Agriculture and Forestry in a Changing World[1]

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We live in an ever-changing world. In fact, change is said to be "the only constant in life." So, change is normal and usual. However, some changes are not normal or usual. Some changes are revolutionary. In fact, every two hundred years of so in history of Western civilization societies have gone through great transformations. I believe we are currently in such a time of fundamental change. The current transition may be at least as important as those of the Industrial Revolution of the late 1700s and perhaps as important as the birth of science in the early 1600s. Such changes come about when society is forced to rethink its ideas about how the world works and their place within it. Such transformations eventually change virtually every aspect of life.

The forces driving the current transformation are the fundamental questions of sustainability. Sustainability asks: how can we meet the needs of the present without diminishing opportunities for the future? When we ask the questions of sustainability, earnestly and honestly, we come to the inevitable conclusion: today's global society and economy are not sustainable. They aren't meeting the needs of most of the world's people today and most certainly aren't leaving equal or better opportunities for those of future generations. We eventually must face the reality that we can't keep doing what we have been doing. Our current way of life is not sustainable.

This is not just a personal opinion. Sustainability ultimately is a matter of energy. Everything of use to us, our houses, clothes, cars, our food, require energy to make and energy to use. In fact all material things are concentrated forms of energy. Human imagination, creativity, and labor also require energy; the brain uses approximately 20% of the energy used by the human body. In addition, we are not born as productive individuals; we are born and helpless infants. We must be nurtured, cared for, socialized, civilized, and educated by society before we become useful to society. All of this requires human energy, specifically, biological energy.

According to the first law of thermodynamics, energy can neither be created nor destroyed. So, it might seem that sustainability is inevitable; we can keep using the same energy over and over. According to the second law of thermodynamics, however, each time energy is used to do anything useful, some its usefulness is lost – the law of entropy. Energy inevitably changes in form whenever it is used to do anything useful. Specifically, it changes from more concentrated, organized forms to less concentrated, disorganized forms, as when gasoline explodes in the cylinder of an automobile. The energy in gasoline isn't destroyed as it propels a car along a road, but it becomes less concentrated, less organized, and thus less useful than before. This isn't just some esoteric theory; it is our everyday reality.

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The economic growth of the past 200-years, the industrial era, was made possible by an abundance of cheap energy. The first source was old growth forests, then surface deposits of coal, and for the past 100-years, shallow reservoirs of oil and natural gas. But most of the old growth forests are gone, we are blasting the tops off mountains in the United States to mine the remaining coal, the most of the remaining oil and natural gas lies deep beneath the ocean floors or in most remote areas of the world hardly touched by civilization. In addition to being more costly to extract and refine, extraction of the remaining stocks of fossil energy presents major risks to the environment. Greenhouse gas emissions from fossil energy, for example, threaten the future of human life on early. The world is not out of fossil energy, at least not yet, but it is quickly running out of abundant and cheap energy.

Experts disagree on how long it will take to deplete the remaining fossil energy. However, most estimates indicate the "recoverable" stocks of fossil energy will be depleted within this century, with the recoverable stocks of oil and natural gas largely gone by mid-century.[i] When it takes more energy to extract and refine fossil energy than the energy made available by the process, there is nothing to be gained from continued extraction. Humanity has perhaps 50-years at most to make the transition from nonrenewable fossil energy to renewable sources of energy.

The only sustainable source of energy is solar energy. However, energy from all the sustainable sources combined – wind, water, solar panels, biofuels – in total, will the less plentiful and far more costly than fossil energy has been in the past. The days of cheap, abundant energy are over. The industrial era was an aberration in human history that is not likely to be repeated. Fundamental change is no longer an option; it is an absolute necessity.

So what does this mean for the future of agriculture and forestry? Our current systems of producing foods and forest products are basically industrial processes. They rely on the industrial strategies of specialization, standardization, and consolidation of control to achieve the economic efficiencies or economies of scale associated with industrial production. However, the economic efficiencies of such strategies are inherently dependent on the availability of low cost fossil energy. They rely on large-scale, mechanized cultivation, harvesting, processing, transportation, and distribution, all of which require fossil energy. The end of cheap fossil energy means the end of industrial agricultural and forestry.

For example, food production in the U.S. currently accounts for at least 17% of all fossil energy use, requiring about ten kcals of fossil energy for each kcal of food energy produced with agriculture accounting for about one-third of the total.[ii] In addition, the global food system accounts for more than 20% of the global greenhouse gas emissions, even more than the transportation sector.[iii] Conversion forest land to farmland is a major contributor to greenhouse gasses in many areas of the world. The major gains in agricultural productivity of the past several decades are linked to increased mechanization and use of commercial fertilizers and pesticides. Nitrogen fertilizers are major users of fossil energy and agricultural pesticides are major contributors to pollution of groundwater, streams, and estuaries. Pollution is equivalent to negative energy, in that it requires energy to prevent or mitigate. We cannot provide food for a growing global population with an agriculture that is inherently dependent of fossil energy in a world that is running out of fossil energy. Fundamental change is not an option, it is a necessity.

Both agriculture and forestry must be radically redesigned to accommodate the needs and demands of global society in the 21st Century. Furthermore, simply increasing energy efficiency and reducing environmental pollution, while necessary, will not be sufficient to meet the challenges of sustainability. Increasing energy efficiency – reducing, reusing, and recycling – does not address the inevitable consequences of entropy. Substitution of solar energy for fossil energy likewise is necessary but does not address the social and human resource challenges of authentic sustainability. Sustainable farms and forests must be socially responsible as well as ecologically sound and economically viable. The simultaneous global challenges of persistent hunger and epidemics of obesity are clear indications of an unsustainable global food system.

Sustainable agriculture and forestry systems of the future must be based on the model of healthy living ecosystems. Only healthy living systems are capable of transforming solar energy into the *biological* forms of energy necessary to sustain human life. The leaves of plants are biological solar energy collectors upon which all terrestrial life depends for biological energy. Equally important, living organisms and ecosystem provide the essential model or paradigm for all sustainable systems of solar energy sequestration, including agriculture and forestry.

Living organisms and ecosystem obviously are subject to the laws of nature, but they do not function according by specific rules or formulas that characterize nonliving machines or electronic mechanisms. Living systems are individualistic, dynamic, evolutionary, and incredibly complex. They function according to general principles rather than precise cause and effect relationships. For example, humans function according to the same general principles, even though their actions and reactions are not precisely predictable. Each human is a unique individual that changes with each new stage of life. The essential principles of living organisms are encoded in their DNA, which allows their physical structures to be born, mature, reproduce, and evolve from generation to generation. The principles by which living systems function are not created by humans and cannot be changed by humans; they exist as an aspect of nature. "Managed ecosystems," such as farms and forests, must respect the principles of living systems.

Sustainable systems of agriculture and forestry must be organized and managed in harmony with the basic ecological, social, and economic principles of sustainable living systems. Living systems are holistic. A farm is something more than the sum of its parts; it is a *whole*. Living systems have properties that emerge from the whole that are not contained in their individual parts; relationships matter. Sustainable farming and forestry must also respect the ecological principle of *diversity*, which is necessary for biological systems capture, store, and recycle the solar energy needed for resilience and regeneration. The payoff from holism and diversity is realized through the principle of *interdependence* or mutuality. Interdependence makes it possible to create sustainable systems out of elements or parts of systems that individually and separately are simply not sustainable.

Farms and commercial forests are managed by people and employ people for the purpose of meeting the needs of people. The families, communities, and societies of which these people are members are living systems and function according to principles rather than precise cause and effect relationships. Sustainable relationships among people must be built upon the social principle of *trust,* rather than laws and contracts. Laws are only effective in constraining those

who are incorrigible or incapable of social responsibility. People must choose to be honest, fair, and responsible in their dealings with others. However, humans are fallible beings; we need mercy as well as justice. So, sustainable relationships must also be based on *kindness*. We must be empathetic, respectful, and compassionate. Finally, it takes *courage* to be trusting and caring. Intentions without actions are of little consequence. It takes "moral courage" to sustain positive relationships in a world where trusting and caring are often seen as naïve or idealistic.

Those who engage in farming and forestry also must respect the principles of economics. The most basic principles of economics are not the creations of economists, but instead reflect fundamental principles of individual human behavior. We value things individually that are *scarce,* meaning there is not enough for everyone to have all they want. We must make our economic living producing things that have economic value. We may support collective decisions that protect clean air and water, but as long as clean air and water are not scarce they have no individual economic value. We also need to get as much usefulness as we can from whatever we have; we need to use our time, money, and energy *efficiently*. Finally, we need to be able to make independent decisions; economic value and efficiency depend on our individual *sovereignty*. We need not accept the all of the dogma of contemporary economic thinking, but we must respect the basic principles of economics if we are to meet our individual needs and sustain our local and national economies.

Finally, sustainable organizations, including farms and forests, must have ecological, social, and economic integrity – all three. The same basic principles must permeate all aspects of life. The principles of holism, diversity, and interdependence must permeate local societies and economies. The principles of trust, kindness, and courage must also be reflected in ecological and economic relationships. And, the principles of scarcity, efficiency, and sovereignty must be used in managing natural ecosystems and maintaining social relationships. Sustainability requires a renewed commitment to integrity based on new ways of thinking about how the world works and our place within it. Sustainability is an emergent property of ecological, social, and economic integrity.

Dee Hock, the founder of Visa Corporations, suggests a management model or paradigm that is appropriate for living systems, such as farms and forests. His would refer to living organizations as being *chaordic*.[iv] Organizations, both living and non-living, are formed for specific purposes. Otherwise, there is no reason for bring people or other resources and materials together in a common coordinated initiative. In a nonliving organization, purpose is designed into its organizational structure. In a living organization, the purpose plays a continuing role in organizational management and thus cannot simply be designed into the structure of the organization. In a living organization, the purpose must be instilled in the hearts and minds of the people in the organization. In living organizations, the focus is on the people who fill the various positions rather than their position descriptions. The people in a sustainable organization must remain personally committed to the purpose of the organization.

The essence of a sustainable organization is embodied in its principles of operation. These organizational principles are expressed as a set of standards for individual and collective actions, which may include both structural and operational values. In addition to the basic principles of sustainability, the principles chosen must be both necessary and sufficient to ensure that the

organization fulfills its specific purpose while maintaining its sustainability. If principles are included that are not necessary, the organization's ability to adapt changes in its environment will be unnecessarily constrained. If the set of principles is not complete or appropriate, the organization may not function effectively in pursuing its purpose, and it may not be sustainable.

The structure of a living organization, either private business enterprise of public agency, must be dynamic rather than fixed. Positions, departments, divisions, and organizational units, must be allowed to change over time. They must be allowed to continually evolving, forming, and dissolving, as the organization transforms and renews itself to meet the ever-changing demands of a dynamic economic and social environment in an ever-changing economic, social, and natural environment. The purpose and principles of the organization, the conceptual DNA, remain unchanging, allowing the structure to evolve as needed to maintain both the effectiveness and efficiency of the organization. Again, these are not esoteric theories of organization. Sustainable farms and forests of the future must be organized and managed according to these principles by which sustainable living systems must function.

The application of this approach to organization and management is clearly embodied in the philosophy of organic farming. The concept of *permanence*, as expressed by early advocates of organic farming, is equivalent to today's concept of sustainability. Sir Albert Howard of Great Britain began his classic 1940 book, *An Agricultural Testament*, with the assertion, "The maintenance of the fertility of the soil is the first condition of any permanent system of agriculture."[v] In his opening chapter, he contrasted the permanent agriculture of the Orient with the agricultural decline that led to the fall of the Roman Empire. Howard concluded, "The farmers of the West are repeating the mistakes made by Imperial Rome." Organic pioneer and publisher, J. I. Rodale, wrote in 1948, 'The *organiculturist* farmer must realize that in him is placed a sacred trust,… an obligation to preserve the fertility of the soil, a precious heritage that he must pass on, undefiled and even enriched, to subsequent generations."[vi]

An organic farm was clearly to be managed as a living organism. The founder of biodynamic farming, Rudolph Steiner, in a landmark series of lectures in 1924 wrote, "A farm is healthy only as much as it becomes an organism in itself – an individualized, diverse ecosystem guided by the farmer, standing in living interaction with the larger ecological, social, economic, and spiritual realities of which it is part."[vii] In this sense, organic describes the organization of the farm as a holistic, diverse, interdependent system – as a living organism. Early advocates of organic farming believed that human health and the health of societies were directly connected to the health of the soil. In 1938, a prominent U.S. soil scientist, William Albrecht, wrote," A declining soil fertility… is responsible for poor crops and in turn for pathological conditions in animals fed deficient foods from such soils, and mankind is no exception."[viii] The principles that guided organic farming were the ecological, economic, and social principles of sustainability.

Unfortunately, many the large food corporations that dominate today's organic food markets are still committed to the old industrial organizational model of specialization, standardization, and consolidation of control, rather than holism, diversity, and interdependent relationships. In their pursuit of economic efficiency, they are compromising the ecological and social integrity of organic foods. As a result, a new sustainable food movement is emerging that gives priority to locally grown foods over industrial foods, including "industrial organic" foods. Conscientious

consumers are buying as much of their food as possible from local farmers, from people they know and trust to provide food with ecological, social, and economic integrity.

The new community-based food systems are not intended to make local communities self-sufficient in food production, any more than sustainable agriculture is intended to make farms self-sufficient. The purpose in both cases is find ways to work and live in harmony with nature, including human nature, – to build positive relationships of trust and kindness among people and between people and the earth. A local, community-based food system encourages and supports production of foods uniquely suited to specific ecological and cultural niches, as a means of achieving this harmony. It also supports the cultural belief that eating foods produced in the places where we live, by people we know, is an act of ethical integrity. It encourages people to come together, to create a sense of community, around food. The challenge is to turn this new commitment to community and society into purchasing patterns and public policies that will create economic viability for more local farmers – while respecting the economic principles of scarcity, efficiency, and sovereignty.

The emergence of these new food systems is also a response to growing concerns about the dependency of the current food system of nonrenewable fossil energy. Consequently, many communities are also looking to agriculture and forestry as sustainable sources of renewable energy. Unlike those who are producing biofuels using the old industrial model of fossil energy, they are committed to sustainable, community-based energy systems that function in harmony with sustainable community-based food systems. Sustainable forestry can make perhaps its greatest potential contributions to sustainable community-based energy production.

Pyrolysis and gasification seem to be among the most promising technologies on the horizon to produce sustainable energy from both forestry and agriculture. Pyrolysis and gasification refer to chemical decomposition of organic materials under high temperatures and in the absence of or with limited oxygen, respectively. These processes have been used extensively in industry for a variety of purposes, including production of charcoal. The resulting biological materials include various types of fuel, biochar, and tars. Bio-gasses created by combustion can be converted into ethanol and biodiesel as well as burned directly.

These technologies have several significant ecological advantages over current methods of producing ethanol and biodiesel. They not require large amounts of water and do not pollute the air with carbon dioxide. Perhaps most important, carbon from the biomass is sequestered in biochar that can be incorporated back into croplands to increase soil fertility by promoting synergistic relationships between the soil, soil organisms, roots of the plants, water, and carbon-dioxide and nitrogen in the atmosphere. Pyrolysis and gasification can utilize raw materials and wastes from forests and perennial farm crops that require no tillage after establishment and require relatively little fertilizer, pesticides, or fuel. Such bioenergy systems may actually sequester more greenhouse gasses than are released.

Pyrolysis and gasification also seem to have particular advantages for sustaining rural communities and local economies. The basic technology is adaptable to a wide variety of sizes, making *decentralized* systems of renewable energy production more feasible and cost competitive. Community-based operations allow recycling of bioenergy and biochar within local

communities – reducing energy costs for local residents by reducing energy losses in transmission and transportation. Biochar could also be applied to home gardens and vacant urban and suburban plots to increase the availability of fertile land for local food and energy production

Sustainable farming and forestry are land-friendly, people-friendly approach to food and energy production that can function in rural, urbanizing, or even urban environments. They provide means of building positive relationships of respect and trust between farmers and foresters and their neighbors and customers. With support from enough people who truly value sustainability, such systems can be economically viable for farmers and foresters as well as ecologically and socially responsible. Farms, forests, and residential developments can all coexist with this approach to agriculture and forestry. New thriving communities can even be built by sharing the same spaces for farming, forestry, and residential development.

This new vision might seem idealistic and its achievement might seem little more than an unattainable dream. But, we should remember the current industrial systems of farming and forestry were not created by some government fiat or decree, but were created by individuals, one person at a time. One-by-one, as consumers changed what they bought and where they bought it, as producers changed what they produced and where they sold it, as citizens changed their support for government policies, one-by-one, our systems of farming and forestry were changes from organic and local to industrial and global. So, one-by-one, as we in our respective roles as consumers, producers, and citizens make different choices, our society and economy can just as easily be transformed from industrial and global to sustainable and local. We are living in a time of fundamental change. Change is not an option, it is a necessity. We have the power to help create a new and better world, if we can find the courage to change ourselves – one-by-one.

End Notes:

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[i] Wikipedia, the Free Encyclopedia, "Fossil Energy," http://en.wikipedia.org/wiki/Fossil_fuel

[ii] David and Marcia Pimentel, *Food, Energy, and Society* (Niwot, CO: University Press of Colorado), 1996.

[iii] Wikipedia, "greenhouse gas", http://en.wikipedia.org/wiki/Greenhouse_gas and "Climate Change and Agriculture," http://en.wikipedia.org/wiki/Climate_change_and_agriculture .

[iv] Hock, *Chaordic Age*.

[v] Sir Albert Howard. *1940. An agricultural testament. Oxford University Press: Oxford, England. also in Small Farms Library http://journeytoforever.org/farm_library/howardAT/ ATtoc.html*

[vi] J. I. Rodale. 1948. The Organiculturist's Creed, Chapter 8. *The organic front*. Rodale press: Emmaus, PA, USA. http://www.soilandhealth.org/copyform.asp?bookcode=010133

[vii] Rudolph Steiner. 1924. *Spiritual foundations for the renewal of agriculture.* Gardner, M (1993) (ed). Bio Dynamic Farming and Gardening Association of USA: Junction City, OR, USA. http://www.biodynamics.com/index.html

[viii] William A. Albrecht, *Soils and Men*, Yearbook of Agriculture (U.S. Dept. of Agriculture,1938), 347-360.