

SUSTAINABILITY AND AGRICULTURE

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Sustainability – the ability to sustain. I define sustainability as maintaining a high quality of life for people for as far into the future as can be imagined. As do all animals, humans require basic necessities, like shelter, food, water, and air to sustain their lives. These can be acquired without agriculture, as hunter-gatherers proved for millennia. However, it was agriculture that allowed people to become sedentary, to live in villages, towns and cities. It was agriculture that allowed civilizations to evolve and to sustain. On the other hand, agriculture has been equally adept at destroying rather than sustaining human civilizations—either by giving one group of people the time to develop weapons with which to overpower and supplant another, or by impairing the ecosystem processes that produce the necessities which all humans require.

Two misperceptions of sustainable agriculture are current today. Mainstream agriculture, which heavily supports agriculture education at universities in this country, regards it as a counter-culture which threatens agri-business and is incapable of feeding the world. Others think of sustainable agriculture as simply the growing of food using organic methods. But we know that organic agriculture is not sustainable in and of itself, as is evidenced by the many civilizations that disappeared prior to the discovery of oil and its resultant products that are associated with conventional agriculture today. To achieve sustainability with agriculture, there must be a different approach from those previously used.

Agriculture provides unique arrangements of nutrients that we call food and fiber. Because these things are deemed to have value in our society, compensation is provided

to farmers and ranchers in the form of direct payments by consumers and also through more indirect forms of support. Sadly, however, most societies have failed to compensate these land stewards for the production of healthy soil. Healthy soil is teeming with more life forms than we can comprehend. If agriculture is to be sustainable and sustained, agriculturalists must be compensated not only for producing food and fiber, but also for creating the healthy soil that sustains civilization.

Agriculture produces food and fiber in two ways: crop production and animal husbandry. Both methods manipulate the four ecosystem processes: solar energy flow, the water cycle, the nutrient cycle, and biotic community dynamics. These four processes function interdependently. A change in one affects the others. Agriculture captures solar energy while cycling water and nutrients. As agriculture collects more solar energy, a more complex biotic community is supported, more nutrients are cycled, and water moves through the ecosystem more effectively. To a large extent, these processes take place close to the earth's surface. Most of the life on planet earth lives close to this surface—both above and below it.

When sunlight reaches a soil surface covered with a green, living plant, its energy is captured and transformed by the chemical process of photosynthesis. A greater volume of energy thus captured results in a greater variety and volume of life forms. Greater complexity increases stability and makes the process more sustainable. At each stage of the food web, a portion of the captured energy is transmitted to the consumer, with the remainder being released as heat to the environment. If the food web is made less complex, less energy is captured. If solar energy strikes asphalt, concrete, or bare soil, food can not be produced and life can not be maintained.

When a raindrop strikes the earth's surface and is rapidly absorbed, it can be used by living organisms in the topsoil, as well as by plant root systems that link microbes to higher life. When their needs are met, residual water flows to underground springs, sponges, and aquifers which provide water to other living organisms before finding its way to lakes, rivers and oceans. If that drop of water strikes a surface that rejects absorption, there is immediate runoff, likely taking with it soil particles as well as dead plant material that hasn't been reincorporated into the soil. In terms of tonnage to leave our shores, soil is the leading export of the United States. With a healthy soil surface, we have wet years and dry years. With unhealthy surfaces, we have floods and droughts.

What of the nutrient cycle? All life is composed of nutrients—unique arrangements of proteins, carbohydrates, fats, vitamins, and minerals. Nutrients come largely from the soil. The only way to sustain life is for these nutrients to cycle through living organisms within and above the soil and back to the soil again, through birth, life, death, and decay. The faster this happens, the more life can be supported. Without death and decay, there cannot be new life. Modern agriculture has stopped or severely retarded the essential

processes of decay by killing the microorganisms in soil that carry it out or by failing to recycle dead plant material. A sustainable agriculture puts as much emphasis on returning nutrients to the soil as on producing nutrients to be sold to humans.

The fourth of the ecosystem processes is biotic community dynamics—the web of interactions among living organisms. From microbes to elephants, from lichen to old growth redwoods, all life forms have a degree of interdependence. Biological succession indicates the degree to which biotic community dynamics are functioning. At a high level, community dynamics buffer extremes and provide stability.

When we change the water cycle, the energy flow, or the nutrient cycle, we also change biotic community dynamics. When we introduce a new type of plant or animal with agriculture we affect all the pre-existing organisms in that community. For example, when we create agricultural monocultures, we simplify a biotic community and eliminate organisms that naturally serve as controls, as was the case when the corn borer wiped out 40% of the annual crop in one year. When agriculture leaves a soil surface bare, increased temperatures at the surface kill critical soil organisms. When we till with our implements of husbandry and thereby relocate near-surface dwellers to depths for which they are not acclimated or when we apply some type of additive, from fertilizer to pesticide, biotic community dynamics are disrupted.

Sustainable agriculture, both crop production and animal husbandry, requires the capture of a maximum amount of solar energy, the effective cycling of water and nutrients, and the enhancement of biotic community dynamics. Crop production necessarily reduces biodiversity and suppresses biological succession in order to grow the particular plants we desire, but these negative effects can be minimized through proper practices. Soils should remain covered rather than bare. To maintain complex communities of living organisms we must cultivate polycultures rather than monocultures. The increased biological complexity that occurs in biomes, also known as the edge effect, can be achieved by planting in smaller areas defined by hedgerows and buffer strips rather than huge fields. The turning or tillage of soil must be minimized. We must recycle food nutrients within local areas instead of using non-sustainable fossil fuel compounds in fertilizers and transportation.

We must also promote the cultivation of perennials along with annual plants.

Most vegetable field crops are annuals, producing seed, and dying in one year. Perennials, for instance vine and tree crops, live longer and reproduce not only with seeds but by other means as well. Because of their deep and complex root systems, perennial plants support photosynthesis throughout the year and thereby collect more solar energy for the food web. These root systems deliver vital nutrients from deep in the soil to the surface providing a balanced diet to their consumers. As top growth is harvested, the root systems recede and regrow, creating a soil structure that allows for water to move

and various living organisms to migrate more freely within the soil. The root systems of perennials also serve to stabilize and anchor the topsoil.

As important as are crops in sustaining civilization, the greatest impact of agriculture is found on the arable surface of the Earth that cannot be used to grow human food crops. These are areas of seasonal and erratic rainfall. Here, the microbial action which causes the breakdown and cycling of nutrients does not happen on the ground for most of the year, but rather in the wet gut of the complex stomachs of large, cud-chewing ruminants, such as bison, cattle, deer, sheep, elk, and goats.

Both wild and domesticated ruminants in these areas tend to be herded animals that depend upon the security of the group to protect themselves from predators. Because of the density of the herd, the plants upon which they depend are quickly consumed in any given area. This, along with fouling of the ground with dung and urine cause them to stay in a given area only for a short time period – not to return until the stench has worn off. This interval allows plants a chance to recover from the grazing before being re-cropped. Predators lurk at water points, so visits by herds of grazers are short and hectic, creating occasional disturbance of the wet riparian areas. Dead plant materials are trampled and thereby brought closer to the organisms of decay residing below. Ecological health is enhanced rather than harmed by such occasional disturbances. This natural pattern highlights the value of cattle, sheep, and goat agriculture in maintaining the nutrient cycle.

Agriculture has a critical responsibility to capture greater quantities of the sun's energy to be converted into food energy, to create effective cycling of water and nutrients, and to nurture a dynamic biotic community of living organisms. If we want to sustain civilization, society must create policies that compensate the stewards of the land, our farmers and ranchers, as they fulfill this responsibility.

Can we create a sustainable agriculture? Can we create a sustainable civilization? As Albert Einstein once said, "the world will not evolve past its current state of crises by using the same thinking that created the situation." The approach of modern agriculture has been to develop a new arrangement of genetic material, a new pesticide, a new nutrition source for our plants and animals, a new set of mechanical technologies to better manipulate our environment, a new set of financial management tools, and a new way of facilitating the movement of products around the world. These are all exciting pursuits utilizing the talents of intelligent and capable individuals. However, they are all examples of the same thinking that has created the declining profitability, reduced soil fertility, increased soil erosion, lessened crop yields, and rural instability that we see today.

The things we do must reflect an awareness that the living world is not a hard system—a series of parts that can be manipulated like a machine, but rather it is a soft sys-

tem with unexpected emergent properties that operates as a whole. We must be more humble in our approach to management. Rather than assuming we've made the right choices followed by any and all actions to defend those choices, we must assume that our decisions might be wrong and closely monitor to check for early warning signs of problems and readjust our actions quickly. The pathway to sustainability is not a matter of intelligence or availability of technology. It is a matter of making better decisions which will lead to a quality of life we desire, for as far into the future as we can imagine. 