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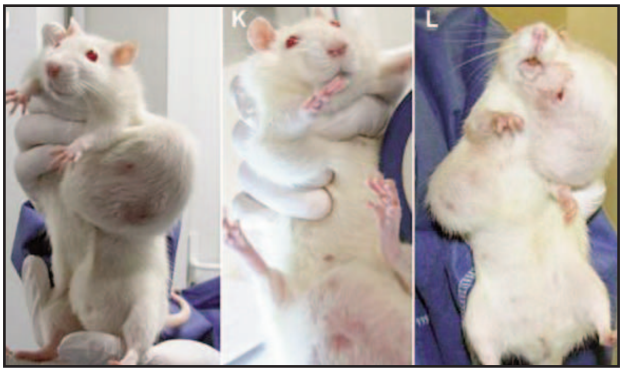
Is Glyphosate On the Way Out?

Signs Are Pointing in That Direction

by Paul W. Syltie, Ph.D.

The last two decades have witnessed a profound increase in the use of the herbicide Roundup (glyphosate), as a consequence of Monsanto's developing genetically engineered varieties of corn, soybeans, cotton, and canola which can withstand this chemical; weeds, on the other hand, are destroyed by its effects. In 2012 it is estimated that 85% of the corn, 91% of the soybeans, and 88% of the cotton seeds planted by United States farmers were genetically modified, most of them tolerant to glyphosate[1]. These data are remarkable considering that these seeds were introduced to the marketplace in the 1970s.[2]

Despite this profoundly profitable program for Monsanto, recent revelations across the heartland of America are pointing towards a possible rethinking of the wisdom of using genetically modified (GM) seeds to grow our crops. The issue of glyphosate resistant weeds proliferating in many areas of the country has already been discussed in the Summer, 2010, issue of *The Vital Earth News, Agricultural Edition* (Vol.16, No. 2). While such a threat to the cultivation of GM crops may be serious, effects on the *quality* of the crop may turn out to be the most serious consequence of growing GM crops. After all, our crops are grown primarily for food, feed, and fiber, and if the effects on food quality — and thus health — are negative, a serious problem is posed: the purpose for growing the crop in the first place has been compromised.



A study published in 2012 revealed that rats fed genetically modified corn, of Roundup itself, developed tumors much more than did rates fed non-GMO corn.

Few studies have been conducted to evaluate the effects of GM crops on human and animal health, and with few exceptions these studies have been short-term. Even so, there have been strong indications from these experiments that glyphosate is indeed harmful to mammals,

For example, in 2005, Irina Ermakova, with the Russian National Academy of Sciences, reported that more than half the babies from mother rats fed GM soy died within three weeks.[3] This was also five times higher than the 10% death rate of the non-GMO soy group. The babies in the GM group were also smaller and could not reproduce. After

See Roundup Contributes to, page 2

The DNA "Junk" Revolution

Some DNA Has Been Called Junk, But Junk It Is Not!

by Paul W. Syltie, Ph.D.

It all seemed so simple. In 1953, James Watson and Francis Crick discovered that two ribbons of deoxyribonucleic acid (DNA), coiled in a weakly bonded configuration, formed the basis of our genetic code. In fact, the sequences of adenine, guanine, thymine, cytosine, and urasil in various sequences that coded for the RNA, which in turn produced the enzymes responsible for fabricating virtually all cell structures, were thought to be all there was to account for what the organism is. All living things are made up of cells: one cell, or trillions of cells. The DNA codes for all that they are.

At least, so scientists thought. It was suggested that, out of three billion base pairs, less than 2% actually manufactured enzymes for the human body[1], and the remaining 98% were "junk", a vestige of evolutionary skullduggery that proved how natural selection, through random chance, made us what we are. Like the appendix, so much of the structure was extraneous and just being car-

See Gene Switches Decide, page 3

The DNA double helix has become an icon of modern biological progress in understanding the human genome.

Roundup Contributes to Poor Structure

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Ermakova's feeding trials, her laboratory started feeding all of the rats in the facility a commercial rat chow using GM soy. Within two months, the infant mortality facility-wide reached 55%.

Recently, a French study published in *Food and Chemical Toxicology* entitled "Long term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize", by Gilles-Eric Seralini and others,[4] showed that major body modifications occurred during a two-year period using groups of male and female Sprague-Dawley rats fed a non-GM corn control diet, a GM diet using corn sprayed with Roundup, and a non-GM corn diet with low doses of Roundup fed in drinking water. The researchers discovered the following:

- Between 50 and 80% of female rats developed large tumors by the beginning of the 24th month, with up to three tumors per animal. Only 30% of the control rats developed tumors.
- Up to 70% of the females died prematurely compared to only 20% in the control group.
- Tumors in the rats of both sexes fed GM corn were two to three times larger than in the control group.
- The large tumors appeared in females after seven months, compared to 14 months in the control group. These large tumors were deleterious to health due to their very large size, making it difficult for the rats to breath and causing digestive problems.

Of particular interest is that the majority of the tumors were detectable only after 18 months, meaning that they could be discovered only during long-term feeding studies. Standard rat feeding assessment studies presently last only 90 days, far too short in duration to detect most tumors. The organs most affected were the kidneys, liver, mammary glands (especially for females), and pituitary gland (also mostly for females). Life spans were reduced by all glyphosate treatments with both sexes.

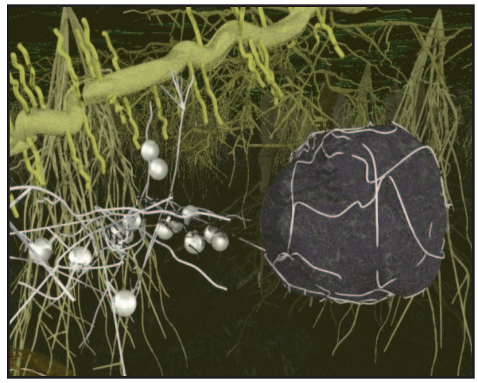
The conclusions of Seralini et al.[5] were quite disturbing: "... lower levels of complete agricultural glyphosate herbicide formulations, at concentrations well below officially set safety limits, induce severe hormone-dependent mammary, hepatic, and kidney disturbances." Besides, the disruption of biosynthetic pathways that may result from the overexpression of the "ESPS transgene" in the GM corn hybrid gives rise to abnormal phenolic acid metabolites; likely, other mutagenic and metabolic effects of the GM corn cannot be excluded.

Further studies will evaluate effects of Roundup and GM crops on these same parameters.This study, however, is the first to document the pathological long-term effects of both GM corn and glyphosate on mammal health.

Besides deleterious effects on human and animal health, glyphosate has many harmful effects on the soils to which they are applied. These effects have not been rigorously researched, but like all herbicides the active agents will affect the total population of soil microorganisms, the survival of species, and their relative balance. Mycorrhizae and nitrogen fixers are especially susceptible to herbicides[6], and suppression of their activity will lower N-fixation and greatly disrupt the absorption of available soil nutrients by plants, especially immobile elements like phosphorus and micronutrients that are dependent on these mutualistic organisms for their uptake.

Besides, soil structure can suffer degradation over time by suppression of soil microorganism activity, since structural development and stabilization depends so much on bacterial, fungal, mycorrhizal, and algal activity.

As the months pass and more research uncovers the deleterious effects of glyphosate and GM crops to the well-being of man, animals, and soils, the question of the viability of this herbicide — the most widely used one in the world[7] — is not an outrageous question. Indeed, logic tells us that when the massive damage that this herbicide-crop combination is doing to our food supply and soil resources becomes known, both will be phased out. The time scale for this phase-out is not known, but a rising mountain of evidence points toward the elimination of this technology, to be replaced by non-toxic crop production methods and crop varieties that place quality and health first. Only then will farmers be able to claim their right as producers of food fit for the most abundant health of the people they are intended to serve. The future of agriculture is biological, and it is coming.



Soil peds (structural units) are critically important to the movement of air and water to plant roots. Mycorrhizal hyphae shown here help encapsulate clay and organic matter particles to form the peds.

Nitrogen fixing organisms, like these rhizobium nodules, are inhibited by glyphosate and several other herbicides.

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Gene Switches Decide What a Gene Does

Continued from page 1

ried only for the ride.

However, in recent decades the appendix has been found to have several functions as an integral part of the immune system. What about that "junk DNA" that tags along with the "essential DNA" of the cell?

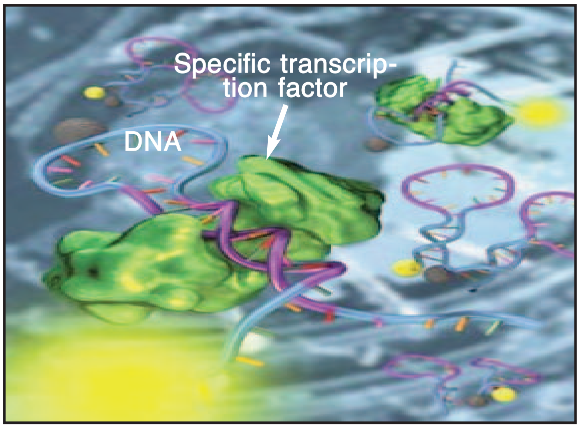
A series of scientific papers, involving 442 researchers worldwide, was released on September 5 of this year. They resulted from a nine-year project called "Encyclopedia of DNA Elements" [ENCODE][2], which discovered that supposedly inactive regions of DNA actually contain "switches" that turn genes on and off, essentially controlling their behavior. Involving over 1,600 experiments, ENCODE cost U.S. taxpayers $185 million.[3]

Despite the great amount of information harvested from this project, the lead coordinators, Ewan Birney of the United Kingdom, humbly stated that only one-tenth of the human genome's secrets were uncovered by these efforts. He said, "I get this strong feeling that previously I was ignorant of my own ignorance, and now I understand my ignorance"[4]

Dr. Birney called the human genome a "jungle" because it contains several layers of information and several dimensions of complexity. Stretches of the DNA were known to contain regulatory switches, but they did not know there were so many. It has been known for years that certain diseases like Crohn's Disease, cancer, immune disorders, and schizophrenia are linked to these genetic switches, but strangely they occurred in regions of the genome that did not produce enzymes.

Because atheistic evolutionists like Richard Dawkins have been hammering away for years at the "junk DNA" issue — that a Creator God would not produce extraneous messages within His creation — it came as a real surprise when it was discovered that indeed there are critical functions for this DNA. So upsetting were these new revelations that Larry Moran, a biochemist at the University of Toronto, stated, "The creationist are going to love this .... This is going to make my life very complicated."[5]

Likely as not, it will be discovered that all 100% of the genome will be found to be active in cell replication and function. It is obvious that not all of the switches would be equally active in cells of different types — say, muscle cells versus brain cells — so that specific traits of different cells would be expressed. It is presumed that some switches are preprogrammed to flip on at certain points during the development of the body, even starting at fertilization of the egg.



A structure-switching nanosensor made from DNA (blue and purple) detects a specific transcription factor (green). These switches are crucial in the expression of DNA through enzyme production.

Interestingly, while some of the switches are located next to the enzyme-producing genes, some are hundreds or even thousands of base pairs away from the genes they control. To explain this, the three-dimensional configuration of the double-helix strands must be considered. Distant "switch genes" may fold down on the enzyme-generating genes they control, and may actually touch them[6].

These new discoveries in biology point towards the wisdom of a marvelous Creator who put this system of life together. To suggest it all happened by chance is not only totally improbable, but illogical, requiring more faith than in belief of a Creator due to the mountains of information pointing towards creation. This creation points not just towards a jumbled array of "junk", but towards marvelous order after a specific pattern.

Stephen Meyer of the Discovery Institute in Settle, Washington, noted "It's layers within layers of complexity. That's what's being revealed in biology. It's mind-boggling."[4]

As the ENCODE project continues, much more will be learned about the awesome nature of the human genome. Yet, we can be sure that whatever is learned will uncover more of the amazing intricacy of the creation around us. In particular, it will reveal how crops adjust their metabolism and structures to face the rigors of a sometimes hostile environment: drought, heat, cold, nutrient deficiencies or toxicities, insect and pathogen attacks, and a host of other stresses. As farmers and ranchers, we ought to appreciate that the DNA in every cell in our bodies, or of our animals and crops, is comprised of 100% functional, purposefully designed "non-junk". We have seen only the tip of the iceberg of how "junkless" we really are!

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4, 5, and 6. See 3. ❑

Discouraged? Then Read This!

The American painter John Sargent once painted a panel of roses which was highly praised by critics. It was a small picture, but it approached perfection. Although offered a high price for it on many occasions, Sargent refused to sell it. He considered it his best work and was very proud of it. Whenever he was deeply discouraged and doubtful of his abilities as an artist, he would look at it and remind himself, "I painted that." Then his confidence and ability would return. There are times when all of us doubt our ability, and the harder the work we do, the more creative it is, the more vulnerable we are to such doubts. We can't live on past achievements, but we can use them for inspiration as Sargent did. Everyone should have a "highwater mark" to look back to, something he can be proud of and say, "I did that, and it is good ... and because I did it once, I can do it again!" [*Bits and Pieces,* September, 1972.]

15-Minute Soils Course

Lesson 36:

Chemical Effects On Soil Biology

Since world War II, conventional agriculture has increasingly utilized chemicals of various sorts to fertilize crop, control weeks, insects, fungi, nematodes, and other pests, and in some cases sterilize the soil to boost production of high value crops. These chemicals have, along with management factors, been shown to affect soil microbial populations.

We have learned throughout this series of soils lessons that soil microbes are extremely valuable in the plant ecosphere, providing available nutrients, vitamins, antibiotics, hormones, and growth regulators for plant growth and protection, and gums and mucilages for a strong soil structure. They deserve to be protected.

Certain microbes adapt within the soil system to attack and degrade added carbonaceous substances. This includes normal crop residues, but also any foreign carbon compounds such as herbicide and pesticides. Soil microbes in time will adapt to these added compounds and break them down rapidly after application.

Herbicide Effects

The world's most widely used herbicide—***glyphosate***—has been shown to damage the soil ecosystem in the following ways:

1. In general, detrimental microbe species are encouraged at the expense of beneficial ones.
2. As a result, available nutrients are reduced, such as Mn, Cu, K, Fe, Mg, Ca, and Zn.
3. Manganese (Mn) reducing bacteria are inhibited, resulting in less uptake of Mn and reduced activity of the disease-fighting shikimic acid pathway.
4. Root fungi increase that encourage "sudden death" and *Fusarium* infestations of corn and soybeans
5. *Rhizobium* N fixing bacteria of legumes are killed or inhibited.

Other herbicides affect the soil biology in various ways, but they all tend to upset the normal diversity and numbers of microbes. Paraquat, atrazine, and simizine reduced the populations of certain mites and fungi so that crop residues decompose slower.

Fungicide Effects

Fungicides are designed to kill fungal species, and among the fungi are the all-important mycorrhizae. These mutualistic soil species transport critically important available nutrients to roots. Note the table below for effects of various fungicides on mycorrhizal fungi.

Fungicide Effects On Mycorrhizae

Fungicide	Endomycorrhiza	Ectomycorrhiza
Azoxystrobin	N	N
Benodamil	S	S
Captan	S	L
Folpet	S	S
Fosetyl-AL	N	N
Ridomil	L	N
Quintozene	L	S
Thiram	N	S
Thiazole	S	L
Triadimefon	S	S

N = no effect; L = no effect at low rate, suppresses at high rate; S = suppresses at any rate.

Insecticide Effects

As with fungicides, different insecticides cause harmful shifts in the soil microbial population. For example, chlorpyrifos reduces bacteria numbers by increasing fungi. Diazinon reduces the population of protozoa, and organophosphate greatly reduce numbers of soil insects and mites, as well as some beneficial nematodes and especially earthworms.

Fertilizer Effects

High soil P levels tend to restrict mycorrhizal activity; they become "lazy" when one of their main functions—to deliver P to the plant—

15-Minute Soils Course

becomes less needed. Interestingly, higher P levels and fertility in general promote earthworm populations, likely because the worms have more food from bigger plants.

Nitrogen fertilizers suppress mycorrhizae root colonization, and also increase certain pathogenic nematodes, like *Pratylenchus thornei*. Nitrogen use over time in intensive agriculture reduces soil organic matter levels, so the entire spectrum of soil microbial numbers and species is lowered. Anhydrous ammonia sterilizes the soil and dissolves organic matter in the application band, so over time this gaseous fertilizer reduces populations of soil microbes.

Sulfur additions reduce protozoa and fungal populations, at least temporarily. Effects of other soil elements can be positive or negative on microbe species, depending on soil conditions, weather conditions, crop grown, and cultural practices.

The Big Picture

Modern agriculture's intensive use of synthetic biocides and fertilizers has had a major effect on soil microbiology, such as the following:

1. ***Fungicides, herbicides, and insecticides all function by poisoning enzyme systems of living cells***, thus injuring or killing many non-target life forms such as beneficial bacteria, fungi, protozoa, actinomycetes, and earthworms.

2. The longer a pesticide is used, the greater will be its effects to disrupt the normal soil community. The biological profile tends to recover each time it is assaulted by a biocide application, but over time the effect is to simplify the ecosystem, eliminating some helpful types: certain mites, earthworms, protozoa, and N-fixers.

3. By reducing the soil microbe numbers and species complexity, crop residues break down slower and may accumulate, tying up N.

4. Reduced microbe activity will lead to soil compaction, and a great reduction in macropores, the sizes that are most effective in transporting air and water to roots. Besides, because of slower infiltration of rainwater, the erosion potential is magnified.

5. Fertilizers have variable effects on soil biological activity, but high N use over time will lead to reduced soil organic matter reserves and microbial function.

Engaging in practices that encourage microbial and earthworm populations will go a long ways in improving your soil conditions and crop yield. These practices include cultural weed control, crop rotations with a legume, minimal tillage, and the limitation of pesticide applications.

See How Much You Learned

1. All biocides poison enzymes. T or F

2. Which of the following adversely affect soil microbes? a. Captan b. Thiram c. Fertilizer N d. Atrazine e. All of these

3. Over time, high applications of __________ fertilizer will reduce soil organic matter and microbial activity.

4. Mycorrhizae are commonly inhibited by fungicides. T or F

5. The most commonly used herbicide, ______________, is very harmful to soil microflora and structure.

6. Glyphosate a. enhances soybean "sudden death" b. reduces Mn availability c. encourages *Rhizobium* bacteria.

7. ______________ are very harmful to earthworms.

Answers: 1.T; 2. e; 3. nitrogen; 4. T; 5. glyphosate; 6. a and b; 7. Organophosphates.

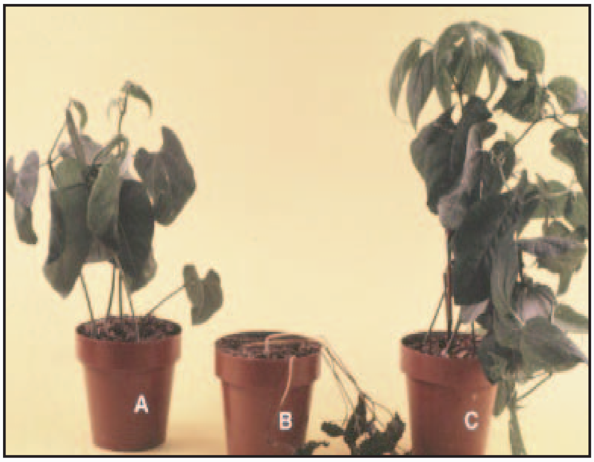
Glyphosate Kills Plants Indirectly

by Paul W. Syltie, Ph.D.

It is generally assumed that glyphosate, the active ingredient in Roundup herbicide, kills plants through amino acid inhibition, just as other herbicides kill through disruption of biochemical plant functions. For instance, 2,4-D, acts as a growth regulator (an auxin) to force broadleaf plants to exhaust their resources and die. Amitrole is a chlorophyll and carotenoid inhibitor, Paraquat destroys cell membranes and kills on contact.

In spite of popular teaching, however, glyphosate works a bit differently than other herbicides. This compound — N-(phosphonomethyl) glycine — is a strong systemic metal chelator, and was initially patented for this purpose. When applied to plants, the effect is to complex with any metals it contacts, such as zinc, copper, manganese, iron, and others. In particular, the chelation of manganese (Mn), a cofactor for the EPSP synthase enzyme in the shikimic acid pathway, gives rise to the herbicidal action of the compound in many microbes as well as in the plant.

While glyphosate applied to a plant growing in sterile soil will stunt the growth, it will not kill it. Micronutrients will be bound and unable to function as metallic activators of enzymes, but enough of these elements will still be available to sustain inefficient growth. However, the glyphosate is readily transferred through phloem tissue to the roots, and is released into the rhizosphere (root zone) in exudates. This root-zone glyphosate then enters the cells of soil bacteria, fungi, and other microbes, in particular the bacteria that reduce Mn^{+4} from its unavailable oxidized form to its reduced available form (Mn^{++}). This is the soluble form of Mn that plants take up and utilize in their defense systems against pathogens.



Pot A: bean plants were grown in vermiculite, which has few pathogens. Pot B: field soil with many pathogens was used; 20 days after glyphosate treatment. Pot C: field soil, with no glyphosate treatment.

Thus, the plant loses much of its ability to resist disease organisms in the root zone with glyphosate inhibiting the conversion of Mn to its available form, and succumbs to root diseases that lead to death. To emphasize this point, notice the figure here, which shows bean plants in three situations: A, glyphosate treated but grown in a vermiculate soil containing few pathogens; B, glyphosate treated but grown in field soil containing many pathogens, such as *Pythium* species; C, untreated control plants grown in field soil. The beans treated with glyphosate but without many root pathogens are less growthy, but by no means dead, while those growing in field soil containing many pathogens are killed by the pathogens, their "immune systems" having been compromised by Mn chelation, and an ineffective shikimic acid pathway.

[For an excellent discussion of the topic discussed here see "Glyphosate Effects On Diseases of Plants" by G. Johal and D. Huber, Department of Botany and Plant Pathology, Purdue University, West Lafayette, Indiana.] ❑

RNAi and the New GMO Varieties

By Alex Daley, Chief Technology Investment Strategist [Excerpts from the Nov. 1, 2012 *The Technology Investor*]

Last month, a group of Australian scientists published a warning to the citizens of the country and of the world who collectively gobble up some $34 billion annually of its agricultural exports. The warning concerned the safety of a new type of wheat....

In a sense, the crop is little different than the wide variety of modern genetically modified foods. A sequence of the plant's genes has been turned off to change the wheat's natural behavior a bit, to make it more commercially viable (hardier, higher yielding, slower decaying, etc.)....

What's really different this time ... is the technique employed to effectuate the genetic change. It doesn't modify the genes of the wheat plants in question; instead, a specialized gene blocker interferes with the natural action of the genes.

The process at issue, dubbed RNA interference or RNAi for short, has been a hotbed of research activity ever since the Nobel Prize-winning 1997 research paper that described the process. It is one of a number of so-called "antisense" technologies that help suppress natural genetic expression and provide a mechanism for suppressing undesirable gene behaviors.

RNAi's appeal is simple: it can potentially provide a temporary, reversible off switch for genes. Unlike most other genetic modification techniques, it doesn't require making permanent changes to the underlying genome of the target. Instead, specialized siRNAs - chemical DNA blockers based on the same mechanism our own bodies use to temporarily turn genes on and off as needed - are delivered into the target organism and act to block the messages cells use to express a particular gene. When those messages meet with their chemical opposites, they turn inert. And when all of the siRNA is used up, the effect wears off.

The researchers responsible are using RNAi to turn down the production of glycogen.... The result would be a grain with a lower glycemic index - i.e., healthier wheat. This is a noble goal. [But] ... there's a risk that the gene silencing done to these plants might make its way into humans and wreak havoc on our bodies.... ❑

It's Time to Engage in a New Conversation

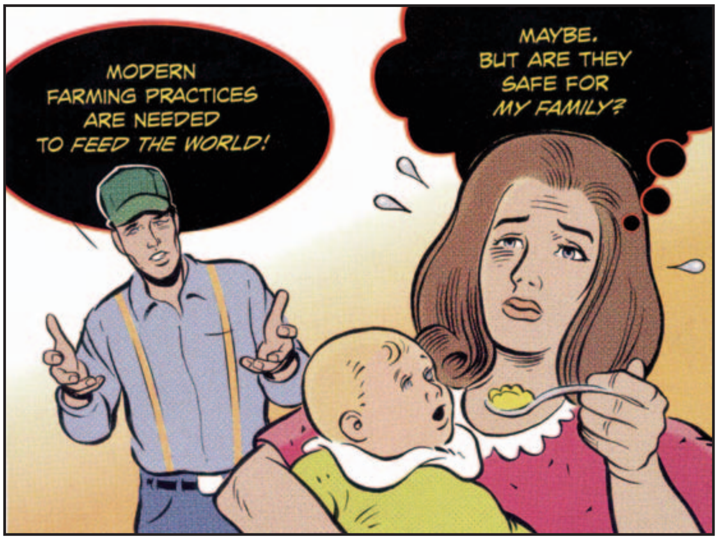
[**Editor's note:** *This item appeared in the November, 2012, edition of* The Furrow, *by Deere and Company. It is interesting to note that by beginning this new organization called U.S. Farmers and Ranchers Alliance, and with major companies like John Deere participating, the large corporations involved with U.S. agriculture are acknowledging that they are not winning the battle for the minds and hearts of consumers of their products.*

This failure is perhaps strongest in the area of genetically modified foods, which most homemakers would refuse to purchase if they are identified on food labels, Their skepticism towards this new technology is well-placed, as the lead article of this newsletter emphasizes. After all, which mother would want to feed her child a food laced with a GMO component that causes tumors, severe hormone-dependent mammary, hepatic, and kidney disturbances, and other diseases in test animals? No wonder why mothers are worried about these foods. We all ought to be.]

by the staff of *The Furrow*

For decades, farm, ranch, and agribusiness groups have told their story to consumer's. It's a story of food safety, abundance, respect for the land, affordability, and feeding the world.Too often those messages fell on skeptical ears. "To influence consumers, we needed more listening and less telling," says Hugh Whaley, U.S. Farmers and Ranchers Alliance general manager.

This communication challenge drove the formation of the U.S. Farmers and Ranchers Alliance (USFRA) in October 2010. "The core of the alliance is made up of state and national not-for-profit farm, crop, and livestock organizations," explains Whaley. "Plus, there are a number of industry partners. Our focus is on improving the conversation between consumers and farmers and ranchers. We do that by helping social influencers and consumers connect with real farmers and ranchers, either through social media or unique programs that bring people face to face.



One recent USFRA event was Food Dialogues, held in Los Angeles. It brought farmers and ranchers together with noted chefs, food writers, entertainment industry representatives, and media officials. "There were four moderated panel discussions, all streamed online," says Whaley. "The event received 88 million media impressions and 14 million Twitter impressions," You can watch this and other events at the website *FoodDialogues.com*.

"For too long we've spoken to consumers," says Don Borgman, the John Deere representative on the USFRA board. We need to speak with consumers. Wether you farm or ranch, supply inputs, or process and distribute food, you need to be engaged with USFRA. Our future is at stake. The key is building relationships between food consumers and food producers." ❑

No greater love ...

I think that love is the only spiritual power that can overcome self-centeredness that is inherent in being alive. Love is the thing that makes life possible, or, indeed, tolerable.

Arnold Toynbee

Statement of Purpose

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