the monoammonium salt of glyphosate in or the raw agricultural commodities barley, grain at 20 ppm; barley, bran at 30 ppm; grain crops (except wheat, corn, oats, grain sorghum, and barley) at 0.1 ppm; canola, seed at 10 ppm; canola, meal at 15 ppm; beets, sugar, tops at 10 ppm; beets, sugar, roots at 10 ppm; and beets, sugar, dried pulp at 25 ppm; and legume vegetables (succulent and dried) group (except soybeans) at 5.0 ppm.”

IX. ETHICAL ISSUES.

- A. R. Doubleday, "The Knowledge Economy: Good Inventions Drive More Innovation," 3 *Food Ethics* (Autumn 2008) at 21.

"The global ambition of GM industry is characterised by a one-size-fits-all approach to technology. Patented GM traits lock farmers into using particular pesticides and fertilisers, which (not coincidentally), are produced by the same firms. Intellectual property regimes concentrate innovative capacity in the labs of six global companies, reducing the scope for local experimentation and invention. GM technology as it is currently developed does not foster wider innovation in the rural economy. In fact GM has a negative inventive potential inasmuch as it promotes standardised farming practices. This 'command and control' vision of GM technologies is diametrically opposed to the kinds of localised and site specific innovation required to support economically and environmentally sustainable rural livelihoods."

- B. P. Andree, *Genetically Modified Diplomacy: The Global Politics of Agricultural Biotechnology and the Environment* (2007) at 280-81:

"The precautionary discourse has also been deployed to further a different kind of resistance, one that continues to challenge the very idea of science-based risk assessment in order to bring the wider social, ethical, and economic issues associated with GE into the conversation, as evidenced by the GMO ERA project. In its articulation, the precautionary principle is an explicit acknowledgement of the relationship between norms and science in risk decision making. This acknowledgement has led to a growing recognition among academics and policy analysts of the closed nature of the process through which these norms are usually determined, involving tacit judgments made by small groups of scientific experts themselves. The arguments for more precautionary regulation have thus been accompanied by demands for more openly democratic decision-making processes on risk issues, as opposed to simply a reversal of the dominant norms,"