COLUMBIA/BOONE COUNTY BOARD OF HEALTH
MEETING MINUTES
February 12, 2015

The Columbia/Boone County Board of Health met for a regularly scheduled meeting at 5:30 p.m., Thursday, February 12, 2015. The meeting was held at the Columbia/Boone County Department of Public Health and Human Services, 1005 W. Worley St. Public Health & Human Services Director, Stephanie Browning, and Assistant Director, Scott Clardy, represented the staff. Senior Administrative Support Assistant, Brittany Klusman, recorded the minutes of the meeting.

MEMBERS PRESENT:	MEMBERS EXCUSED:	MEMBERS NOT EXCUSED
Dr. Michael Szewczyk	Lynelle Phillips	
Jean Sax	Dr. Colin Malaker	
Dr. Beth Hussey		
David Sohl		
Cynthia Boley		
Denise Stillson		
Mahree Skala		
Harry Feirman		
Dr. Sally Beth Lyon		

CALL TO ORDER

Chair Dr. Michael Szewczyk called the meeting to order at 5:30 p.m.

APPROVAL OF AGENDA

Mr. Sohl noted that he did have an item to discuss under New Business.

APPROVAL OF MINUTES

Dr. Lyon made a motion to approve the minutes, which Dr. Hussey seconded. Motion carried.

PRESENTATION

Robert Kremer, PhD – Adjunct Professor of Soil Sciences at the University of Missouri

Genetically Modified Organisms

Dr. Kremer has worked for the University of Missouri for over thirty years in the Department of Soil, Environmental & Atmospheric Sciences and Division of Plant Sciences. Additionally, he has worked with the United States Department of Agriculture- Agriculture Research Service (USDA-ARS) for over thirty years as a research microbiologist with the Cropping Systems and Water Quality Research unit in Columbia, Missouri. He explained that his specialty is soil microbiology. Dr. Kremer explained that his presentation is an introduction to Genetically Modified (GM) crops and how widespread they are now. He will include some data that has been discovered over the years. Dr. Kremer has been working with GM crops since 1997, which was the year after they were introduced for commercial production.

Starting off, Dr. Kremer went over what GM crops are and how the definition could be applied to conventional breeding techniques. He explained that the more modern definition for GM plants is, "the deliberate introduction of a gene from a different organism into a plant to express a desirable trait". Basically, an alien gene is being intentionally inserted into the DNA of a plant; Dr. Kremer explained that this manipulation may be more accurately referred to as Genetic Engineering (GE). This will be the definition Dr. Kremer will refer to throughout his presentation. Furthermore, Dr. Kremer explained that currently in the United States, there are roughly 183 million acres of GE crops. Over ninety percent of the U.S. soybeans and over seventy-five percent of the U.S. corn are genetically engineered.

Dr. Kremer touched on the overall implications of the GE crop systems, and described how it is a simplified weed management system. He explained that glyphosate is the active ingredient in the herbicide Roundup, therefore GE Roundup-ready crops are resistant to glyphosate. However, there has been a natural development of glyphosate-resistant weeds which require additional herbicide applications. This system has possibly improved soil conservation, increased production of commodity crops per farmer, and reduced the use of some insecticides. Additionally, GE crops have indirect or non-intended effects that occur, and Dr. Kremer went over specific details and examples. He explained that GE seeds are being publicized to yield more crops and allow farmers to spray the insecticide; however, GE soybean yields have not increased relative to non-GE soybeans. Dr. Kremer went over differences between GE seeds and conventional seeds, and explained some impacts of transgenic (GE) cropping systems on soil function and soil health.

Moving onto glyphosate; Dr. Kremer explained how it works in the plant, how it can be released into the soil, and how factors of the soil can affect how it breaks down. He presented evidence of glyphosate being detected in soils and that it takes roughly twenty to forty days for it to break down. He clarified that the over application of glyphosate is the concern, basically it is the primary chemical that is being used and there is hardly any rotation of different chemicals. Dr. Szewczyk asked if there were any programs designed to rotate the herbicide being applied in order prevent weeds developing resistance to the herbicide. Dr. Kremer said that would be helpful but there are difficulties in getting the farmers to implement programs. Dr. Kremer went over some plant tissue testing which shows a reduced nutrient efficiency when using glyphosate. He discussed data on how Roundup-ready seeds already lose some nutrients, but even more so after glyphosate is applied to the plants. He discussed some ways farmers can overcome this loss of nutrients. He also mentioned that the results from the data being shared are from a limited number of varieties growing in only one or two soils.

Dr. Kremer revealed that there is a rise in glyphosate being found on crops that are not genetically engineered. He went over some possibilities of how it can be transferred to non-GE plants which included: burndowns, vegetative management in orchards and vineyards, and sometimes used as a desiccant or drying agent. He explained how a farmer should wait seven to ten days after a burndown before planting new seeds. Dr. Kremer believes that overall, this is a good advancement system if used wisely, but overuse of glyphosate leads to resistant weed biotypes and soil nutrient problems. He explained that food should be produced in a manner that promotes or respects environmental quality. Dr. Kremer believes it is in our interest to educate consumers about GE crops, and how the use of glyphosate may impact agriculture systems, in order to develop an awareness of food production and food quality. He suggested the Board visit the Factor GMO website, http://factorgmo.com/, which is the world's largest international study on GMO and pesticide safety.

The floor was opened up for questions. Dr. Szewczyk wanted to know if a governmental agency has to approve the GE seeds. Dr. Kremer explained the process noting that the Environmental Protection Agency (EPA), Food and Drug Administration (FDA), and the U.S. Department of Agriculture (USDA) are all involved in setting requirements that have to be met. The Vitamin A rice or the "Golden Rice" was discussed. Dr. Kremer clarified that the "Golden Rice" can only be achieved by genetic modification, but it has not been approved for wide-spread cultivation yet; however, we could be moving in that direction. Overall he sees it as a beneficial product. That said, there still may be some indirect effects that will occur when it is put in to wide spread use. Ms. Sax asked how GE crops affect the consumers who buy their food at the grocery store. Dr. Kremer explained that the consumer should be made aware of GE crops so they could make an informed decision on whether or not they will purchase items made with GE products. He explained that anything which contains corn or soybeans will have genetically modified product in it.

Dr. Lyon clarified that Dr. Kremer's expertise is on the environmental impact from GE crops rather than on the health impacts for humans. Agreeing with Dr. Lyon, Dr. Kremer verified that based on his studies, he has observed this system lowers the nutrients in the crops, but his expertise does not expand into what effect this may have on humans. He does believe consumers need to be made aware of the issue.

After Dr. Kremer's presentation, Dr. Szewczyk asked the Board where they would like to take this topic. Ms. Stillson would like to see a community wide educational forum on the issue. Dr. Lyon mentioned that she has no objection to being more educated on GMO's, but over time she feels it would be beneficial for the Board to integrate their work with the Columbia/Boone County Department of Public Health and Human Services' strategic plan to help support the already established priorities. Dr. Szewczyk agreed with Dr. Lyon. He explained that this presentation was to get an introduction to the topic to see if it was something the Board wanted to pursue. He believes this topic is becoming a concern to more and more people and the Board of Health would be an appropriate entity to sponsor a public symposium. Ms. Stillson made a motion to create a subcommittee to further investigate creating this symposium. Ms. Boley seconded the motion and the motion carried. Ms. Stillson, Ms. Sax, and Ms. Boley volunteered to be on this subcommittee. It was decided that Ms. Stillson would chair the subcommittee and be responsible for scheduling a meeting and setting the agenda. Dr. Szewczyk noted that once the meeting was scheduled, the date and time should be sent to all Board members, so anyone who wanted could attend the meeting.

Dr. Kremer's slideshow presentation is attached for additional information.

DIRECTOR'S REPORT

Ms. Browning mentioned the Department is working on budget preparations, watching legislation, monitoring measles, and preparing the City's strategic plan for the next three years. She touched on a piece of legislation that is trying to eliminate the Missouri Department of Health and Senior Services in order to create a new Department called MO Health Net.

OLD BUSINESS

School Lunch Programs

Dr. Szewczyk and Ms. Skala are working on a letter to the USDA in regards to this issue. Ms. Skala proposed to take a different approach and send a letter to the School Board and the superintendent of schools to show the Board of Health's support. The Board was in agreement to proceed in this direction.

Tobacco21 and e-cigarettes

The Board members have not heard anything new on this issue. There was a short discussion on all the studies that are starting to surface about electronic cigarettes.

NEW BUSINESS

Mr. Sohl explained that in the Rockbridge High School newspaper, *The Rock*, there was an article about random drug testing in public schools. He noted that Jefferson City is beginning to implement random drug testing in their public high school but Columbia Public Schools has no intention of creating such a policy. The article continued to explain that in the last twenty years, there has been a large increase in US public schools that have implemented a random drug testing policy. Mr. Sohl is curious as to why Columbia Public Schools is taking the stance against implementing this. He would like to have someone present more information on the issue to help understand why this is occurring. Discussion followed. Dr. Lyon noted that a more broad discussion of substance abuse and services for youth would be helpful and perhaps we should get more information about the work being supported by the Boone County's Children Services Fund. She suggested someone present some information about the five million dollars in grant money that was just awarded to non-profit organizations to provide mental health services for children, including substance abuse prevention and treatment. Hopefully, a presenter could speak about the projects that have been funded so far in Boone County.

Ms. Browning mentioned that she would call Kelly Wallis, the Director of the Children Services Fund, to discuss the programs that they are funding. Ms. Boley suggested inviting the Substance Abuse Advisory Commission to join the meeting, which the Board agreed to.

ADJOURN

There being no additional business, Dr. Hussey made a motion to adjourn the meeting at 7:15 p.m. Mr. Sohl seconded and the motion carried.

GE Crops and Use In Agriculture and Food Production

R.J. Kremer

Professor of Soil Microbiology
Department of Soil, Environmental & Atmospheric Sciences and
Division of Plant Sciences
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Genetically Modified Crops - GM or GMO

Genetic modification may include "conventional breeding" techniques where desirable traits of one crop variety are transferred to another variety *within the same plant species*, resulting in a modification of traits in the offspring (i.e., cross-pollination)

"Modern GM plants" – deliberate introduction of a gene *from a different organism into a plant* to express a desirable trait.
Example:
a)Introduction of gene from bacterium *Bacillus thuringiensis* to code for production of the insecticidal protein toxin "Bt" by a plant (corn, cotton) –

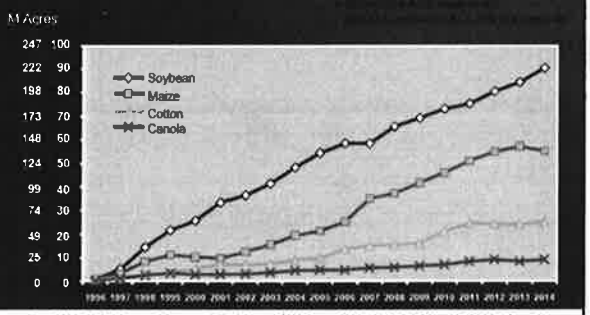
a) Desirable trait: resistance to feeding by certain insects
b) Introduction of gene from bacterium (*Agrobacterium*) to code for production of an enzyme with resistance to a herbicide by a plant (corn, soybean, cotton, canola)
a) Desirable trait: resists effects of herbicide applied to kill weeds (i.e., glyphosate)

Because an alien gene is intentionally inserted into the DNA of a plant, this manipulation may more accurately be referred to as *Genetic Engineering* (GE).

"Biotechnologically Modified Organism"?! (Oliver, 2014)

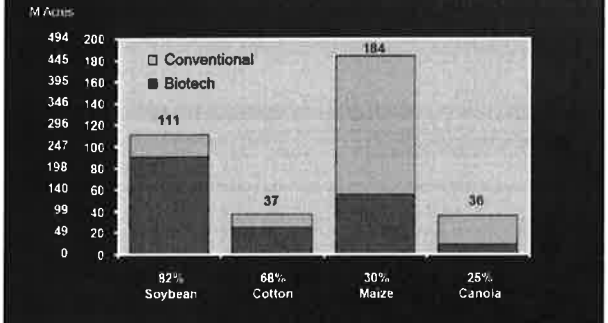
Modern ***Biotechnology*** => "Biotech Crops"? (see next figures)

Global Area of Biotech Crops, 1996 to 2014: By Crop (Million Hectares, Million Acres)



James, Clive. 2014. Global Status of Commercialized Biotech/GM Crops: 2014. *ISAAA Brief* No. 49. ISAAA: Ithaca, NY.
The International Service for the Acquisition of Agri-biotech Applications (ISAAA).

Global Adoption Rates (%) for Principal Biotech Crops (Million Hectares, Million Acres), 2014



Source: Clive James, 2014
Hectarage based on FAO Preliminary Data for 2012

***Increasingly difficult to discuss impacts (advantages or detriments) of GE crops without also considering contribution of Glyphosate to overall effect.*

- Glyphosate is "active ingredient" in the herbicide "Roundup"
- GE "Roundup Ready" crops are resistant to glyphosate
- Many GE crops are engineered to express both Bt and glyphosate resistance traits
- Some GE crops with resistance additional herbicides will soon be available for production

U.S. GE - Herbicide Resistant Crop Area

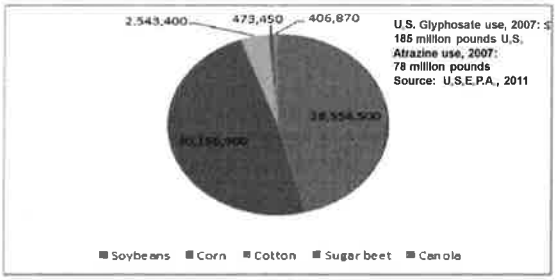


Figure 1. United States GM HT crop plantings 2013 by crop (hectares).Sources: derived from USDA, ISAAA, GK Animal and Crop Health
Note: Base area of the 5 crops 62.1 million ha.

Brookes, G. (2014) Weed control changes and genetically modified herbicide tolerant crops in the USA 1996–2012. GM Crops & Food: 5:321-332

Overall Implications of GE Cropping Systems

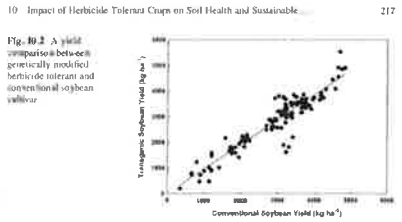
- **Simplified weed management** (but development of glyphosate-resistant weeds now require additional herbicide inputs)
- **Possible improved soil conservation**
- **Reduced use of some insecticides**
- **Increased production of commodity crops (per farmer)**

Do GE crops have other effects on soil and environmental health?
⇒**"Pleiotropic Effects" (Indirect or non-intended)**
⇒vs "Desired Effects" of GE traits

Limited documented evidence on effects of genetic transformations alone on alterations of crop physiological activity (including nutrient accumulation in grain)

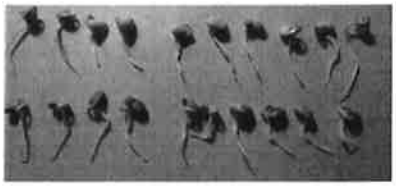
Difficult to assess impacts of most GE crops without also considering contribution of Glyphosate to overall effect

GE soybean yields have not increased relative to non-GE soybean:



Lee et al. 2014. Impact of herbicide tolerant crops on soil health and sustainable agriculture crop production. Pp. 211-238 In: D.D. Songstad, J.L. Hatfield, D.T. Tomes (eds.) Convergence of Food Security, Energy Security and Sustainable Agriculture. Springer, New York.

Are differences in seed viability, germination, seedling vigor due to pleiotropic effects?



"Conventional, non-GE" soybean

Note seed coating on GE seeds

Differences in seed viability, germination, seedling vigor

Note variable seedling growth of GE soybean

Impacts of Transgenic (GE) Cropping Systems on Soil Function or Soil Health*

GE Trait Alone (Bt & GR)*	GE Trait + Glyphosate (GR)	Glyphosate Alone**
Soil fauna suppression (Bt)	Alter soil/root microbial structure	Mycorrhizae suppressed
Alter root microbial symbioses	Suppress antagonistic microbes	Reduce earthworm activity
Alter root exudates; GE-DNA released into environment	Increase potential root pathogens; Mycotoxin production potential	Increase potential pathogens; Mycotoxin production
Shift root-associated microbial community structure & function	Increase nutrient immobilization	Nutrient immobilization
Alter plant nutrient uptake	Decrease soil N uptake	Increase foliar/seed fungi
Increase susceptibility to soybean cyst nematode	Rhizobia infection, nodulation, N fixation decrease	Potential increased mycotoxin production - grain, roots (?)
Alters nutrient uptake, photosynthesis patterns; mycorrhizae (GR weeds)	Mycorrhizal association affected; alter P, K, water uptake, pathogen protection	Glyphosate moves thru soil, absorbed by by non-target plants/crops; harmful effects
Higher water requirement (poor water-use efficiency) - GE soybean	Stimulate 'sudden death syndrome' disease (soybean)	Eliminates food plants for wildlife (i.e., Monarch butterfly)
Lower seed quality/seedling vigor	Glyphosate released thru roots	
Bt toxin increases glyphosate persistence in soil	Glyphosate re-absorbed by roots lead to root damage, pathogen attack	
Reproductive abnormalities in cotton; Bt pollen may effect beneficial insects	Reproductive abnormalities in cotton	

*Impacts of GE alone due to pleiotropic or unintended effects of transgenic transformation; NOTE: Supporting literature available for effects.
**Effects of Glyphosate alone due to direct contact with soil during application to GE crop or burndown (knockdown)

Genes coding for resistance to glyphosate and for Bt insecticidal toxins can be released into soil from roots of transgenic plants

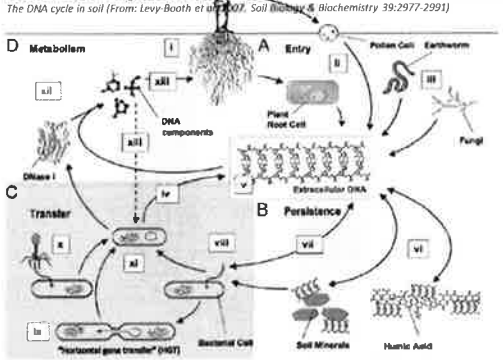
Detected "large concentrations" of transgenic (GE) DNA in the soil food web in fields after 3 years of Roundup Ready corn – Roundup Ready soybean rotation; provides an opportunity for "horizontal gene transfer" (HGT) of transgene into native soil bacteria. Whether these genes would be functional or pose other risks within the soil ecosystem is not known.

Hart, M.M., J.R. Powell, R.H. Gulden, D.J. Levy-Booth, K.E.Dunfield, K.P. Pauls, C.J. Swanton, J.N. Klironomos, I.T. Trevors. Detection of transgenic cp4 epsps genes in the soil food web. Agron. Sustain. Dev. 29:497–501.

Transgenic (GE) DNA entering mammalian system likely degraded rapidly during digestion process (Oliver, 2014)

Possible fates of transgenic DNA released into soil (*including Bt & glyphosate transgenes*)

The DNA cycle in soil (From: Levy-Booth et al. 2007. Soil Biology & Biochemistry 39:2977-2991)



(A) Entry of DNA into Soil; (B) Persistence of DNA in Soil; (C) Transfer of DNA in Soil; (D) Degradation of DNA in Soil

All plant DNA is transient in soil – rapid degradation suggests limited opportunity for natural transformation of transgenic DNA into soil microbes – Gulden et al. 2008. Weed Science 56:767-774

Glyphosate – modes: inhibits amino acid synthesis; inhibits production of compounds that resist pathogen attack/infection

Glyphosate contributes to overall impact of GE crops with herbicide resistance --

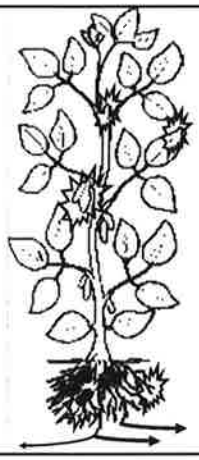
Glyphosate *systemic* – <u>transported throughout the plant</u>.

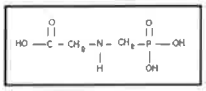
In RR soybean, glyphosate has been found *localized* in meristematic tissues of growing points, leaves and roots; pod and seed; nodules.

Also glyphosate is *actively released through roots* into rhizosphere soil (root zone) likely with high amounts of carbohydrates & N-compounds in RR soybean -

****May affect nearby non-GE plants**

(Kremer et al. Int. J. Environ. Anal. Chem. 85:1165, 2005)

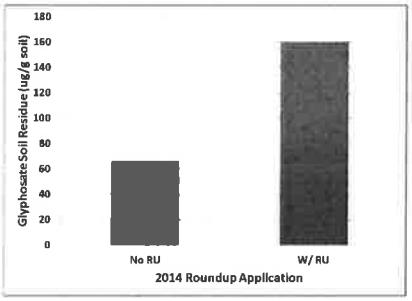




Some factors affecting persistence, availability, degradation of glyphosate in soils:

1. Soil pH
2. Soil mineralogy (texture)
3. Soil organic matter content
4. Soil P content, sorption
5. Soil nutrient status (cationic nutrient content)
6. Herbicide formulation and components (i.e., surfactants)
7. Soil surface vegetative residue cover
8. Type of crop management system in place (crop sequence, cover crops)
9. Soil oxygen status; compaction (anoxic conditions prolongs persistence)
10. Composition of soil microbial community (adequate diversity [consortium] to completely degrade molecule?)

Residual glyphosate in rhizosphere soil of GE soybean with and without Roundup* in 2014 (Mexico silt loam, Boone County, MO)**



* Application rate = 0.75 lb a.i./A
**Roundup applied at field site in periodically thru 2013

The following data are factual and have been published in peer-reviewed journals.

Results are from a limited number of varieties growing in only one or two soils.

We must be cautious to not extrapolate the effects to all GE crops at this time.

Whether our results are exceptional based on experimental conditions or not, it is obvious that more trials are necessary to better understand impacts of GE crops and/or glyphosate on final crop quality.

Reduced Nutrient Efficiency of Isogenic Roundup Ready (RR) Soybeans (Zobiole et al, 2008, 2009)

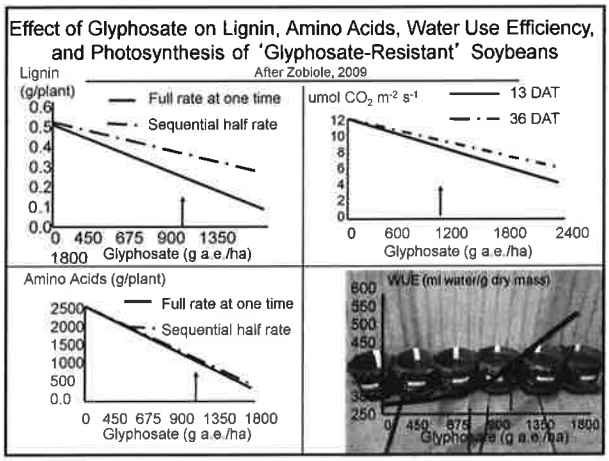
Variety (Isoline)	Tissue Mn %	Tissue Zn %	Range
Normal (non-GE)	100	100	100
Roundup Ready (RR)	83	53	10-70
RR + glyphosate	76	45	

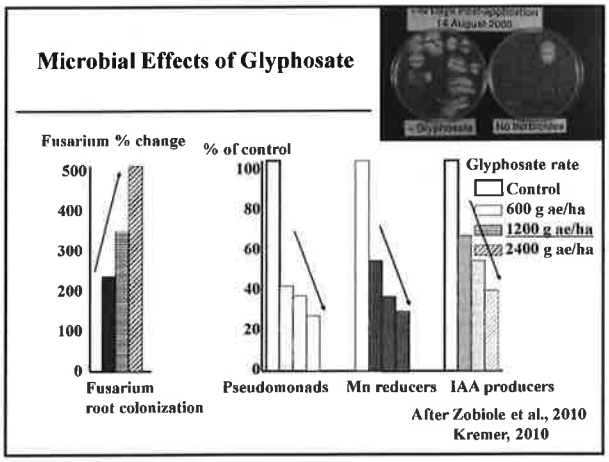
Copper, Iron also lower in the RR isoline and reduced further by glyphosate

Table 3. Micronutrient concentrations of early GE soybean cultivar and its respective near-isogenic non-GE parental lines at R1 growth stage*.

Treatments	Zn	Mn	Fe	Cu	B	Total Micro
	mg kg^{-1}					
Non-GE –No glyphosate	72.67 a	270.27 a	219.28 a	24.21 a	49.79 a	636.33 a
GE – No glyphosate	44.18 b	232.73 b	168.00 b	22.11 a	34.18 b	**501.24 b**
GE + glyphosate (450 / 450 g a.e. ha^{-1})	42.43 b	**181.67 c**	**127.60 c**	**9.55 b**	**29.38 c**	**390.72 c**
GE + glyphosate (900 g a.e. ha^{-1})	**37.64 c**	**163.67 c**	**127.15 c**	**13.55 b**	**28.53 c**	**370.61 c**

*Data represent the average of two soil types and four independent replicates. For each column, within each cultivar maturity group, statistically significant differences are indicated by different characters according to the Scott-Knott test at P<0.05.

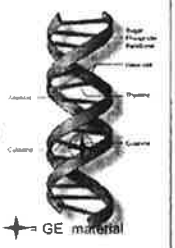




Why might pleiotropic effects occur with GE plants?

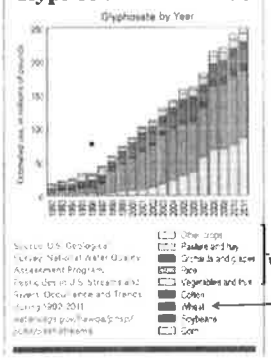
Genetic Engineering Impact on the Genetic Code

- **The bases in DNA are cytosine, guanine, adenine and thymine so the code of DNA is written in C's, G's, T's and A's (codons).**
- **A & T are a "base pair" as are C & G.**
- **The code used in GM crops is radically changed from that of the recipient and also the named bacterial sources.**
- **GE changes the bases, spatial, amino acid, 'environmental' and internal relations.**



Genetically engineered gene insertion could alter the genetic code used for plant biosynthesis of carbohydrates, proteins, fatty acids, etc.

Pesticide Boom: Glyphosate on the Rise



*GE Crops introduced

Why/how is glyphosate used in non-GE crops?? "Burndown", vegetative management in orchards, vineyards, etc.; "desiccants"

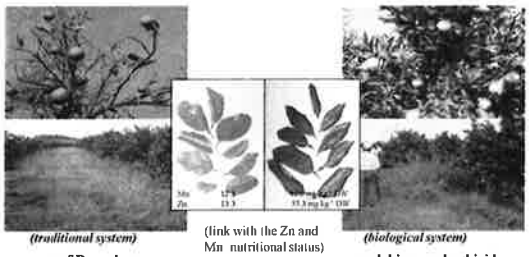
Except for Gm alfalfa (hay); sugarbeet, canola (other)

Non-GE

Source: Consumer Reports. March 2015, pp. 12-15

Observed interactions between glyphosate and diseases

The dieback syndrome (C.V.C.) is particularly expressed in traditional production systems with a high application rate of the herbicide Roundup (Glyphosate), but less in biological production systems with *Brachiaria* mulch for weed control.



(traditional system)
use of Roundup

(link with the Zn and Mn nutritional status)

(biological system)
mulching, no herbicide

Glyphosate and Glyphosate-Resistant Crops ('Roundup-Ready' [RR] Production System)

- **Advancement in effective weed management**
- **Good tools -- but must be used wisely**
- **Over-use leads to**
  - **Glyphosate-resistant weed biotypes; soil nutrient problems**

Soybean with glyphosate-resistant waterhemp, Boone County MO, 2010

Why should we be concerned about GE crops and glyphosate use in agriculture?

If we recognize food production as a system of relationships that intertwine soil, water, air, and the human community, food should be produced in a manner that promotes (or respects) environmental quality ("*Food Sovereignty*")*.

It is then in our interest to educate consumers about how GE crops and the use glyphosate may impact agricultural systems to develop an awareness of food production and food quality.

*A. Natsoulas, 2014. *Food Voices: Stories From The People Who Feed Us.* John Natsoulas Press, Davis, CA.

Some items of interest - - - -

Web: http://factorgmo.com/

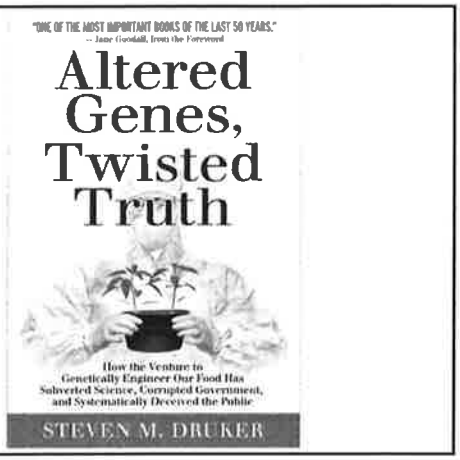
$ 25 MILLION INTERNATIONAL GMO AND PESTICIDE SAFETY STUDY SET FOR PUBLIC LAUNCH

WORLD'S LARGEST EVER STUDY ON GMO AND PESTICIDE SAFETY

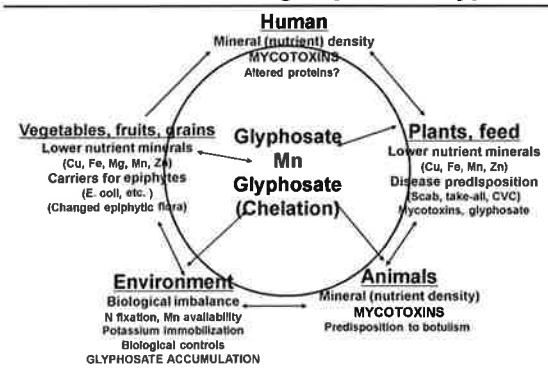
Factor GMO's preparatory phase started in early 2014. The full experiment will begin in 2015 and will last 2-3 years, with interim results being published at regular intervals during that time.
The study will test a herbicide-tolerant GM maize and realistic levels of the glyphosate herbicide it is engineered to be grown with.

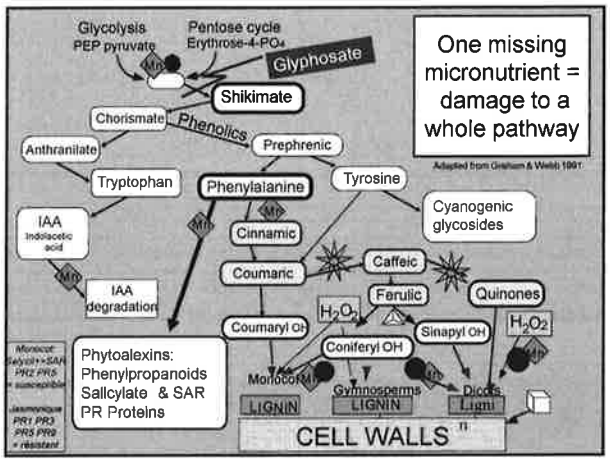
The three arms (toxicity, carcinogenicity and multi-generational arms) of the experiment will enable vital questions to be answered, such as:

- **Is the GM food (or its associated pesticide) toxic to organ systems over the long-term?**
- **Does the GM food (or its associated pesticide) cause cancer?**
- **Does the GM food (or its associated pesticide) reduce fertility or cause birth defects?**
- **Is the mixture of chemicals present in Roundup herbicide more or less toxic than its active ingredient glyphosate?**



Potential Far-Reaching Impact of Glyphosate




Glycolysis
PEP pyruvate
Pentose cycle
Erythrose-4-PO4
Glyphosate
Shikimate
Chorismate
Phenolics
Prephrenic
Anthranilate
Tryptophan
Phenylalanine
Tyrosine
Cyanogenic glycosides
IAA
Indolacetic acid
IAA degradation
Cinnamic
Coumaric
Caffeic
Ferulic
Quinones
Coumaryl OH
Coniferyl OH
Sinapyl OH
H2O2
Phytoalexins:
Phenylpropanoids
Salicylate & SAR
PR Proteins
LIGNIN
LIGNIN
CELL WALLS
One missing micronutrient = damage to a whole pathway