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PLACE-BASED FOOD SYSTEMS KEYNOTE ADDRESS

A new cosmology * A new food system

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Abstract
Our European ancestors came as a poor people to a seemingly empty land in North America, and we built our institutions with that perception. Now we've become a rich people in an increasingly poor land, one that's filling up, and our institutions don't hold. We've patched them up, given them a lick and a promise, but they don't hold.

Dan Luten said almost those same words nearly four decades ago as the two of us crossed the Bay Bridge from San Francisco to Berkeley. I will go beyond citation of the source here to entertain a useful digression. Dan was a U.C. Berkeley professor. We were on the board of Friends of the Earth (FOE). The staff director of FOE was Rafe Pomerance, who, backed by the board, tried to spur some grassroots action which would lead to policy to reduce greenhouse gases. But it was clear FOE was failing in that and other environmental efforts, and thus the conversation with Dan.

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Note
This paper is selected remarks from a keynote plenary entitled *The Food System Imperative: Shifting Ideologies to Meet the 21st Century Challenges* at the Place-Based Food Systems Conference, hosted by the Institute for Sustainable Food Systems at Kwantlen Polytechnic University on August 9, 2018. The conference brought together community and academic leaders to share research and practice and to foster effective collaboration. More information is at https://www.kpu.ca/pbfs2018

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Here we are nearly four decades later, still missing the deep causes of what's wrong. The rapacious use of carbon by humans, with so many of Nature's checks reduced or eliminated, is why heat-trapping carbon is accumulating in our atmosphere. The course seems to have been set in oceanic thermal vents 3.4 billion years ago. That is when some experts estimate the transition from mere minerals to cells began. Those cells got the energy they needed first from those hot ocean vents, but eventually they adapted to metabolize carbon compounds to produce energy. Ever since, we animals have gone for that carbon-based energy. I call this the 3.4-billion-year-old 'carbon imperative.'

Let's entertain for a moment the idea that our big problem does not come primarily from our institutions or our religions, but from this carbon imperative. We are like bacteria on a sugar-laden petri dish. We have eliminated essentially all of our predators and attempt to manage what wants to eat us from the inside. Our population is exploding like deer whose predators are greatly reduced. We have a mind that could practice restraint, but we act more like the bacteria or the deer. We don't seem to have a way to effectively motivate ourselves to do what it takes to restrict carbon use. Just mention the need for rationing fossil fuels along with a tightening cap on carbon and see where that goes. We fool around our institutions' edges with economic tricks like cap-and-trade and carbon taxes. But by refusing to cap and ration carbon, we are likely to reach a point where our options to preserve a healthy and productive ecosphere will be gone. No species has ever had to do what we must do to overcome what must have begun in those early cellular energy wars.

We know that long before our evolution, which gave us the big brain, some 150,000–200,000 years ago we lived in a world run mainly on contemporary sunlight. It was only in the last 10,000–12,000 years, through agriculture, that we gained access to the first rich pool of carbon: the young, pulverized coal of the soil. The domestication of both plants and animals kicked the human carbon-grabbing enterprise into high gear—and put us on a trajectory that now makes a human future uncertain. This and all of our other carbon pools took longer to accumulate than it will take us to exhaust them. We know the next pool was tapped 5,000 years ago, when we began to rapaciously cut and burn trees to smelt ore in the Bronze and Iron ages. The soil and forest carbon were ecological capital, and we dismembered self-sustaining ecosystems long before the burning of coal, oil, and natural gas. But we humans have become so good at getting and using that carbon that we endanger the rest of the creation. It is a cruel irony that our success in seeking carbon not only allowed the expansion of our species, but also created the conditions for our potential demise.

Our brain power, collaboration, and language allowed us to get at carbon in ways no other species could have imagined. And for a time, our cleverness has allowed us to transcend the limits that the ecosphere had long imposed—or, more accurately, to *appear* to transcend them, since no organism can live outside the laws of physics and chemistry that organize the ecosphere. That's the trap we've walked into. It is the Elegant Trap, elegant in at least three ways:

1. By the time we could understand the consequences of that pedal-to-the-metal pursuit of energy-rich carbon, there was no easy way out. It was like the long con before the trap is sprung in the movie *The Sting*.

2. Once we were aware of the trap, we believed that doubling down with cleverness would get us out. Our collective hubris led us to believe we were smart enough to invent our way to sustainability. Wind machines, solar collectors, and greater efficiency combined will not be enough to save us.

3. Finally, the trap plays on the better angels of our nature, on our compassion. Because we feel the suffering of others, we struggle to find ways to feed our less fortunate brothers and sisters. We are often cruel, but we also care about others, an instinct that we want to foster. We don't want to kill our own kind with war or starvation in the interest of reducing our carbon footprint.

Some societies have avoided the Trap. Maybe they weren't tempted by its elegance, or perhaps their science and technology simply hadn't advanced to the level necessary to tap the five carbon pools. But once the Trap was sprung in the world, no one could escape the consequences. Humans travel the globe, and those who have been willing to do what's necessary to accumulate wealth and power have generally dominated.

Is there any hope? What do we need for an Elegant Escape? Well, the scientific method and the thoughtful deployment of technology produced from science is certainly part of the process. Rather than a knowledge-as-adequate worldview (Vitek & Jackson, 2008), we might turn instead toward an ignorance-based worldview, where we acknowledge that we are billions of times more ignorant than knowledgeable, as a way to dampen human cleverness. This would amount to a direct attack on technological fundamentalism. But we also need a new story.

Where will this new story come from? It will draw on the wisdom of the ages, especially the wisdom of those people who were not pulled as deeply into the Trap. But things are different today, and one of the differences is how much we know about our origins and about ecosystems and how they work.

The Journey of the Universe project (Tucker, Grim, Kennard, Northcutt, & Butler, 2011) features the universe as a story, not a place. It was done by Mary Evelyn Tucker and her colleagues. They hoped that if more of us knew of our origins, we would be inspired to act in better ways. Through this large-scale story, we know the cosmos and Earth as our creator.

In the last 50 to 100 years, discoveries have led us to our cosmic beginning from stardust. And our universe turned out to be larger, more dynamic, and with a composition different than what we had thought. It is sobering that we humans have become matter and energy's only known way to self-recognition. In a certain material-energy sense, we have, as the scriptures promised, a new heaven. Other scientists have given us a framework for the journey from minerals to cells. There is much left to do, but we already have Darwin's picture of vertical evolution through natural selection.

No previous cosmology has had the science to back it up. Now the origin and proliferation of life have come to be understood on scientific grounds. These stories have the potential to inspire us. The late, great George Wald (1964) said it well a half-century ago:

> We living things are a late outgrowth of the metabolism of our galaxy. The carbon that enters so importantly into our composition was cooked in the remote past in a dying star. From it at lower temperatures nitrogen and oxygen were formed. These, our indispensable elements, were spewed out into space in the exhalations of red giants and such stellar catastrophes as supernovae, there to be mixed with hydrogen, to form eventually the substance of the sun and planets, and ourselves. The waters of ancient seas set the pattern of ions in our blood. The ancient atmospheres molded our metabolism. (p. 609)

Will this help us see ourselves as participants in the creation? All of this inspiring knowledge resulted from our becoming a species out of context, meaning out of our evolution in the Upper Paleolithic. It started with agriculture. The resulting literature, art, and scientific discoveries seem to have been a bargain. But there has been a cost: our destructive course. Ending that cost need not demand giving up all we have learned. Few of us would want to live in a world without the insights of Copernicus, Newton, Lavoisier, Darwin, and Einstein, or the Sistine Chapel ceiling, Michelangelo's David, *Ode to Joy, Amazing Grace,* and Shakespeare's sonnets.

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So, the good news is that reducing our dependence on energy-dense carbon through rationing would not mean all is lost. It could start us on the path toward a more information-intensive world. After all, that was the primary feature for gatherers and hunters. To explain what I mean by information, here is an example. A legume's roots use bacteria to capture atmospheric nitrogen and make it useable for growth. This involves 21 enzymes derived from the plant's DNA code. The industrial capture of nitrogen, considered by Winnipeg professor Vaclav Smil (1991) as the most existentially important invention of the 20th century, requires temperatures of 400° to 650° C (752° to 1202° F), pressure of 200 to 400 atmospheres of pressure, and burning loads of fossil fuel. This is the energy-intensive way. The bacteria and legumes rely instead on information.

Nitrogen fixation is only one of nature's countless efficiencies. Let's imagine a natural ecosystem such as a prairie, which, like all of nature's ecosystems, is information rich. If we were to put a cap on carbon—at the mines, the wellheads, the ports of entry, the forests, and even the soils—is there not reason to believe that with those limits we might begin a journey to discover those information-intensive efficiencies?

* * *

Wisconsin's Aldo Leopold was the author of *A Sand County Almanac*. In noting the failure of education to do something for conservation, some of his colleagues had said more education was needed. Leopold asked, "Is it certain that only the *volume* of education needs stepping up? Is something lacking in the *content* as well?" (1949, p. 173). He went on to say, "No important change in ethics was ever accomplished without an internal change in our intellectual emphasis, loyalties, affections, and convictions" (1949, p. 174). Part of the answer to Leopold's question came from the late, great University of Saskatchewan ecologist J. Stan Rowe. Rowe teamed up with a colleague, Ted Mosquin, to publish a manifesto (Mosquin & Rowe, 2004), which de facto provided the missing content. Their manifesto features an ecocentric, or home-centric, worldview to replace the current biocentric, or organism-centered, standard. The stated aim in their manifesto is to extend and deepen people's understanding of the primary life-giving, life-sustaining values of Planet Earth.

Scientific, philosophical, and religious attitudes toward nonhuman nature have advanced in recent decades. Much of our vision has turned outward to the values of lands and oceans and plants and other creatures. In spite of all this progress, Mosquin and Rowe (2004) say we still lack an ecocentric philosophy. Our increased goodwill is "scattered in a hundred directions" and, "made ineffective by the one, deep, taken-for-granted belief that assigns first value to Home sapiens… We're first, and what we directly need is second" (p. 7).

Where might we find more missing content that could change our loyalties and affections? Maybe not in words, but with action. For example, if we cap carbon, accompanied by rationing, we will begin a journey to move from an energy-intensive world to one that is more information-intensive for meeting our bona fide needs. Consider the fossil carbon behind nitrous ammonia versus the 21 enzymes and sunlight behind biological nitrogen fixation. The language would say, "We need a more *information intensive* world, both culturally and biologically." Add the ecosystem concept for the management of our resources, and we will be moving away from the too-narrow biocentric emphasis.

This information-intensive, ecocentric approach is exemplified in The Land Institute's effort to solve the 10,000-year-old problem of agriculture. That effort began as the result of two experiences in 1977, when I read the U.S. General Accounting Office (GAO; 1977) study of soil erosion in the United States. It looked to me like erosion was about as serious as when the U.S. Soil Conservation Service was born back in the mid-1930s. I thought, how can this be? Thousands of miles of terraces, grass waterways, shelter belts, to little effect. Shortly thereafter, I took my student interns to the never-plowed Konza Prairie, and we recognized this: no detectable soil erosion, no fossil fuel dependency, no chemical contamination of the land. The only visible industrial product was the barbed wire fence. Coming and going to that native prairie 60 miles away, we passed corn, with soil erosion; soybeans, with soil erosion; sorghum with soil erosion. We all knew that fossil fuels had been spent for fertilizer, traction, and pest control. The Konza Prairie, like most natural ecosystems of the land, whether rainforest or alpine meadow, features perennials growing in mixtures. Why did humans not have perennial grains growing in mixtures like most of nature's ecosystems after 10,000 to 12,000 years of agriculture?

I talked to my geneticist and ecologist colleagues about the possibility of perennial grain polyculture. Their response was something like, "Well, Wes, everybody knows that's not possible. A plant will either allocate its resources to the root or to the seed, but it can't do both." I asked, "How about fruit trees? They're high-yielding." That was considered different, because they are woody. But what does that have to do with a trade-off?

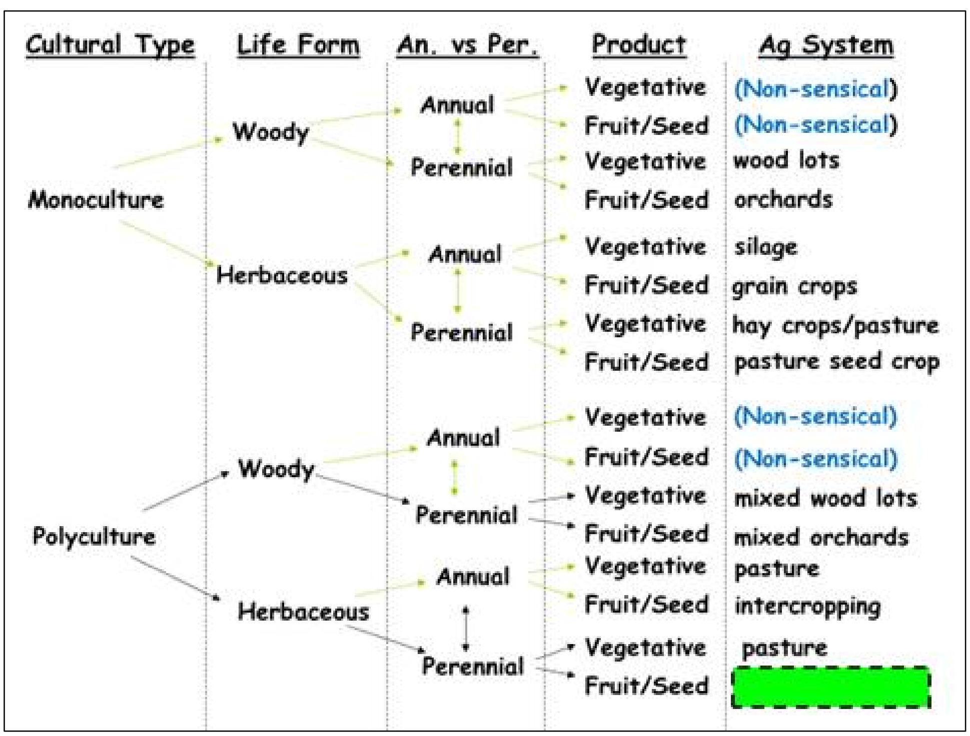
I thought of how humans have used plants, based on four contrasting traits: herbaceous vs. woody, perennial vs. annual, use of seed vs. vegetative parts, and polyculture vs. monoculture. This yields 16 combinations. Four are irrational (there's no such thing as woody annuals), leaving 12 possible combinations. Eleven of those had been used by humans. There was one blank: There had been no herbaceous, perennial, seed-producing polycultures used by humans (see Figure 1). If there had been, it would be a perennial grain polyculture—a domestic prairie. With such an ecosystem could we see those wild integrities of the prairie come to the farm? I reckoned that if we stopped with a perennial grain monoculture, we would miss half the point. So, we set our sights on perennial grain polyculture: a domestic grain-producing prairie.

The GAO report and the Konza field trip were on my mind in 1977. Soon after, I wrote a piece for our *Land Report* and for a Friends of the Earth publication called *Not Man Apart*. I reckoned it would take 50 to 100 years to develop perennial grain polycultures. You can imagine the enthusiasm for that projection.

Our research efforts started 41 years ago. David Van Tassel is now working on an oilseed crop called silphium; it is in the sunflower family. Pheonah Nabukalu came to us as a post doc from Uganda to work with Stan Cox on sorghum. She is now a full-time staff member. She and Stan have their perennial sorghum breeding done here and in Africa. Lee DeHaan is working on intermediate wheatgrass. We call this perennial Kernza®. Shuwen Wang is working on perennial wheat, Brandon Schlautman on legumes. There are now thousands of acres of perennial rice in China. Three-year-old plants are still experiencing high yield two times a year.

Three of our scientists—David Van Tassel, Lee DeHaan, and Stan Cox—have concluded why our ancestors never developed perennial grains and why we can now. It has to do with the fact that annuals tend to accept their own pollen—which, when it happens, represents the tightest form of inbreeding. Any lethal or sublethal mutation that happens will be eliminated. Desirable traits such as resistance for the seed to shatter are retained, allowing seeds to be harvested, rather than falling to the ground. In such a way, agriculture became possible. Perennials tend to outcross, and therefore their genetic load builds up. (Humans are outcrossers, but we manage it with an

Figure 1. The Blank



incest taboo.) We now know how to purge the genetic load in perennials with knowledge of molecular genetics and with modern computational power.

Now we're helping scientists at Saint Louis University and Missouri Botanical Garden develop a global inventory of herbaceous perennials as possible new "hardware" for agriculture. I don't like that word for organisms, but it is useful for now.

The annual grain hardware is limited and requires agronomists to be primarily prescriptive. Ecologists have from the beginning been descriptive. With perennial polycultures, the descriptive and prescriptive can become one, bringing two scientific cultures together. Ecological agriculture may be—just may be—our last best hope to keep alive all that we have discovered during our prodigal journey. If we are successful, we will protect our potential for producing food by reducing soil erosion and getting rid of fossil fuels and chemicals. A whole different kind of flowering is needed and seems possible for meeting our bona fide human needs. Leading this orchestra is our ecologist and research director, Tim Crews. He and his colleagues are studying mixtures of various perennials, with ecological intensification as a major goal. The Land Institute researchers, along with an increasing number of colleagues around the world, are out to fill that blank on Figure 1.

In the poem, "For the Children," from his book *Turtle Island,* Gary Snyder (1974) captured the challenge that is ahead of us.

> The rising hills, the slopes,
> of statistics
> lie before us.
> The steep climb
> of everything, going up,
> up, as we all
> go down.

His poem continues on with a note of hope.

> In the next century
> or the one beyond that,
> they say,
> are valleys, pastures,
> we can meet there in peace
> if we make it. (p. 86)

The Land Institute research has contributed and still contributes to those rising hills, the slopes of statistics. The researchers and their technicians have tractors, combines, lots of lab equipment, and three greenhouses. Every scientist has a pickup truck. All of that is industrial equipment, which contributes to those slopes and rising hills of statistics.

Once established, will these new perennial grain mixtures still require the industrial world that brought them into existence? With "require" as the key word here, my answer is no. Their creatureliness remains and will depend only on the long-term life support system of our Earth. Should one of our ancestors, Rip Van Winkle–like, appear from the first millennium of agriculture, he or she would know what to do, with less time managing weeds, and, with this being a polyculture, experience fewer whole-field crashes. The industrial or material world can't say that.

Once we assess our technologies against a background of ecosystem concepts that feature creatureliness, information-intensive becomes a way of being. Once we put a cap on carbon emissions and keep ratcheting it down, an information imperative will gradually replace energy-intensive culture.

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