Moringa *(Moringa oleifera)*

CHAPTER TEN

Leaf Vegetables In Sustainable Agriculture

SUSTAINABLE FOR HOW LONG?

Any discussion of sustainable agriculture has to begin with what we mean by "sustainable," and any discussion of "sustainable" has to begin with the question "for how long?" Thinking about sustainable agriculture is difficult because we can't get back far enough to see the subject with an adequate time horizon. Agriculture itself is only about 10 thousand years old. How long do we want to be sustainable? Is 100 million years realistic? It was for dinosaurs. Even 1 million years seems too long to grasp. Maybe thinking in terms of another 10 thousand years is enough. Maybe we can consider ourselves roughly halfway through our experiment with agriculture.

We don't have much to go on. Most of the nations that sign the international treaties and laws intended to protect the Earth's future are less than one hundred years old. Modern science and agricultural technology have been enormously impressive in their ability to increase human food supplies, but they are too new to the scene for us to know if they will hold up for the long haul. Their success may prove to be just a stirring sprint at the start of an agricultural marathon. Craft agriculture, on the other hand, has had a limited scientific basis, but has had the valuable perspective that can only be gained from centuries of trial and error.

The best guidance for designing lasting food systems may be found in the natural ecosystems that support life on our planet. Mature ecosystems are as close as we can find to sustainable biological systems. These are communities of plants and animals which, through the process of ecological succession, or the development of vegetation in an area over time, have reached a near equilibrium or "steady state." They are largely self-regulating and self-repairing organizations that appear capable of running indefinitely on the energy supplied by the sunlight that they intercept. They are characterized by a great biodiversity that provides important checks and balances and redundant services. Frugal use and thorough recycling of nutrients, water, and energy enables climax ecosystems to support a large community of living organisms for a very long time.

Agriculture that tries to learn from and emulate ecosystems is sometimes called agro-ecology or eco-agriculture. It is likely that an emerging sustainable agriculture will incorporate elements from modern technology, craft, or traditional agriculture as well as from close observation of natural ecosystems. The sophisticated tools of observation that modern science can bring to this endeavor will probably prove more useful than its powerful

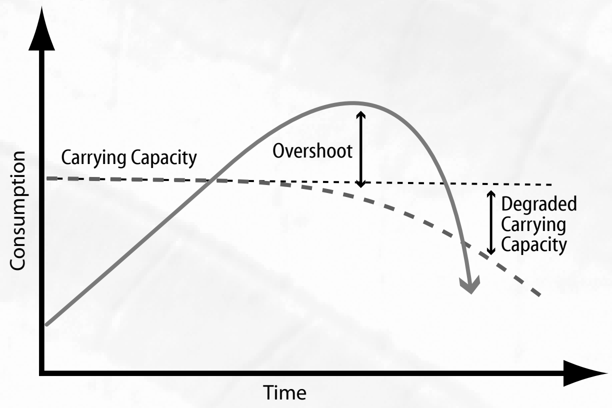

FIGURE 10–1
Carrying capacity

technologies for manipulating biological material.

SUSTAINABLE FOR HOW MANY?

Alongside the fundamental question "for how long?" sustainable agriculture will eventually have to consider "for how many?" This is the question that determines how much food an agricultural system will need to produce.

As a species, human beings *(Homo sapiens)* have been remarkably successful at obtaining food. We have a digestive system adaptive enough to derive nourishment from a huge variety of food, including leaves, fruits, seeds, roots, meat, fish, seaweed, eggs, milk, fungi, and insects. We've also developed highly adaptive brains and sufficient manual dexterity to develop and use an ever-expanding catalog of tools. We set out on our evolutionary journey from east Africa with the digestive flexibility to adapt to the new environments we encountered and with the growing capability to control those environments with our tools.

Learning to manipulate fire to cook food significantly improved our food supply by allowing us to soften and detoxify many plant foods and to kill parasites in meat. Archeological evidence from the Middle East suggests cooking may have begun something like 700,000 years ago. Cooked food gradually became universal in human societies. Heat increased the net caloric value of our food by reducing the effort required for chewing and digestion. This increase in food value is often cited as a prerequisite for the development of the large human brain.

The second and perhaps most important change in how we managed food came much later with the Neolithic Revolution and the dawn of agriculture. Rudimentary farming of wheat and barley is generally thought to have begun some 10–12,000 years ago. Like cooking, agriculture appears to have spread from its origins in the Middle East until becoming nearly universal in human settlements. While agriculture represented a sharp break from the old hunting and gathering lifestyle, in some ways it was simply the application of gradually increasing levels of control over those more traditional activities. Hunters made hunting easier by fencing and eventually breeding their prey. Gatherers made gathering more productive by planting the seeds of the most desirable plants, protecting them from herbivores and eventually modifying those plants to make them even more desirable for gathering.

Humans have always needed to eat, and agriculture developed as a response to that need. It was a means to an end. Ideally, it would provide a plentiful and secure supply of food for everyone despite the unpredictability of Nature. Since the beginning of agriculture humans have been advancing their food supplies by using a fairly simple strategy: identify the factor that most limits the food supply and find a way to remove that limitation. When we thought that lack of land was the most limiting factor, we cleared more land (after chasing off whoever had been previously using it). When shortage of water limited food production, we built irrigation systems. We pushed back the limiting factors of soil fertility and insect competition with the invention of synthetic fertilizers and pesticides. When the nature of a food plant or animal limited the potential of our food supply, we altered its fundamental form, first with selective breeding and more recently with direct manipulation of its genetic make-up.

In many ways this has been a spectacularly successful approach to getting food and, as we are fond of telling ourselves, we have been a spectacularly successful species. The current human population is something like 7,000 times greater than it was at the dawn of agriculture. The annual increase in our population, now estimated at about 77 million, likely exceeds the entire number of humans in the world at the time of the Neolithic Revolution. Most projections now assume that we will reach a peak population of about 9 billion around the middle of the twenty-first century.

Around 1798, when there were still fewer than one billion people, Thomas Malthus published the idea that human population increases at a geometric rate (i.e. 1, 2, 4, 8, 16 . . .), whereas the food-supply grows at an arithmetic rate (i.e. 1, 2, 3, 4, 5 . . .). More disturbingly, he proposed that, if population growth were unchecked, a "gigantic inevitable famine stalks in the rear, and with one mighty blow levels the population with the food of the world."[1]

In ecological terms, Malthus might have illustrated his grim prediction with a simplified growth-overshoot-collapse graph (Figure 10–1 on page 100). This describes any very rapidly growing population, such as yeast in grape juice, eventually exceeding the carrying capacity of its environment and then even more rapidly declining. Carrying capacity is basically the population of a given species that can be maintained indefinitely in an environment. It is determined mainly by food supply but also by habitat or physical space and by the environment's ability to absorb the waste products of the species in question. There is a brief "fool's paradise" called overshoot, during which the population continues to grow despite having gone past the point of equilibrium with its food supply. This is akin to the cartoon character running off a cliff but not falling for a second or two until he looks down, by which time it is, alas, too late for any course corrections.

Obviously providing secure access to a well-balanced diet for billions of people is a

1 An Essay on the Principle of Population, As It Affects the Future Improvement of Society, with Remarks on the Speculations of Mr. Godwin, M. Condorcet, and Other Writers Malthus, Thomas Robert 1798 London

Bitter gourd *(Momordica charantia)*

prodigious undertaking. Not only are there now more people alive than ever before, but they are living much longer and they are demanding more foods higher up the trophic pyramid.

As Malthus and later Paul Ehrlich, of *The Population Bomb* fame, found out, predicting doom is a tricky business. Timing is critical. Is it possible that these oft ridiculed projections of population growth disaster were right in essence and only the time of the inevitable collapse was wrong? That depends on your viewpoint.

Shrugging off the warning are those with the cornucopian worldview. This is the belief that human ingenuity is limitless and will continue to find ways to feed the growing population as it has in the past. This belief is largely rooted in the capitalist concept of supply and demand, which posits that when the demand for food exceeds the supply, the price will rise and generate sufficient motivation for innovators to increase the supply. In this view resources do not run out, they simply become more expensive. There are some flaws to the logic, such as the difficulty of expressing demand for food when one has no money; but overall, innovation and industry do have an impressive record of increasing food supply to match rising population. The rapid advances of the computer industry are often cited as an example of how innovative an industry can become when the financial motivations are unencumbered.

This cornucopian view is countered by a more constrained belief that we are approaching some very real limitations to the continuing growth of human food supply imposed by finite natural resources. This view came into public awareness with great fanfare when Donella H. Meadows published *The Limits to Growth* in 1972.[2] The author of this influential book argued that at the current rate of usage many key natural resources would be seriously depleted within a hundred years, and economic growth-including the growth of food supplies-could not be sustained. This opinion is probably most strongly presented today by the "peak oil" movement. They argue that industrial agriculture and global food systems have become totally dependent on cheap petroleum, and that dramatically higher oil prices will shrink economic productivity and shrink the pool of capital needed to create post-petroleum agricultural and food distribution infrastructure. This viewpoint certainly became more compelling with volatile crude oil prices reaching $150 a barrel and grain prices tripling between 2000 and 2009, setting off food riots in dozens of countries. The frantic investment in food production innovations indicates that historically high food prices are indeed good motivators. Time will tell how well the cornucopians rise to this latest challenge.

Wherever one falls along this continuum of speculation between the cornucopia and the limits of growth, it has become very difficult to imagine that the world's human population can continue feeding itself for long using the same systems that are currently being employed. Two radically different strategies are confronting the daunting challenge of re-making the world's food systems.

THE FURTHER INTENSIFICATION OF INDUSTRIAL FOOD PRODUCTION

Farms would become computerized biological factories growing a few genetically engineered crop and animal varieties. These outputs would become the feedstock for centralized processing operations where most of the food we eat would be manufactured. This strategy stems from a functional view of Nature as a provider of valuable goods and services. In its more enlightened forms it accepts that ecosystem services should be more accurately accounted for and protected for their economic value. In this view food is a commodity that should be produced efficiently, as with any other commodity business. Labor costs are minimized. This basic strategy requires a belief in human capability to maintain centralized control.

2 *The Limits to Growth* by Donella H. Meadows, Dennis L. Meadows, Jørgen Randers, and William W. Behrens III. Signet (October 1, 1972), ISBN-10: 0451136950, ISBN-13: 978-0451136954

ECOLOGICAL AGRICULTURE IN ITS VARIOUS FORMS

This approach would have much smaller farms with many more farmers. Gardening would also make major contributions to the food supply. The biological sciences would contribute to the craft of local production and simple processing of food. This strategy has roots in the recurrent Arcadian ideal, expressed by Thomas Jefferson and many others, of harmonious compromise between Man and Nature or between the Wilderness and the City. It requires affection for nature, neighborliness, and modest material demands. From this perspective food is the most basic connection between Nature and people. Labor costs are higher. This basic strategy relies on decentralized control and adaptation.

The differences between these two basic strategies for adapting our foods systems are so profound and contentious that is difficult to discuss the future of food without further examining the worldview behind these two camps. Although the industrialization mode is clearly dominant at this point, there seems to be increasing enthusiasm for both approaches as they wrestle for hearts, minds, and market share. The rapid increase of genetically engineered foods and mega-stores, and the parallel rapid growth of organically grown foods and farmer's markets illustrate these alternate views of our food future.

GENETICALLY ENGINEERED ORGANISMS

Modern biotechnology and DNA sequencing have allowed increased speed and precision in plant and animal breeding techniques. Where conventional breeding shaped the somewhat random movement of thousands of genes within the limitations of sexual reproduction, genetic engineering can transfer specific genes between organisms, even between organisms of very different species.

Proponents of genetically modified organisms (GMOs) argue that this increased level of genetic control will both increase food supply and be a boon to our natural environments. The most important trait currently inserted into food plants by genetic engineers is resistance to herbicide in soybeans, corn, and rape (canola). This not only reduces labor cost in food production, it enables farmers to do less tilling of their land, which in turn reduces the amount of soil that is eroded. Another important GMO trait in food crops is increased resistance to insect damage. This is usually conferred by inserting genes from the soil bacteria family of *Bacillus thuringiensis* (Bt)[3]. Because these crops have insecticidal properties from the bacteria,

3 *Bacillus thuringiensis* (Bt) is a naturally occurring bacterial disease of insects. It was discovered in 1911, but not commercially available until the 1950s. It is safe for most non target organisms including humans, and beneficial insects, and has been widely used by organic agriculture, especially for protecting vegetables crops.

Dock *(Rumex spp.)*

they require less insecticide. A genetically modified crop that has received considerable attention is "Golden Rice." It has been modified to greatly increase its level of beta-carotene. Reducing soil erosion, insecticide use and vitamin A deficiency all sound promising to environmentalists.

Despite the promise, however, the rapid deployment of genetically modified food crops violates several of the key principles of ecologically sound food systems. While the public has remained openly suspicious of genetically modified foods and many respected biologists have urged greater caution, a few multinational corporations have lobbied vigorously to get sales permits for their products. They have succeeded to the extent that after little more than a decade, over 280 million acres worldwide were planted in GMO crops in 2007, about half of them in the United States.

The core problem with GMO crops is reductionism. Ecosystems are by their very nature extremely complex entities that develop gradually over many generations. New biological forms are usually tested slowly in natural systems so that any potential problems have time to emerge and to be addressed before wholesale changes are made. The history of inadvertently introduced invasive species such as Asian chestnut trees and kudzu into the Americas or cats in Australia should give any reasonable person pause before assuming millions of acres of GMO food crops won't have any unintended consequences.

Although we have not yet identified any catastrophic dietary problems, such as new allergens, we are already seeing numerous unintended negative consequences to the food ecosystems upon which we will all depend for the foreseeable future. Fields planted in GMOs have significantly less biodiversity than traditional crops.[4]

Neither is it surprising that the big benefits of the herbicide resistance and of the Bt insecticide are already beginning to diminish. Profitability and yield of most current GMO crops are closely tied to the fact that they can withstand glyphosate herbicide, and their competing weeds cannot. An estimated 85–90 million pounds of this herbicide is used each year in the United States alone, to reduce competition from weeds and to reduce the labor costs of keeping crops relatively weed free.[5]

Worldwide glyphosate use is also soaring as transgenic soybeans, corn, canola, and other crops are increasingly sown. Unfortunately, at least six weeds, including ragweed and pigweed, have already developed some degree of genetic resistance to glyphosate, the key ingredient in Monsanto's RoundUp herbicide. By the summer of 2009 this problem was already reaching catastrophic proportions in the southeastern US, where herbicide-resistant Palmer amaranth is making cotton harvest nearly impossible, and threatening soybean fields. It is very likely that other weeds will soon become resistant to RoundUp, in a manner reminiscent of the development of antibiotic resistance in many common disease bacteria.

A similar situation is unfolding with food plants that have been genetically modified for insect resistance, by the insertion of Bt genes. Now that the Bt gene is presenting itself in enormous monocultures, insects are quickly beginning to develop resistant strains through natural selection. The diamondback moth, a serious pest of plants in the cabbage family, has already shown significant resistance, and no doubt other pests will soon follow that lead.[6] This overuse of Bt in genetically modified seeds will likely render one of our most effective integrated pest management tools ineffective. This will be a serious blow to organic agriculture.

Despite these warning signs, the acreage planted in GMOs is still increasing by millions of acres per year. Consumers, however, do not yet share the farmers'

4 This is not surprising given that all but the target plants are generally killed with herbicide. This leads to fewer birds, bees, butterflies, and other creatures that pollinate crops and hold pest populations in check.

5 US EPA 2000-2001 Pesticide Market Estimates

6 *Sustaining Life: How Human Health Depends on Biodiversity* by Eric Chivian and Aaron Bernstein, Page 393, Oxford University Press, USA; Ill edition (June 2, 2008), ISBN-10: 0195175093, ISBN-13: 978-0195175097

fervor for the designer foods. Most public opinion polls, especially in Europe, have shown that the majority of people would rather not eat genetically modified foods. Rather than convincing the public to embrace their genetically modified foods, it seems that the industry is now trying to get people to simply accept that much of their manufactured food already contains GMOs and there is little they can do about it.

Certainly some of the resistance to GMOs is generated by the arrogance and aggressiveness of the handful of corporate giants currently profiting from them. Below that level there is an instinctive reaction to the intellectual property aspect of the GMO industry. While the big bioengineering companies argue that their investments in the research must be protected, the idea that a company can outright own forms of life does not sit comfortably. Wes Jackson, of the Land Institute in Kansas, delineated the difference between the bioengineering viewpoint and the ecological viewpoint with this question: "Should a crop plant be regarded more as the property of the human or as a relative of wild things?" The question itself acknowledges that most of the development of crop plants and animals was evolutionary with no human involvement. This critique sees the bioengineers as tweaking an organism's DNA in a minor way, then claiming ownership.

ORGANICALLY GROWN FOODS

Organic agriculture is a term that came into use in North America, Europe, and Japan in the 1940s and 50s to describe a method of growing that avoided the use of synthetic fertilizers and pesticides. Initially much of the motive for organic agriculture came from consumer suspicion about pesticides, a suspicion that has still not disappeared. By the 1970s several organizations began programs to certify food as being organically produced. This was intended to reassure consumers that they were actually getting the products they were generally paying a premium for, and to reassure farmers that the extra effort they put into growing food organically would be rewarded. There are now hundreds of organic certification programs throughout the world, including a national program in the United States overseen by the Department of Agriculture.

While not quite matching the explosive growth rate of the GMO acreage, organic food is nonetheless a dynamic force in world agriculture, with an estimated 96 million acres planted in organic crops in 2007. Economically it is even more impressive because the organic produce draws a premium price, while the genetically modified crops are usually added to cheap animal feeds. Sales of organic produce have been increasing by over 20% a year from 1990 through 2009.

Butterfly pea *(Clitoria ternatea)*

Red Russian kale *(Brassica napus pabularia)*

There are several differences between organically grown food and food grown with synthetic fertilizers and pesticides (sometimes called conventionally grown, despite the relatively recent emergence of this type of agriculture). Organically grown food, as one would expect, has lower levels of pesticide residues. This is a critical concern for many consumers, especially those with children. Because their bodies are rapidly making new cells, young children are the most vulnerable to problems from pesticides. Organic produce also tends to be somewhat richer in iron and vitamin C, as well as several phytochemicals that play a beneficial role in fighting disease.

Flavor differences between the two types of agricultural produce are less pronounced. Most blind taste tests have shown people have trouble telling which foods are organically grown and which aren't. On the other hand, people can tell the difference between varieties of produce, for instance a red delicious apple and a Cortland apple, and organic growers tend to grow more different varieties of fruits and vegetables.

The biggest differences between organic and conventional agriculture, however, show up not on the table, but in the land. Organic farms are much more biodiverse landscapes. Compared to conventional farms, they typically have much higher populations and more varied species of birds, reptiles, amphibians, mammals, insects, and especially soil organisms. They are much more likely to produce a variety of crops and to use polycultural methods such as alley cropping, rotations, cover crops and fallows than their conventional counterparts. Smaller farm size combined with greater retention of forested land on the farm margins, mixed crop and livestock systems, and the prohibition of most pesticide and soluble fertilizers are thought to be the primary factors resulting in the greater biodiversity.

The perception that organic agriculture is a quaint and outdated way of producing food is itself quaint and outdated. Cutting edge organic agricultural research is being carried out at many research institutions and on thousands of farms and gardens. For example, using custom made charcoal to stabilize soil carbon and help lower atmospheric carbon levels is an important area of investigation. Use of microorganisms to stimulate plant growth is another promising branch of organic research. Mychorrhizal fungal inoculants, phosphate solubilizing bacteria, and actively aerated compost tea are all techniques for using specific microbes to make soil nutrients more available to plants. Very often it is both cheaper and more ecologically sound to work with microbes to unlock nutrients already in the soil than to purchase manufactured fertilizer.

The energy use on organic farms per acre and per unit of food produced is typically 30% lower than conventional farms, largely because of the high energy demand in making synthetic nitrogen fertilizer. This could become a bigger factor in the near future as rising costs are increasingly driving up world food and fertilizer prices.

Organic farms tend to be smaller and, in the US, their operators are about ten years younger on average. Soil erosion is significantly lower on organic farms, as is contamination of water with pesticides and nitrates. The soil on organic farms holds more water, which reduces the frequency and severity of flooding and droughts. This gives farmers a degree of protection from the destructive cycle of boom and bust years.

Organic soil also locks more atmospheric carbon into stable compounds. The amount of carbon in the soil is several times greater than the carbon in the atmosphere and in vegetation. Agricultural practice determines whether the food producing soil is a "source" or "sink" for atmospheric carbon dioxide. Organic agricultural techniques, including cover crops, compost, and grass-fed beef tend to greatly increase the stable carbon compounds, especially glomalin and humus, in the soil. According to USDA research the organic matter increasing and soil building capability of organic agriculture significantly exceeds even that of the heavily promoted no-till techniques.[7]

Not only does this improve the soil's water and nutrient holding capacity and buffer pH and salinity, but it can also reduce greenhouse gas emissions, compared to conventional agriculture. The increased carbon in organically managed soil reduces the negative impact of farming on global warming. Overall the ecological footprint tends to be smaller with organic agriculture and the relationship with the environment more benign than with conventional agriculture.

What are the downsides to organic agriculture? The two problems cited most often are reduced yields and increased labor requirements. Some studies have shown that organic farms yield only about 80% of what conventional farms yield per acre in the United States and other industrialized countries. With demand for food rising rapidly, some observers don't believe organic agriculture will be able to adequately feed the world. These types of statistics naturally vary a great deal depending on the motives of those generating them.

A closer look at yield figures shows that switching to organic is actually likely to increase yields somewhat in developing countries while decreasing them slightly in more industrialized ones. This is likely a function of the improved soil health under organic regimes in areas where farmers can't afford large inputs of soluble fertilizers. The increased yields in the less developed countries might be more important to actually making sure people get enough to eat than reduced yields in the rich countries, where so much of the agricultural output goes to animal feed. There is also some evidence of yields declining rather sharply during the transition to organic and then rebounding to close to conventional yields after a few years. This is a complex and politically charged issue and one can find statistics to back either position.

What is not in question is that labor costs tend to be higher on organic operations. This factor has provided the greatest motivation for switching away from traditional organic agricultural methods as agri-chemicals became available. The more complex systems for maintaining soil fertility and for managing weeds and pests result in more time demands for the organic grower. From the consumer viewpoint, the biggest drawback to organic agriculture comes at the checkout counter where prices are consistently higher, up to 50% higher.

Skeptics often portray organic agriculture as if it were a radical and unrealistic fantasy capable only of overpriced salad greens. The reality is that our bodies evolved eating wild organic foods. Humans

7 Teasdale, John R., "No Shortcuts in Checking Soil Health", July 2007 Agricultural Research magazine, United States Department of Agriculture,

have been successfully practicing agriculture for 10,000 years. For 99% of that time we have used exclusively organic methods. It is "conventional" petroleum based agriculture and biotechnology that are radical new techniques.

At the extreme end of the anti-organic spectrum some people view organic agriculture as unethical and dangerous, claiming that 2 billion people would be left foodless if we were to stop using synthetic nitrogen fertilizer. While there would certainly be some rough patches in making a transition away from conventional petroleum based farming, organic agriculture covers an enormous spectrum of techniques. Given better research and greater support for training, these organic techniques could be adapted to incrementally replace conventional methods.

If we truly are unable to feed the human population without rapidly destroying the natural resource base of food production and driving half our fellow species to extinction, we are simply saying that we have exceeded our carrying capacity. Populations adjust to food supply. Mainly through increasing energy inputs from fossil fuel, food supply has expanded remarkably over the past sixty years. Human population more than doubled during that time to keep pace with the increased food supplies. The success of the industrialized food system in feeding this growing population has fostered technical optimism. As fossil fuels, irrigation water and new farm land become scarcer; the idea that nine billion humans can be sustained indefinitely may come to appear unreasonable.

On the other hand, if we are able to create a sustainable food system, the human population will no doubt adjust to it. We are faced with two daunting global food quandaries: First, how do we quickly make a transition to a food system that minimizes damage to natural ecosystems without undue human suffering? Secondly, how do we achieve a long lasting equilibrium between a sustainable food system and a relatively stable human population?

Simplistic free market capitalism and its handmaiden, reductionist science, may prove to be instruments too blunt for the creation of a durable and ethical food system. Perpetual growth and total control are infantile illusions. We need less powerful and more elegant solutions to our food problems. An elegant technology is one with a high ratio of output to input and a minimum of unintended consequences.

This is where biology shines. Spurred on by competition for limited energy, nutrients, water, and space, living beings have developed an astonishing library of elegant designs. Those natural designs that prove themselves to be sustainable, usually demonstrate flexibility, adaptability, and creativity; traits that human food systems will also need to become more sustainable. The bio-luminescence of fireflies, the strength of spider webs, and the beautiful hard finish of mother-of-pearl are examples of elegant natural technologies that use little energy and create little waste. Bio-mimicry is the hugely promising new field of imitating some of these elegant natural designs to achieve efficiencies in manufacturing products such as bullet-proof vests, adhesive tape and breathable waterproof fabrics.

In the long run-and agriculture was never a sprint-weeds and insects are best managed with an integrated system that relies on careful observation and the least intrusive interventions that will get adequate results. Fertility is best managed by maintaining vigorous soil ecology. These strategies take more time to yield results and require more labor or, if you prefer, less unemployment. Beyond bio-mimicry is the realm of eco-mimicry or designing whole systems that imitate the elegant self-supporting interplay of species in mature ecosystems. This is the most promising direction to look for guidance in building a truly sustainable agriculture.

Those who are inspired by a model other than Nature, a mistress above all masters, are laboring in vain. *—Leonardo da Vinci*

CORPORATE SEEDS

US-based Monsanto is by far the largest seed company in the world. It is also the most aggressive and successful promoter of patented, genetically modified seed. These are seeds that have been genetically engineered to have new traits. When farmers or gardeners buy Monsanto genetically modified seed, they have to sign a contract that forbids them from saving any of the seed from their crop to plant the next season. Saving seed has been a common agricultural practice for thousands of years, but Monsanto requires farmers to buy new seed from the company every year. An estimated 87% of the total area planted in genetically engineered crops in 2007 was sown in Monsanto seeds (or seeds under license from Monsanto).

In addition, Monsanto is the largest producer of herbicides, chemical compounds that are used to kill weeds, in the world. This is not just a coincidence. Over 80% of the world's land planted in genetically engineered crops has at least one genetic trait for herbicide tolerance. Herbicide resistant plants so dramatically reduce the labor costs for producing crops that it is already difficult for farmers to compete without using them. Selling patented genetically engineered seed that can't be saved by farmers or gardeners as well as herbicide that kills everything but the plant from their seed, Monsanto has profoundly altered the nature of agriculture.

Closer to your kitchen table, Monsanto and Dole have recently begun a joint venture to produce genetically modified vegetable seeds in the US. Dole is the largest producer of fruits and vegetables in the world, producing and selling over 200 products in 90 countries. Their joint effort will start with trying to improve the nutrition, flavor, color, texture, taste and aroma of broccoli, cauliflower, lettuce and spinach through genetic engineering. According to David Stark, vice-president of consumer traits at Monsanto, "The consumer wins because Dole's market knowledge combined with our research and development capabilities will help bring new healthy and flavorful products to consumers." This is a shift from earlier genetically modified crops that were mainly used to produce cotton and animal feeds, rather than familiar garden vegetables.

"Consumer" is the corporate term for what we used to call citizens. Consumers shop; citizens participate. To Monsanto the seeds of our food plants are just another product, like buttons, cigarette lighters or can openers. Assurances that the genetically engineered foods are perfectly safe are beside the point. A single corporation whose sole purpose is to earn money quickly for its stockholders should not be allowed to usurp thousands of years of painstaking agricultural work or millions of years of evolutionary history. Declaring that life forms can be the intellectual property of corporations is a profoundly bad idea.

Seeds are inherently far too important for Monsanto to monopolize. Wherever people have ventured they brought with them the seeds of their food plants. Explorers, pilgrims, pioneers, immigrants and slaves all traveled with the best of their seeds tucked away safely. Seeds are both the symbol and the embodiment of our future. They deserve our deepest respect if not our affection.

This was the goal of the leaf and root.
For this did the blossom burn its hour.
This little grain is the ultimate fruit.
This is the awesome vessel of power.
—George Starbuck Galbraith