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Integrating Crops and Livestock

Part of the Natural Systems That Sustain Us

By Paul W. Syltie, Ph.D.

There are some topics in agriculture that just keep coming back time and time again, perhaps because they are so critical within the big picture of things. We have one earth, and finite resources to sustain a burgeoning population, and the soil constitutes the most important resource that mankind has to sustain the inhabitants of this earth. It provides our food, clothing and in many cases the shelter that sustains us from day to day.

Upon this thin skin of fertility that covers the lands that feed us, we grow the crops and raise the livestock that have sustained civilizations for millennia. If we carefully observe how a native ecosphere operates in all climates and situations, we will see certain laws in action. This topic I covered in some detail back in the summer 1997 edition of *The Vital Earth News* (Volume II, Number 2), in which I summarized "Nature's Seven Immutable Laws." These are as follows:

1. Mixed farming is the rule; plants and animals are always found together.

2. The soil is always protected from the direct action of sun, rain, and wind.

3. Rainfall is carefully preserved in surface layers and subsoil.

4. The forest manures itself, making its own humus and supplying its own minerals.

5. Mineral matter needed by trees, grasses, and undergrowth is obtained from the soil.

6. The soil always carries a large fertility reserve.

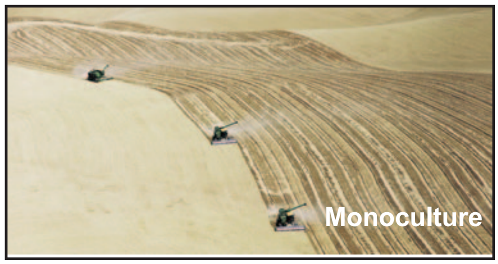
7. Crops and livestock look after themselves, and maintain health due to internal vitality imparted by the soil.

Sir Albert Howard, the English agriculturalist who championed the improvement of soil organic matter and natural methods of culture in the early 1900s, outlined these principles of land management in one of his books, *An Agricultural Testament*.[1] He, like other champions of regenerative, sustainable agriculture, understood that the laws built into the creation should be studied and emulated by everyone, whether they be farmers or gardeners, and the first principle is to practice mixed farming.

Mixed Farming — a Rule of Nature

Mixed farming is the raising of animals and crops on the same land area. In


Mixed Farming


Monoculture

See Industrial Monoculture, page 2

Mixed Farming in Action

British Gardener and a Robin — Inseparable Friends

By Louise Bevan

A British gardener has formed a unique friendship with a robin named Bob whom he visits at least twice a week. Owing to Bob's love for the camera, the pair have become world-famous for their heartwarming garden antics.

Tony Putman, 39, who lives in the English town of Crowborough, East Sussex, met Bob in his hometown of Edenbridge, Kent, in early November of 2019.

"Bob is a European robin. He lives at one of my jobs, where I work two days a week," Putman told *The Epoch Times* by email. "I can, and do, visit Bob whenever I can if not working."

When Bob hears Putman's truck coming, he will greet him right at the gate. "Bob has, and will, land on my head if he wants. I can walk right up to him and he won't be concerned by me at all," the gardener said of their bond. "He will follow me if I call him, and sometimes he'll call me to get my attention. He's at complete ease with me, but only me."

See Take Time to Appreciate, page 3

Industrial Monoculture vs. Mixed Farming

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the natural world this is the rule. Take, for instance, the Great Plains before it was settled by the Europeans in the 1800s. Bison, deer, antelope, and elk in the millions regularly grazed the grasslands that stretched from Canada to Texas. They deposited their manure on the soil surface as a closed-nutrient ecosystem sustained huge numbers of livestock, maintaining that ecosphere indefinitely. Badgers, prairie dogs, gophers, woodchucks, and a host of other animals fed on the prolific banquet of plants, never depleting the soils but rather maintaining them century upon century.

Enter the Industrial Farmer

When the early European settlers arrived to claim the untamed lands of America—first the eastern colonies, and later the Midwest and Plains with the Homestead Act of 1862—they essentially practiced mixed farming, since most farmers and ranchers raised cattle and horses, either grazing their pastures or feeding grains and hay to dairy cattle, while manure was returned to the fields on a regular basis.

I grew up on a dairy farm in western Minnesota and understand well the process of harvesting the corn, oats, and hay crops needed to feed the cows. The manure was judiciously spread back on the fields from which the crops had been harvested; the only net export of nutrients was the in the milk that was sold, besides some fields of cash crops like wheat, barley, rye, and flax. These were sold at the local grain elevator.

As the years passed and horses were replaced by tractors, especially during the mid-1900s, the nearly universal dairy farms were gradually replaced by all-crop farms in major portions of the U.S. farm belt. Soil fertility was harvested by the corn, soybeans, cotton, wheat, sorghum, and barley that were marketed to millers, food processors, oil extractors, and exporters. Cattle became progressively concentrated into feedlots, where their manure became more of a waste problem than a fertility asset. The cycle of nutrient return was broken, and to remedy that came the commercial fertilizers which replaced manure, along with hybrid and eventually GMO crops that accelerated the extraction of soil nutrients from the land, and at the same time reduced soil organic matter levels. With a plethora of row crops, often grown on sloping land, erosion swept away goodly amounts of topsoil.

The sins of forsaking mixed farming began to haunt the tenders of the land as high yields of commercially grown hybrid crops, fed by fertilizers and treated with herbicides and pesticides, further eroded the health of the soil and the nutritional quality of the crops those deficient soils produced.

The concentration of cattle into feedlots, instead of having them graze on pastures, is symptomatic of the effects that modern Western agriculture has had on limiting mixed farming on our lands.

Mixed Farming in the World

This flight away from mixed farming is not universal around the world, however. According to the U.N. Food and Agriculture Organization (FAO), mixed farming covers about 2.5 billion hectares (6.35 billion acres) of land worldwide. This includes 1.1 billion hectares of arable rainfed cropland, 1.2 billion hectares of grassland, and 0.2 billion hectares of irrigated cropland. Mixed farming systems produce 92% of the world's milk supply, all of the buffalo meat (mostly in African and Asian countries), and about 70% of sheep and goat meat worldwide.[2]

The lack of mixed farming systems comes mainly from the developed Western countries, such as the United States, Canada, Australia, and parts of Europe. In these areas the effects of high-intensity commercial farming have had their greatest impact, and continue to do so.

Why Mixed Farming Is So Important

Mixed farming is probably the most benign agricultural production system from an environmental perspective, being a predominantly closed system. The "waste" products of one enterprise, such as crop residues in the field, are used by the other enterprise, which returns its own waste products, such as manure, back to the first enterprise.

As reported by FAO, "In many situations crop and livestock production [of mixed farming] is largely in balance with nature. There are important exceptions, such as some mixed farming systems of the tropical highlands of Asia and Central Africa which, partly because of overgrazing, are amongst the most eroded and degraded systems of the world. On the other end of the development spectrum, heavy use of feed and fertilizer in the industrial world and in some of the fast growing economies of East Asia has led to nutrient loading, habitat destruction, and water pollution. In this context, it has to be remembered that integrating crops and livestock neither generates new nutrients (with the exception of nitrogen fixation by leguminous plants) nor reduces nutrient surpluses."

With increased population pressure the tendency is for mixed agriculture to decrease, and in particular for biodiversity to decrease. For example, arthropods, which comprise 90% of all animal species, dominate biodiversity, but are severly damaged by monoculture, overgrazing, and commercial Western farming practices. However, manure added to the soil will greatly magnify the number of these small soil creatures.

The Need to Renew This Practice

There appears to be some renewed interest in the U.S. to encourage mixed farming, as evidenced by the recent award of an SARE Research & Education grant for the proposed project, "Match Made in Heaven: Livestock + Crops."[3] The project will survey producers in six Midwestern states about the opportunities and barriers related to integration or re-integration of livestock and

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crop production. This project will attempt to identify, over three years, strategies to capture the environmental, economic, and social benefits of diverse crop rotations and integrated systems.

It appears that many people are rediscovering the past. Indeed, the laws of our lands will always remain viable and futuristic. It would behoove all of us—farmers and gardeners alike—to heed this essential principle of land management: incorporating animals with crops. We can do this by leaving highly erosive, steep hillsides in grasses and trees, and avoiding chemical applications as much as possible. ❐

Footnotes

1. Sir Albert Howard, *An Agricultural Testament*, Oxford University Press, New York, 1943.
2. Anonymous, Mixed Farming Systems and the Environment, *www.fao.org*.
3. Anonymous, Match made in heaven: Livestock+crops, Green Lands Blue Waters, *www.morningagclips.com*.

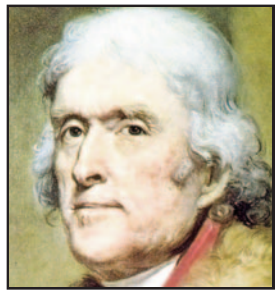
Jefferson and the Land

◆ "Cultivators of the earth are the most valuable citizens. They are the most vigorous, the most independent, the most virtuous, and they are tied to their country and wedded to its liberty and interests by the most lasting bonds." Thomas Jefferson to John Jay, 1785.

◆ "The United States... will be more virtuous, more free, and more happy employed in agriculture than as carriers or manufacturers. It is a truth, and a precious one for them, if they could be persuaded of it." Thomas Jefferson to M. de Warville, 1786.

◆ ""Agriculture... is our wisest pursuit, because it will in the end contribute most to real wealth, good morals, and happiness." Thomas Jefferson to George Washington, 1787.

◆ "I think our governments will remain virtuous for many centuries as long as they are chiefly agricultural.... When they get piled upon one another in large cities as in Europe, they will become corrupt as in Europe." Thomas Jefferson to James Madison, 1787.



◆ "A prosperity built on the basis of agriculture is that which is most desirable to us, because to the efforts of labor it adds the efforts of a greater proportion of soil." Thomas Jefferson: Circular to Consuls, 1792.

◆ "The commercial cities... are as different in sentiment and character from the country people as any two distinct nations, and are clamorous against the order of things established by the agricultural interest." Thomas Jefferson to M. Pictet, 1803. ❐

Take Time to Appreciate Animal Friends

Continued from page 1

Putman takes immense pride in saying that Bob recognizes him as an individual, which he thinks is "amazing" for a little bird.

Bob disappeared after spring of 2020, which Putman expected; as robins establish their territory in the late fall or early winter, hatch their young, and stay only until the end of spring when food becomes plentiful. However, to Putman's surprise, Bob did return.

According to Putman, robins generally get used to him and will follow him in hopes of tasty treats. Over the years, he has known eight robins, in total; but Bob is the only one that has ever returned.

Sharing in detail about the bond he shares with robins, Putman said: "It all actually started six years ago with another robin I named 'Robin.'"

"I had no interest in photography or social media at the time, but when I met Robin, everything changed. He very much became my photography subject," he added.

Six years on, Robin is gone, but Bob has filled his boots. Putman chronicles their sweet interaction on his Facebook page, "Putman and Robin," and even sells prints, cards, and calendars to fans all over the world.

Putman says he receives countless messages from netizens thanking him and Bob for bringing joy to their lives during dark times. He knows their unlikely friendship is one of a kind.

Integrating animals and birds into our farming and gardening enterprises can have unexpected benefits, not the least of which is peace and healing.

Yet Bob's global appeal is not the only joy he has brought to Putman's life. After a couple of months, as Bob returned back to the garden in 2020, Putman's father had a brain aneurysm the following day. Hospital visitations were restricted because of COVID-19, and Putman's family endured a "3-week waiting game."

Amidst all difficulties, Putman's father pulled through, and Bob's unexpected return couldn't have been better timed. "Photographing him and being with him put my mind at ease," said Putman. "I forgot about my problems for a moment."

In a video filmed for the BBC, the gardener quoted a well-known proverb: When a robin appears, a loved one is near. "I don't know how true that is, but it's quite strange how he turned up during a time that I really needed," Putman reflected.

"Bob is a wild animal, he comes and goes as he pleases, and there is no greater privilege than earning the trust and respect of a wild animal," Putman told *The Epoch Times*. "I'm truly honored to call him my friend.

"We need to look after our animals more," he implored. "They are easily forgotten in our busy world and our hectic day-to-day lives. Take a moment to notice and appreciate them, that's all I do." ❐

Abridged from *The Epoch Times*, September 27, 2021.

15-Minute Soils Course

Lesson 54: Soil Conductivity

Soil electrical conductivity (EC), expressed in deciSiemens per meter (dS/m), measures the ability of soil water to carry an electrical current. The values correlate strongly with several soil physical and chemical properties, so can be of great use in soil management decisions.

Electrical conductivity is an electrolytic process that takes place principally through water-filled pores. Cations such as Ca^{+2}, Mg^{+2}, K^{+1}, Na^{+1}, and NH_4^{+1}, and anions such as SO_4^{-2}, Cl^{-1}, NO_3^{-1}, and HCO_3^{-1}, from salts dissolved in soil water carry electrical charges and will conduct an electrical current. As a result, the concentration of ions determines the EC of soils.

In agriculture, EC has been used principally as a measure of soil salinity. However, in non-saline soils EC can be an estimate of other soil properties such as soil moisture and soil depth.

What Soil Conductivity Tells Us

Soil EC is not known to directly affect plant growth, but has been used to indirectly indicate plant available nutrients available for plant uptake in non-saline soils, and salt levels of saline soils, among other things. EC has been used as an indicator of salt concentration, organic matter level, cation-exchange capacity, soil texture, soil thickness, nutrient levels (especially nitrate), water-holding capacity, and drainage conditions.

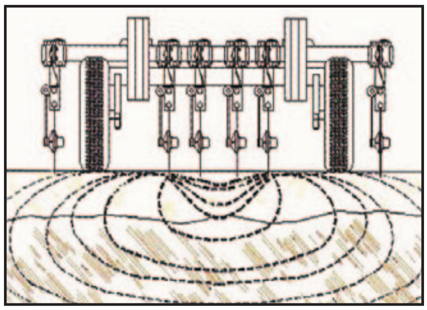
A problem with using EC to evaluate such a complex array of factors is that it is oftentimes impossible to know which factor, or factors, are primarily responsible for the value obtained.

In specific field use and high-intensity soil surveys, EC is used to partition units of management, differentiate soil types, and predict soil fertility and crop yields. For example, farmers can use EC maps to apply different management strategies, such as nitrogen fertilizer levels, to sections of a field that have different soil types. In some management units, high EC has been associated with high levels of nitrate and other selected soil nutrients (P, K, Ca, Mg, Mn, Zn, and Cu). Most microorganisms are sensitive to soil salts. Actinomycetes and fungi are less sensitive than bacteria, except for halophyte (salt-tolerant) bacteria. Microbial processes, including respiration, nitrification, denitrification, and decomposition decline as EC increases.

What Soil Electrical Conductivity Can Tell Us

Salt levels (Na, K, Ca, Mg, plus anions)
Soil texture (sand, silt, and clay amounts)
- **Sandy soils have low EC**
- **Clayey soils have high EC**

Available plant nutrients
Yield potential
Soil organic matter levels
Cation exchange capacity
Drainage conditions
Water-holding capacity
Soil depth



A contact EC unit usually has coulters, that emit and measure an electrical current.

Measuring EC

Two different systems of measuring EC are used: contact and non-contact devices. ***Contact devices*** can include hand-held probes, or machines with disks spaced in a pattern as shown above. Usually, two to three pairs of coulters are used. One pair provides electrical current to the soil while the others measure the voltage drop between them and use that drop to calculate electrical conductivity. Contact sensors usually measure soil electrical conductivity at one foot and three feet.

Non-contact devices have two or more sets

15-Minute Soils Course

of coils that are electrically connected and separated by a fixed distance. The transmitter coil (primary field) is used to generate an electromagnetic field at a specific frequency. This causes electrical currents to flow in conductive materials in the subsurface. The flow of currents in the subsurface, called eddy currents, generate a secondary magnetic field, which is sensed by the receiver coil. The magnitude of the secondary field sensed by the receiver depends upon the type and distribution of conductive material in the subsurface.

Crop tolerance to EC

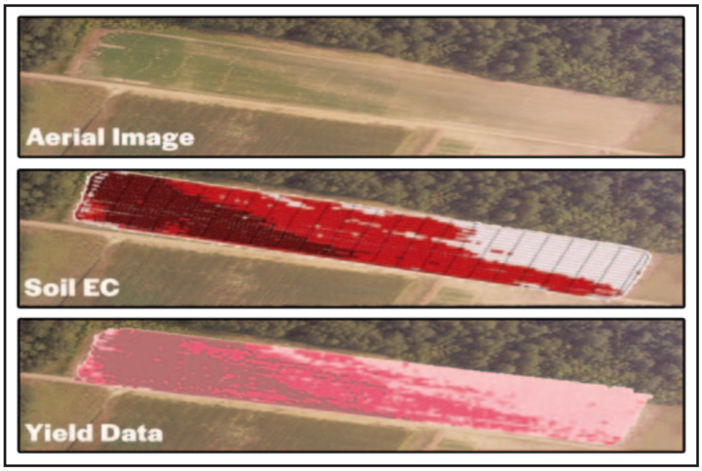
Crops differ greatly in their ability to withstand high salinity levels. The chart here shows that even a 1 EC increase can reduce the yield of all crops, by up to 29%. An EC value above 4 dS/m is a signal for expecting crop growth problems. Microbial activity, and thus nutrient availability, will be limited, and water uptake inhibited due to plasmolysis. Soils with a high EC resulting from a high concentration of sodium generally have poor structure and drainage, and sodium becomes toxic to plants.

Salt Tolerance of Crops; Yield Decrease Beyond Threshold Level (decrease per unit)

Crop species	Threshold EC (1:1 soil/water)	Percent yield decrease
Alfalfa	1.1 - 1.4	7.3
Barley	4.5 - 5.7	5.0
Cotton	4.3 - 5.5	5.2
Peanut	1.4 - 1.8	29
Potato	1.0 - 1.2	12
Rice	1.7 - 2.1	12
Soybean	2.8 - 3.6	20
Tomato	1.4 - 1.8	9.9
Wheat	3.9 - 5.0	7.1

Improving Soil EC

The best way to reduce soil salinity and reduce the EC is to irrigate with water that is low in salts, preferably less than 1.5 dS/m, to move salts below the root zone. Avoid overwatering since a rising water table may bring salts into the root zone. In arid climates, plant residues and mulch help soils to remain wetter and thus allow seasonal precipitation and irrigation to be more effective in leaching salts from the surface. Adding gypsum ($CaSO_4$) to soils will help leach salts with water due to SO_4^{-2} taking with it cations like sodium. Biostimulants like Vitazyme, as well as humic acids, are also helpful in overcoming a high soil EC. ❒



As this progression of photos shows, higher soil EC (darker reds, middle photo) correlates directly with higher yields (brown and red, lower photo).

See How Much You Learned

1. Soil electrical conductivity cannot be extrapolated to indicate anything besides salts. T or F.
2. Soil conductivity can tell us about a. soil salts, b. yield potential, c. organic matter, d. texture.
3. Conductivity is a measure of the soil's ability to conduct an electrical current due to ____________ and _____________.
4. Crops differ substantially in their ability to tolerate soil salts. T or F.
5. A good way to reduce soil salts is to leach them out with _____________________.
6. Electrical conductivity can be measured by ____________ or _______________ devices.
7. Most soil organisms are sensitive to soil salts. T or F.

Answers: 1. F; 2. a, b, c, d; 3. anions, cations; 4. T; 5. irrigation water; 6. contact, non-contact; 7. T.

Scientists Solve Plant Growth Mystery

By Jules Bernstein

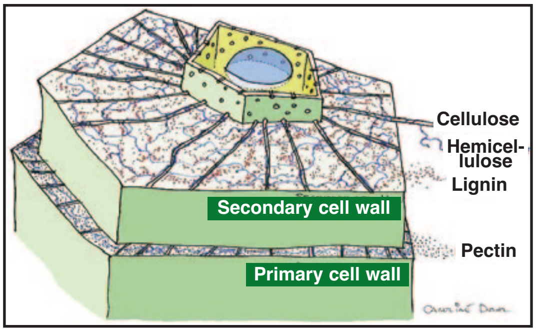
A team of researchers led by UC Riverside has demonstrated for the first time one way that a small molecule turns a single cell into something as large as a tree. For half a century, scientists have known that all plants depend on this molecule, auxin, to grow. Until now, they didn't understand exactly how auxin sets growth in motion.

The word auxin is derived from the Greek word "auxein," meaning "to grow." There are two main pathways that auxin uses to orchestrate plant growth, and one of them is now described in a *Nature* journal article.

Plant cells are encased in shell-like cell walls, whose primary layer has three major components: cellulose, hemicellulose, and pectin. "Cellulose works like rebar in a high rise, providing a broad base of strength. It's reinforced by hemicellulose chains and sealed in by pectin," said UCR botany professor and research team leader Zhenbiao Yang.

These components define the shape of plant cells, resulting in sometimes-surprising formations like the puzzle-piece-shaped leaf epidermis cells that Yang has been studying for the last two decades. These shapes help tightly glue cells together and provide physical strength for plants against elements such as the wind. With everything locked so tightly by the cell walls, how is movement and growth possible?

One theory posits that when plants are ready to grow, auxin causes their cells to become acidic, loosening the bonds between components and allowing the walls to soften and expand. This theory was proposed half a century ago, but how auxin activates the acidification remained a mystery until now.



Auxins enable protons to enter cell walls and activate expansin, which breaks links between cellulose and hemicellulose to allow cells to expand.

Yang's team discovered auxin creates that acidity by triggering the pumping of protons into the cell walls, lowering their pH levels. The lower pH activates a protein, expansin, appropriately named because it breaks down links between cellulose and hemicellulose, allowing the cells to expand.

The pumping of protons into the cell wall also drives water uptake into the cell, building inner pressure. If the cell wall is loose enough and there is enough pressure inside the cell, it will expand.

"Like a balloon, expansion depends on how thick the outsides are, versus how much air you're blowing in," Yang explained. "Lowering the pH in a cell wall can allow water outside of a cell to move in, fueling turgor pressure and expansion."

There are two known mechanisms by which auxin regulates growth. One is the pH lowering that Yang's team described. Another is auxin's ability to turn on gene expression in the nucleus of the plants' cells, which in turn increases the amount of expansion and other growth-regulating factors in the cell....

It is an understatement to say that auxin simply "contributes" to plant growth. It is essential to nearly every aspect of a plant's growth and development, including aspects that are important to agriculture such as fruit, seed and root development, shoot branching, and leaf formation. ❐

Abridged from *University of California, Riverside News*, November 18, 2021.

Characterizing Compost Quality

By David M. Crohn
University of California-Riverside
Cooperative Extension Service, 8-2016

Composts are widely used as organic amendments to add organic matter and nutrients to soils and are also sometimes used as mulches to control pests and conserve water. Compost quality can be evaluated through laboratory analysis, but the measurable properties used to evaluate composts are different from those used to describe the soils to which they are added. Parameters such as the carbon- to-nitrogen (C:N) ratio, organic matter content, salinity, total nitrogen, total phosphorus, stability, phytotoxicity, pH, maturity, boron, chloride, sodium, particle sizes, heavy metal concentration, and pathogen concentrations are factors to evaluate when you are comparing available compost products.

Compost Quality Parameters

Carbon-to-nitrogen ratio (C:N)
Organic matter content
Salinity
Total nitrogen
Total phosphorus
Stability
Phytotoxicity
pH
Maturity
Boron
Chloride
Sodium
Particle sizes
Heavy metal concentration
Pathogen concentrations

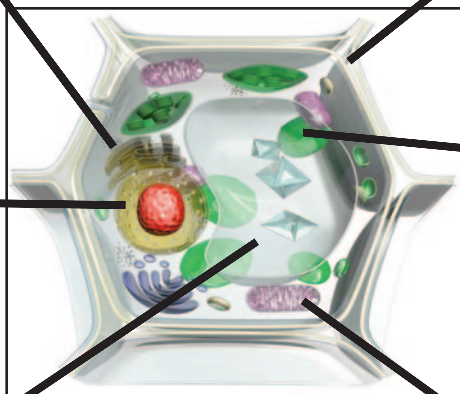
While it is hard to give absolute values to these parameters for acceptable composts, here are some guidelines for the use of compost as a soil amendment.

C:N: <20:1
Organic matter: 25-65%
Salinity: <1 dS/m
Nitrogen: variable
Phosphorus: variable
Stability: <8 mg CO_2/g OM/day
Phytotoxicity:
pH: 6-8.5
Maturity: cucumber germination test
Boron: <100 ppm
Chloride: <1% of dry weight
Sodium: <1%
Particle sizes: great variation
Heavy metal concentrations: low
Pathogen concentrations: very low ❐

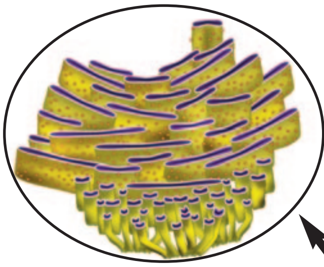
Incredible Complexity of Plant Cells

By Paul W. Syltie, Ph.D.

The structure of all cells, both plant and animal, is incredibly complex, well beyond even our present-day enlightened ability to fully comprehend. Shown here is a typical plant cell and its internal structure, a structure that the originator of evolutionary thought— Charles Darwin —in ***The Origin of Species*** considered to be a rather simple matrix of undifferentiated cytoplasm. How wrong he was!

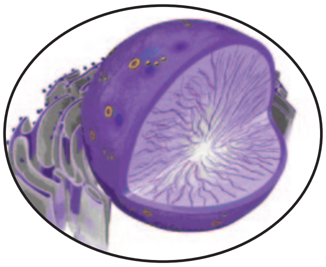


The number and types of cellular organelles and structures is only partially shown here. There are many other structures, including the Golgi apparatus (to package and transport proteins and lipids), ribosomes (the site of protein synthesis), plastids (organelles similar to chloroplasts), peroxisomes (to metabolize lipids and fatty acids), lysosomes (to digest and remove wastes), and the cytoplasm, the gel-like medium of structured water in which the various organelles and cellular processes operate. The cell interior moves in a slow vortex fashion.



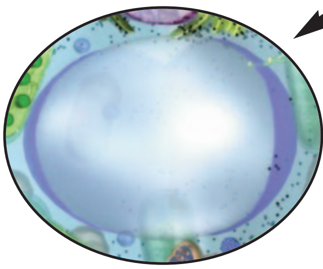
Endoplasmic Reticulum

Forms a skeletal framework for the cell, and is involved in detoxification and the synthesis of proteins and lipids



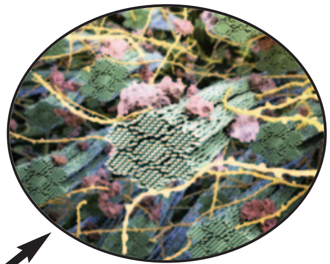
Nucleus

Control center of the cell, containing the genetic material with its DNA in the chromosomes



Vacuoles

Provide shape and rigidity for the cell, and aids in the digestion, excretion, and storage of various substances

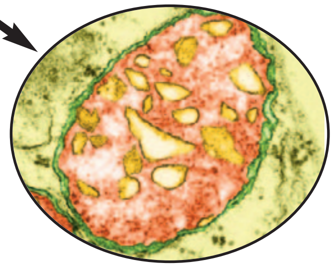


Cell Walls

The exterior capsule of the cell, comprised of cellulose, hemicellulose, and lignin that protects the contents

Chloroplasts

The site of photosynthesis, where CO_2, sunlight, O_2, and water are catalyzed with sunlight to create fixed carbon



Mitochondria

The main sites for respiration and storage of energy in the form of ATP for use in cellular functions

Statement of Purpose

Vital Earth Resources is a for-profit private corporation dedicated to the development, production, and sale of top-quality, ecologically sound horticultural and agricultural products. *The Vital Earth News* is a periodic publication of Vital Earth Resources to inform customers and other interested parties about our products and programs, and to educate our readership on critical issues facing growers today and in the future.

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Thank you! The Team at Vital Earth Resources, Inc.

A Brassinosteroid-based Biostimulant Integrated with an Innovative Crop System Improves Maize Productivity

By Robert J. Kremer, Timothy M. Reinbott, Paul W. Syltie, Manjula V. Nathan, and C. LeRoy Deichman

A paper has been presented at the Biostimulants World Congress 2021 that summarized the results of field work done at the University of Missouri, headed by Dr. Robert Kremer. A novel solar corridor cropping system with corn, where every two rows in a 30-ich row spacing are planted to a cover crop such as cowpeas, showed that yields were not suppressed compared to a monoculture in which all rows were planted. Two hybrid corn varieties were used, one of which was more responsive to the solar corridor. Vitazyme applied within this system produced excellent increases in root mass, nutrient uptake, photosynthesis, soil microbe species and numbers, and yield. Note a summary of these effects below.