

## History of Soil Quality and the Impact of Chemical Use

For as long as humans have been growing food, farmers understood and respected the land. They knew what had to be done to keep the land healthy. There are 5 basic techniques that were used to keep soil healthy.

- **COMBINING and MIXING CROPS.** Using a variety of crops both during different and even the same growing season on the same field. Modern fields are huge expanses of single, or monocropped, fields which tend to deplete specific nutrients leading to nutritional imbalances. Year after year of growing the same crop on the same land leads to depletion. Today in the US, only 10 counties grow more than 10 varieties of fruits and vegetables.
- **COVER CROPS** are plants grown to protect and enrich soil and make sure soil is healthy by putting nutrients back into it. They help slow erosion, control pests and diseases, and increase organic matter. The use of cover crops has also been shown to increase crop yields.
- **CROP ROTATION** is a technique of planting different crops in the same field, but during different times. This helps soil because some plants take nutrients from the soil while others add nutrients. Changing, or rotating, crops keep the land fertile because not all of the same nutrients are being used with each crop. Historians believe that that crop rotation was used as early as 6,000 B.C.!
- **BUFFER ZONES** are strips of vegetation planted between fields and bodies of water such as streams and lakes. These plants help keep soil in place, keeping soil out of the water source. Buffer zones also act as a filter for water that flows from the field to the waterway.
- **NO TILL FIELDS.** In tilled fields, soil is broken up to make it easier for crops to grow. Because the soil is loose, it can blow away in the wind or be washed away by rain. By not breaking up the soil in their fields, the soil stays in place when it rains and helps retain moisture.
- **MANURE.** Allowing large animals like cattle and pigs to graze and poop in the fields is hugely beneficial. Not only does their manure provide nutrients to the soil and add to the formation of topsoil, their grazing and hooves aerate the soil naturally. Their manure feeds various organisms such as insects and earthworms.

Around 1900, a few things happened. First, steel grinding was introduced (from stone grinding) which allowed more refinement of flour and the era of processing and nutrient deficient foods began. Second, we changed how we farmed. With increasing demand and pressure to produce more food for the growing population, we started to disrespect the land and the importance of traditional, soil-preserving farming practices. This led to massive death of the topsoil and loss of which led to the dustbowl (1920's-30s). This was a difficult time in the US. Food was much scarcer and there were food lines. People went hungry. We started outsourcing and relying on imported food.

During World War 2, there was a public campaign encouraging people to grow food at home called "Victory Gardens" to help feed the troops. This was quite successful, and by the end of WW2 we were growing 45% of our food in our backyards. Unfortunately, this all ended with the advent of fertilizers!

At this time, there was a significant rise in petroleum-based warfare (more, trucks, ships, tanks, planes...). We learned how to produce petroleum on massive scales. After the war, there was a glut in this market and focus was turned to using the petroleum, for other things. We learned to extract nitrogen (N), phosphorus (P) and potassium (K) and chemical based fertilizers were developed (NPK fertilizers). This took the pressure off the farmers who were still struggling with poor soil. They could replace natural forms of growing (crop rotation, rest, compost...) with fertilizers. We ignored the behaviors which led to soil degradation and the dustbowl.

To compare this to the medical/pharmaceutical industry, taking a drug deals with symptoms rather than fixing the underlying disease. The drugs don't fix the problem, they are just a band aid. Unfortunately, they do come with a variety of side effects and complications requiring other drugs to compensate. In the case of farming, the

fertilizers did not fix the soil problem, they just bolstered up the deficient parts, making the problem continue to worsen while giving the appearance of good health.

The introduction of fertilizers and the subsequent growth of massive amounts of agricultural products were called the “green revolution”. Nitrogen and Phosphorus do make plants turn green because that is what those minerals do but the plants became weak because they lacked all the other nutrients from healthy soil that were missing. The plants’ immune systems could not protect themselves from pests nor could they excrete protective compounds that would keep weeds around them at bay. Along came the chemical industry with weed killers and pesticides. The drugs to counteract the side effects of the first drugs. Just like in medicine.

Also, during WW2, we developed the first antibiotic, penicillin. This was revolutionary as it prevented many war-time injuries from festering and saved many of our war heroes. Penicillin and the subsequent antibiotics which it spawned, have saved millions of lives over the years. But just like anything that is good, we have abused and overused antibiotics and we now have a much bigger problem known as drug resistance. There already exist bacteria resistant to all known antibiotics which have a 50% death rate. It’s only a matter of time before there is a pandemic.

Pesticides, fungicides and herbicides are the soil equivalent of antibiotics. Pesticides are actually antibiotics. The most famous one is Roundup (the active ingredient is glyphosate). Glyphosate was never patented as a weed killer. It’s only been patented as an anti-biotic and then re-patented as an anti-parasitic. Glyphosate, which was developed by a Japanese scientist in the 1950s, is water soluble so it dissolves in anything with water and it distributes everywhere. Once in our environment, it’s impossible for us to remove. Fat soluble compounds are sequestered (bound) by the mycelia (fungi) in the earth and decomposed as well as bound by our fat cells, preventing it from getting into other organs including the brain. The Japanese government, to its credit, understood how dangerous this chemical was and never approved its use. They saw its potential devastating side effects to our environment. The patent for glyphosate was then sold to the Monsanto in the US who had no qualms about approving its use.

Monsanto, the chemical and food giant recently purchased by the German drug company Bayer for \$93 billion, started as a company making herbicides used during the Viet Nam war, like Agent Orange and Napalm, which were used to destroy, exfoliate and deforest the jungles to expose the Viet Cong soldiers. After the war, they transitioned to an agricultural chemical company when they purchased the patent for glyphosate and called it Roundup. Actually, glyphosate was first used as a chemical to de-clog sewers since it chelates (binds) minerals. The company became aware that downstream from the unclogged sewer pipes, ponds, their aquatic life and the flora and fauna around them were dying off. They quickly rebranded it as a weed killer. It was great as a weed killer that but it also killed everything it touched.

Before it was sprayed all over crops, it was used as a “spot” treatment to kill weeds. This was relatively time consuming so not much of it was used by farmers. It was the homeowner who was contributing the most to environmental contamination. The EPA approved Roundup for private use in the 1980s. Remember the commercials of a man with a “weed” gun shooting dandelions? How ironic that dandelions and their greens are actually a superfood and kill cancer cells. Since then, we’ve been drinking it in our water supply. Monsanto scientists insisted that it was “Safer than water” however their own studies showed that at high enough doses, it was toxic in animals and induces various cancer. They actually published that data voluntarily not thinking that it would be used in the amounts that would be toxic to humans. They were dreadfully wrong.

In 1992, Monsanto started marketing Roundup as a “desiccant”, or drying agent, for wheat and corn. By spraying on crops near the time of harvesting, with 3 days, the crops were dead and dried out which made collecting those products easier. In 1996, we genetically modified crops to be able to tolerate glyphosate. Scientists inserted genetic material from a bacterium which coded for an enzyme making it resistant to glyphosate and, in turn, made the plants resistant to this herbicide. Note that the enzyme is exactly like the one found in plants in terms of what it does. The engineered form simply can do “its thing” in the presence of the herbicide. Most likely the plant form and the bacterial form trace back through evolution to the same gene.

Glyphosate is also known to increase the amount fruit a plant produces and to speed up crop yields. How it achieves this is quite sad however. The evolutionary purpose of any organism is to survive long enough to reproduce and pass on its genetic material to its progeny. This includes plants. When a plant is stressed, for example when it grows in nutritionally depleted soil (which glyphosate creates) or is sprayed by chemicals like glyphosate, it's instinctual response is to grow faster so it can grow more fruit faster so it can reproduce.

Glyphosate works by blocking an enzyme pathway in soil bacteria, fungi and plants, called the *shikimate* pathway. More specifically glyphosate inhibits an enzyme called *5-enolpyruvylshikimate 3-phosphate synthase*, sometimes abbreviated EPSPS. This enzyme is needed for the synthesis of a particular group of amino acids called essential amino acids which our bodies cannot produce. 9 of the 20 amino acids are essential. We can only get essential amino acids from these beneficial bacteria, fungi and more importantly, plants. Humans and all other animals do not have a shikimate pathway and can't make essential amino acids.

Blocking the shikimate pathway leads to deficient soils and deficient foods. This is bad not only for humans but also for all our pets, livestock and wildlife in general.

Vincristine is one of the most widely used chemotherapeutic agents worldwide. It's a naturally occurring alkaloid compound which is present in many foods. These alkaloids are also made through the shikimate pathway that glyphosate blocks. Using this chemical eliminated production of this cancer fighting compound naturally contained in plants.

Glyphosate has been shown in humans to cause hypoxic (low oxygen) damage to the human intestinal lining. This results in overexpression of CXCR3 which is a cell wall receptor which binds *gliadin*, the problematic protein in gluten. This results in the production of a compound known as *zonulin* which opens up what are called "tight junctions" between the intestinal cells.

We use 4.5 billion pounds of glyphosate globally annually. Not only is it used as a pesticide and herbicide, it is used as a desiccant (drying agent) just prior to harvesting just to make harvesting easier.

Only 0.1% of the roundup used on the planet actually hits a weed. The rest of the 99.9% gets into the soil and subsequently the water system and is washed downstream and into the deep-water aquifers in the earth. This water-soluble toxin is now locked into our environment. We have used so much of it that 75% of air and rainfall is contaminated with roundup in some states. 70% of municipal water samples are contaminated. Even crops grown organically are contaminated because they are getting watered and rained on by Roundup contaminated rainwater and tap water. This chemical can be measured in human breast milk and urine samples.

The Mississippi River collects over 80% of the Roundup in the country. The last 90 miles of the Mississippi River, between Baton Rouge and New Orleans, is known as "Cancer Alley" because the cancer rate here is the highest in the world. We have used so much glyphosate that we are now seeing glyphosate resistant super weeds. This results in adding new chemicals to combat that growing problem. This is called the "pesticide and herbicide treadmill".

There are bacteria and fungi that can digest the glyphosate but we have to stop using it to let them catch up. We are decimating those very same organisms. Current estimates are that if we stopped spraying roundup today, it would take 50 years before the ecosystem got to a point where the glyphosate would be below toxic levels.

Another concerning effect of glyphosate is on how our cells attach to each other and communicate.

The cells that line the intestinal tract are held together by connections called *tight junctions*. Glyphosate loosens these connections by causing direct injury to the protein structure that holds the gut lining together. Every membrane in the body is held together by these same tight junctions. This includes your blood vessels, lymphatic system, the blood brain barrier, the kidney tubules which detox your body... The blood brain barrier is an essential barrier which protects the brain from things floating around in your blood stream. Certain medications can cross this barrier and these are usually the ones which cause side effects like sleepiness and

brain fog. Some are intended to cross this barrier like antidepressants and seizure medications. However, when molecules not meant to cross this barrier do, problems arise.

It's no surprise that since 1996, when glyphosate use exploded, there has been a dramatic increase in the rate of various neurologic conditions like autism, Parkinson's disease, Alzheimer's and other dementias. MS and other autoimmune conditions have also seen a dramatic increase.

In a nutshell, glyphosate affects how the body holds itself together and protects itself.

Tight junctions are like spot welds that keep cells together. Tight junctions are on either end of the cells (2 of them). In the middle are *gap junctions*. These are clusters of tubes, microtubules, 100x thinner than the width of a human hair, which connect the cytoplasm (intracellular fluids). There are thousands of these in each cluster. They are like fiber optic cables. These tubules also get damaged by glyphosate disrupting vital communication between these cells.

When damaged cells are still in communication with other cells, the body recognizes this and the cells get repaired or killed off. There are 2 mechanisms damaged cells get "cleaned". *Apoptosis* is the programmed or induced cell death which naturally occurs and *Autophagy* is essentially the self-digestion or breakdown of cells thus cleaning them up and re-absorbing their components. These processes do not occur when cells lose contact and communication with one another and the damaged cells run rampant and lead to cancers.

Our mitochondria play a crucial role, not only in energy production, but also in cell health and apoptosis signaling. Glyphosate impacts greatly on mitochondrial function. Glyphosate alters the protein structure of mitochondria deforming its spindle structure so it can't function properly. The mitochondria are an extension of the microbiome. The average 2 year old has 200 mitochondria in each cell. In adults, it can be as much as 2000 depending on the cell type. They digest sugar and fat, converting them into ATP (adenosine triphosphate) which is what actually powers cells. The sugar and fat are not actually what provide energy, it's the ATP that mitochondria produce out of them which does. Mitochondrial health dictates cellular health since they also involved in signaling leading to repair and apoptosis. If the mitochondria are damaged, the cells can't call for help in repair or kill themselves so it's only survival option is to divide. That's partly why cancer cells divide so rapidly and out of control.

Monsanto had a stranglehold on the agricultural industry controlling more than 90% of the seed, both GMO and non-GMO, sold worldwide. They sold the seed along with the chemicals to spray the plants when they started growing. Now, Bayer has that control. Bayer has developed their own GMO seeds known as *LibertyLink*. These seeds are resistant to their own herbicide. This one works by blocking an enzyme pathway leading to the production of the essential amino acid glutamate which has many functions in cell biology, hormone production and fertility.

Glyphosate went off patent in 2007 and now, the largest producer and use is China. Not surprisingly, between their hunger for the Western, animal based diet and their use of this horrible chemical, they are experiencing the most rapid rise in chronic diseases like diabetes, heart disease as well as various cancers, previously rare in their more traditional plant based and locally sourced diets. Because of the free trade agreement between Australia and China, Australia's farming market has been flooded with cheap glyphosate and they are now experiencing the same health problems we are here in the US.

## **DISEASES LINKED TO GLYPHOSATE**

**ADHD:** In farming communities, there's a strong correlation between Roundup exposure and attention deficit disorder (ADHD), likely due to glyphosate's capacity to disrupt thyroid hormone functions.

**Alzheimer's disease:** Roundup causes the same type of oxidative stress and neural cell death observed in Alzheimer's disease. It affects CaMKII, an enzyme whose dysregulation has also been linked to the disease.

**Anencephaly (birth defect):** An investigation into neural tube defects among babies born to women living within 1,000 meters of pesticide applications showed an association for glyphosate with anencephaly, the absence of a major portion of the brain, skull and scalp that forms during embryonic development.

**Autism:** Glyphosate has a number of known biological effects that align with the known pathologies associated with autism. One of these parallels is the gut dysbiosis observed in autistic children and the toxicity of glyphosate to beneficial bacteria that suppress pathogenic bacteria, along with pathogenic bacteria's high resistance to glyphosate. In addition, glyphosate's capacity to promote aluminum accumulation in the brain may make it the principal cause of autism in the U.S. The autism rate has increased from 1:5000 in 1975 to 1:35 as of 2017. The rate has dramatically increased since the mid-1990s as well. At the present rate of acceleration, 1 in 3 kids will have autism or one of the spectrum disorders by 2035.

**Birth defects:** Roundup and glyphosate can disrupt the Vitamin A (retinoic acid) signaling pathway, which is crucial for normal fetal development. The babies of women living within one kilometer of fields sprayed with glyphosate were more than twice as likely to have birth defects according to a study from Paraguay. Congenital defects quadrupled in the decade after Roundup Ready crops arrived in Chaco, a province in Argentina where glyphosate is used roughly eight to ten times more per acre than in the U.S. A study of one farming family in the U.S. documented elevated levels of glyphosate and birth defects in the children, including an imperforate anus, growth hormone deficiency, hypospadias (an abnormally placed urinary hole), a heart defect and a micro penis.

**Brain cancer:** In a study of children with brain cancer compared with healthy children, researchers found that if either parent had been exposed to Roundup during the two years before the child's birth, the chances of the child developing brain cancer doubled.

**Breast cancer:** Glyphosate induces human breast cancer cells growth via estrogen receptors. The only long-term animal study of glyphosate exposure produced rats with mammary tumors and shortened life-spans.

**Cancer:** House-to-house surveys of 65,000 people in farming communities in Argentina where Roundup is used, known there as the fumigated towns, found cancer rates 2-4 times higher than the national average, with increases in breast, prostate and lung cancers. In a comparison of two villages, in the one where Roundup was sprayed, 31 percent of residents had a family member with cancer, while only 3 percent of residents in a ranching village without spraying had one. The high cancer rates among people exposed to Roundup likely stem from glyphosate's known capacity to induce DNA damage, which has been demonstrated in numerous lab tests.

**Celiac disease and gluten intolerance:** Fish exposed to glyphosate develop digestive problems that are reminiscent of celiac disease. There are parallels between the characteristics of celiac disease and the known effects of glyphosate. These include imbalances in gut bacteria, impairment in enzymes involved with detoxifying environmental toxins, mineral deficiencies and amino acid depletion.

**Chronic kidney disease:** Increases in the use of glyphosate may explain the recent surge in kidney failure among agricultural workers in Central America, Sri Lanka and India. Scientists have concluded, "Although glyphosate alone does not cause an epidemic of chronic kidney disease, it seems to have acquired the ability to destroy the renal tissues of thousands of farmers when it forms complexes with [hard water] and nephrotoxic metals."

**Colitis:** The toxicity of glyphosate to beneficial bacteria that suppress clostridia, along with clostridia's high resistance to glyphosate, could be a significant predisposing factor in the overgrowth of clostridia. Overgrowth of clostridia, specifically *C. difficile*, is a well-established causal factor in colitis.

**Depression:** Glyphosate disrupts chemical processes that impact the production of serotonin, an important neurotransmitter that regulates mood, appetite and sleep. Serotonin impairment has been linked to depression.

**Diabetes:** Low levels of testosterone are a risk factor for Type 2 diabetes. Rats fed environmentally relevant doses of Roundup over a period of 30 days spanning the onset of puberty had reduced testosterone production sufficient to alter testicular cell morphology and to delay the onset of puberty.

**Heart disease:** Glyphosate can disrupt the body's enzymes, causing lysosomal dysfunction, a major factor in cardiovascular disease and heart failure.

**Hypothyroidism:** House-to-house surveys of 65,000 people in farming communities in Argentina where Roundup is used, known there as the fumigated towns, found higher rates of hypothyroidism.

**Inflammatory Bowel Disease (“Leaky Gut Syndrome”):** Glyphosate can induce severe tryptophan deficiency, which can lead to an extreme inflammatory bowel disease that severely impairs the ability to absorb nutrients through the gut, due to inflammation, bleeding and diarrhea.

**Liver disease:** Very low doses of Roundup can disrupt human liver cell function.

**Lou Gehrig's Disease (ALS):** Sulfate deficiency in the brain has been associated with Amyotrophic Lateral Sclerosis (ALS). Glyphosate disrupts sulfate transport from the gut to the liver, and may lead over time to severe sulfate deficiency throughout all the tissues, including the brain.

**Multiple Sclerosis (MS):** An increased incidence of inflammatory bowel disease (IBS) has been found in association with MS. Glyphosate may be a causal factor. The hypothesis is that glyphosate-induced IBS causes gut bacteria to leak into the vasculature, triggering an immune reaction and consequently an autoimmune disorder resulting in destruction of the myelin sheath.

**Non-Hodgkin lymphoma:** A systematic review and a series of meta-analyses of nearly three decades worth of epidemiologic research on the relationship between non-Hodgkin lymphoma (NHL) and occupational exposure to agricultural pesticides found that B cell lymphoma was positively associated with glyphosate.

**Parkinson's disease:** The brain-damaging effects of herbicides have been recognized as the main environmental factor associated with neurodegenerative disorders, including Parkinson's disease. The onset of Parkinson's following exposure to glyphosate has been well documented and lab studies show that glyphosate induces the cell death characteristic of the disease.

**Pregnancy problems (infertility, miscarriages, stillbirths):** Glyphosate is toxic to human placental cells, which, scientists say, explains the pregnancy problems of agricultural workers exposed to the herbicide.

**Obesity:** An experiment involving the transfer of a strain of endotoxin-producing bacteria from the gut of an obese human to the guts of mice caused the mice to become obese. Since glyphosate induces a shift in gut bacteria towards endotoxin-producers, glyphosate exposure may contribute to obesity in this way.

**Reproductive problems:** Studies of laboratory animals have found that male rats exposed to high levels of glyphosate, either during prenatal or pubertal development, suffer from reproductive problems, including delayed puberty, decreased sperm production, and decreased testosterone production.

**Respiratory illnesses:** Surveys of 65,000 people in farming communities in Argentina where Roundup is used, known there as the fumigated towns, found higher rates of chronic respiratory illnesses.