CHAPTER 1

Toward a Permanent Culture

Life — all life — is in the service of life. Necessary nutrients are made available to life by *life in greater and greater richness as the diversity of life increases. The entire landscape comes alive, filled with relationships and relationships within relationships.*

—Frank Herbert, *Dune*

Prologue

Vast challenges face our relationship to our planet. Although these challenges are now topics on the evening news, they are not new. Many people have been working for decades to alert the general public to the myriad human-caused environmental problems and social and economic inequities, that are, in a word, unsustainable.

To the student of permaculture, problems are signposts pointing to solutions. Permaculture attempts to find solutions in cultural and ecological systems rather than technology. The environmentalist adage that technological solutions breed new technological problems has proven true. The converse can be true of ecological solutions. Thoughtful application of ecological design for problem solving can set in motion regeneration of soil, watersheds and local ecosystems that in turn help heal regional and global environments.

It is easy to forget that everything *is* connected. The choices we make in how we grow and sell our food, the energy we use to produce our products, and the way we manage our diminishing resources all have effects for the entire planet.

All the tools and information needed to design and plan sustainable communities are available now. The question is whether we decide to use those tools or not. And the consequences won't affect only us. As developing nations seek to emulate Western culture, Western culture

needs to demonstrate stewardship based on scientific understanding and environmental consciousness.

One cannot predict what a long-term sustainable future will look like. But we believe it will be rooted in the land. It will come as an organic outgrowth of a rekindled dynamic relationship between people and their landscape. The book in your hands is intended to be a tool for those who want to participate in the continuing evolution of a sustainable society.

Book Outline

This book is roughly divided into two parts. The first part, chapters 1 through 6, introduces permaculture concepts and methods for designing a permaculture market garden farm. The second part, chapters 7 through 15, provides a detailed study of permaculture design applied to Three Sisters Farm's activities, landscapes, and the bioshelter.

This first chapter introduces the concept of a sustainable food system and permaculture design with a first look at Three Sisters Farm. Chapter 2 examines issues relevant to safe, healthful and secure food systems. Chapter 3 looks at marketing options and strategies for the small farm. (Note that in this book the word "marketing" does not mean advertising. For us "marketing" and "selling" are almost interchangeable, but the word "marketing" evokes our role as farmers who produce crops to sell at a particular community's local *market.*) Chapter 4 details the use of permaculture to design and plan a small-scale, year-round, intensive farm, with staged development. Chapter 5 looks closely at sustainable energy systems on the farm. The final introductory chapter, Chapter 6, presents ecological strategies and methods for controlling pests and disease.

Chapter 7 and 8 begin a closer study of Three Sisters Farm, looking at the details of farm design and management, crops and tools and seasonal work cycles. Chapters 9 and 10 finally come to the study of bioshelter design and management. A bioshelter is essentially a solar greenhouse managed as an indoor

ecosystem. Our bioshelter is the heart of our farm, and the preceding chapters provide the necessary context for understanding its role on the farm. Chapters 11 and 12 examine details of the role of compost and chickens in the bioshelter and on the farm. Chapter 13, "Permaculture for Wetlands," is offered as a tool for preserving wetlands and learning to use the special capabilities of wetland plants in our landscapes. Chapter 14 presents the farm as an education center, both as a source of revenue and as a service to the community. And finally, chapter 15, "Knowing Home," and the epilogue look at the ongoing development of the farm and the application of permaculture to our own homestead. The appendix provides facts and figures related to solar design.

Five Acres and Interdependence

Three Sisters Farm began as a five-acre field of bare soil and corn stubble. The soil was good silt loam, but had been depleted of life and nutrients by decades of conventional agriculture. A scrubby tree line on the abandoned barbed wire fencerow defined the space but added little diversity. The year was 1983. We were starting with a clean slate. On this open field, we could put into practice the permaculture theory we wanted to explore. Our youthful idealism was influenced by philosopher Stephen Gaskin, of The Farm, an intentional community in rural Tennessee. To paraphrase Gaskin's Zen-inspired directive, "If you see a problem, you probably should fix it." Thus empowered, we began our preparations to become part of the solution — as permaculture market gardeners.

The chapters that follow provide a narrative of the changes that have occurred in this small field since 1983. Though our work is framed by human intent, our palette and canvas is provided by nature. As we've followed an unfolding vision of what we wanted the farm to be, we have been guided by the principle of caring for the earth so she will care for us. Our farm has been an experiment in permaculture design. And it has been an attempt to forge a right livelihood out of the universal struggle to survive and prosper.

This book functions on several levels. While it closely examines Three Sisters Farm and the bioshelter concept, it also presents a broader picture of sustainable food systems and the larger role farms can play in a sustainable society. Three Sisters is just one regional project among many. In this book, I also examine the work that others are doing

developing gardens, landscapes and bioshelters, and integrating community and educational activities into the farm plan. There is a growing momentum toward the development of sustainable food systems. People of all ages, but especially young people, are drawn to a life closer to the earth and closer to the source of fresh food.

The Value of the Small-Scale Farm

The small-scale intensive farm can offer many benefits to a community and a region: food security is enhanced, organic matter and excess fertilizer are removed from the waste stream, healthy soil is built, streams are cleaner, and groundwater is recharged. The organic farm, with its diversity of crops and other plantings, enhances local biodiversity and helps create and preserve critical habitat for wildlife, especially birds and pollinating insects. Farms offer jobs and training. They can also engender many related enterprises, including craft production and value-added processing. The small-scale intensive farm can offer a pleasant space for social gatherings and community events, and there are many opportunities for educational activities and for reconnecting the community to the earth. Local culture as a whole is enhanced when local foods are available, events are seasonal, and people have direct access to nature and agriculture.

Food

Fresh, local, and organic food should be accessible to everyone. The fact that this is a political statement is unfortunate. "Be on good terms with all people," say the great teachers. But declaring oneself organic apparently implies that something is wrong with how the "conventional farmer" farms. Similarly, to promote the superiority of fresh, local food somehow impugns the entire food industry and the global economy. Although it's true we would prefer that no one use chemical fertilizer, herbicides or insecticides, we know that national and international trade is here to stay. And we recognize and applaud the moves toward more sustainable agriculture that many conventional farmers are making.

What we *do* mean to imply, or rather, to state clearly, is that much of our food can be produced locally, in a manner that helps preserve and heal the planet, build strong communities and make us healthier in the process.

Biodiversity

We live in a world of expanding populations and diminishing natural resources. A changing climate is putting further stresses on the natural world. As wildlands continue to be developed, remaining habitat becomes ever more critical to the health of the planet. We can address these issues through thoughtful and informed land use. The ecologically designed agricultural landscape is a contribution to the preservation of natural habitat and biodiversity.

Spring Peepers.

Protecting biodiversity includes protecting the quality of water in our streams and rivers, preserving critical habitat and undeveloped wildlands, managing forests sustainably, using and preserving native plants in our landscapes, protecting native pollinators and promoting habitat for the entire web of the natural world. Nature is the matrix within which we must develop our production systems.

Education

A farm is a valuable educational facility that offers many different types of instruction — organic gardening, diet and nutrition, nutrient cycling, diverse agricultural enterprises and the farm's interconnection with the natural world. Many young people seek internships on working farms to learn the trade. Home gardeners seek out advice and opportunities to learn. At a farm, children can learn to love the earth and begin to understand its processes. It all begins with personal contact with nature. All of these things are services the farm can provide to a community while at the same time earning income to keep the farm viable. As visitors learn the value of the farm on the landscape and of fresh local food in their diet, they become customers of the farm.

Creation of Sustainable Local Food Systems

Challenges to the revitalization and re-creation of regional food systems are many — and formidable — but they are not insurmountable. The economic viability of small farms is the foremost challenge. Competition

Benefits of Small-Scale Intensive Agriculture

- Food security
- Employment
- Nutrient cycling
- Biodiversity
- Pollinator preservation
- Water cycling
- Education
- Social space for gatherings
- Building a local food system
- Right livelihood in a community
- Sustainable food systems

with global food systems requires creative design, management and marketing. Start-up cost support and innovative partnership funding is often required. Other issues include access to land and resources, zoning and tax laws, insurance costs and the seasonal nature of most farm incomes. Because we are in the process of re-creating local and regional food systems, there are many missing links in support structures and market access.

Making a living from agriculture has always been difficult. One is dependent on the weather, the market and the quality of the labor force. All are variable. Because cash flow is seasonal and not always dependable, most agricultural enterprises rely on the farmer to wear a lot of hats. Besides being able to plan and manage crop production, soil fertility and other farm resources, the farmer needs to be a capable mechanic, carpenter, electrician, plumber, supervisor, planner, accountant, marketer, office manager — and gardener. An organic and permaculture farmer also needs to be an ecologist, an ecological designer and planner, a natural builder and an alternative energy specialist. Knowledge about regulations for organic certification, compost management, health and safety requirements and tax codes also is required.

Farming is rightfully said to be a lifestyle choice. You do not get rich farming, but you can profit in many ways. People are drawn to a rural lifestyle to be close to nature, to benefit from the slower pace of traffic and life in general and to engage in the care and nurturing of plants and animals. However, you need more than to eat well and have a roof over your head and shoes on your feet. Because health care and education are primary needs for most families, the majority of small-scale farmers are either part-time farmers or they have other income. Many people retire on a pension or savings account to become market gardeners as a second career. Part-time, seasonal work or a working spouse is often inevitable for the small farmer trying to compete with the global economy.

A local food system that truly supports the sustainable farm's economic viability requires not only creativity and innovation but also the support and assistance of community leaders, local government, national policy and consumers.

In a very real sense, a return to regional food systems is a return to life of a century ago. Home food systems, supported and supplemented

by neighborhood farmers markets, grocers, butchers, and the milkmen, fed the nation well. As we attune to the role of being good earth stewards in our daily lives, we will see the value of lower energy-use models of the 18th and early 19th centuries.

All these issues are examined in the chapters ahead. The picture I portray, of a diverse agricultural enterprise, demonstrates permaculture farms' role in the regional food system and local community.

In the sustainable society we seek, each farm will be unique, with its own mix of crops, enterprises and relationships. To achieve this sustainable society we will need many more small-scale farmers, literally one in every neighborhood. Farmers will need stable, profitable markets and the organizations and infrastructure to support a diverse and economically viable local agriculture. The issues are complex. Many gaps in local food systems and many disconnects in our modern lifestyles discourage both local consumers and producers. However, as discussed in the next chapter, many groups and agencies are working to promote a resurgence of local agriculture.

Integrated Systems: Permaculture Design

Permaculture (a.k.a. permanent culture or permanent agriculture) is a system of land-use planning that incorporates concepts of ecosystem dynamics, ecologically appropriate technologies and an ethic of care of the earth into a comprehensive design system.

Permaculture is also a growing and evolving network of individuals and organizations. Practitioners of permaculture are dedicated to searching for, creating and exploring sustainable solutions to the dilemma of our confused human relationship to the natural world.

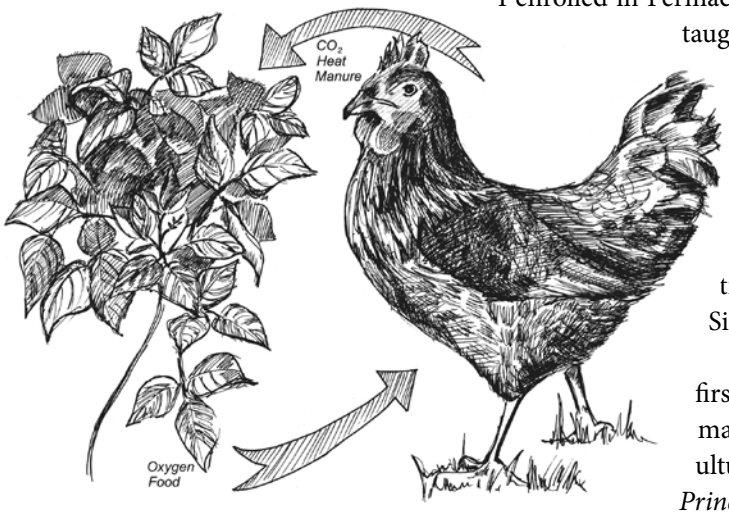
My study of permaculture began in 1981, when I read an interview with Bill Mollison in *Mother Earth News.* Mollison described in detail a system for the design of agricultural ecosystems. He succinctly explained the concept of permaculture and summarized its main goals and principles, presenting a way for modern societies to rediscover cultural links to a healthy landscape. This is done by designing our homes, towns and regions with an understanding of ecology, energy dynamics and a logical ethic of caring for the earth — so it can care for us.

This system was first articulated in the book *Permaculture One,* which Mollison co-authored with David Holmgren, and further

developed in *Permaculture Two*. In the 1980 *Mother Earth News* interview, Mollison stated that the essence of permaculture was to "apply the principles of environmental science to our production systems." In explaining the permaculture concepts of designing integrated systems, that is, of placing design "elements" into functional relationships to maximize productivity, Mollison presented the idea of combining a chicken coop, a forage yard and a greenhouse. Such an integration sets up ecological relationships: the exchange of oxygen and carbon dioxide; a nutrient cycle between plants and poultry; and poultry regulating their own temperature by being able to move outside during the day and inside at night.

Reading this interview forged new synapses in my mind, connecting many lessons of homestead management that my wife, Linda, and I had been learning from rural neighbors. I immediately knew I wanted to be a permaculture design consultant. For the next six years we did a thorough study of permaculture, beginning with the references Mollison and Holmgren used to write *Permaculture One* (first published in 1978) and those Mollison used in *Permaculture Two* (published in 1979). We studied ecology, design, native and useful plants, landscaping, and many other facets of sustainable design. In 1984, we began to specifically apply permaculture to the development of the land that became Three Sisters Farm and the ten-acre property our house was on. In 1986 I enrolled in Permaculture Design at Slippery Rock University taught by teacher, writer and publisher Dan Hemenway. This intensive course was a three-week, 120-hour class that provided an in-depth study and the opportunity to apply the permaculture design process. After my completion of the course work, Linda and I were re-invigorated to continue work on the development of the Three Sisters Farm property.

Illustration of chicken and bioshelter exchanges.



In the years since Mollison and Holmgren first articulated the principles of permaculture, many voices have been added to the permaculture design field. In 2002, in *Permaculture: Principles and Pathways Beyond Sustainability,*

David Holmgren redefined the field with his 12 permaculture design principles. The principles built upon and expanded the literature on permaculture design.

Permaculture design has spread globally. The pages of *Permaculture Activist,* published in the US, and the UK's *Permaculture Magazine* feature the work of hundreds of permaculture designers around the world.

Ecological Design

In the course of our studies, we soon learned about the developing field of ecological design. As with permaculture, ecological design draws its inspiration from nature and ecology. But, whereas permaculture was a grassroots effort that hadn't yet reached academia, ecological design as a field was already developing in colleges and universities and through the work of progressive architects and research institutes. Among these was the New Alchemy Institute on Cape Cod. Happily, the New Alchemists thoroughly documented their work in aquaculture, bioshelter design and sustainable agriculture in their journals, quarterly newsletters and several books, so there was solid information available.

A number of authors have developed principles of ecological design as tools to guide planners. John Todd and Nancy Jack Todd, writing in *From Eco-Cities to Living Machines: Principles of Ecological Design,* defined ecological design as "design for human settlements that incorporate principles inherent in the natural world in order to sustain human populations over the long span of time." They present nine "Precepts for Emerging Biological Design."

William McDonough, with Michael Braungart, developed a set of ecological design principles known as the Hannover Principles. These ten principles offer concepts to consider as design criteria. Fundamental to the Hannover Principles is the need to evaluate materials, and designs to reduce and eliminate negative environmental impact.

The Ark Bioshelter at New Alchemy Institute. Original design.

Earle Barnhart

McDonough has also spoken of the need to keep the products of technology away from the natural world. The products of technology tend to disrupt and degrade the natural world, but they are too valuable to waste by allowing them to simply become pollutants. In effect, he calls for two "nutrient" cycles, one that produces and recycles the products of technology and industry, the other the natural biological cycle that nurtures life.

Sym Van der Ryn, with Stuart Cowan in their book *Ecological Design* call for design that focuses on *local* solutions implemented by *local* people using *regional* materials. Their approach necessitates an understanding of the surrounding environment and nature's processes.

These various approaches to ecological design have many similarities: a call for human-scaled and socially equitable planning, a need to set the design in the local and bioregional landscape, and the need to reduce negative impact on the biosphere. Beyond the need to reduce negative impact, ecological design calls for our buildings and landscapes to become integrated into and actually enhance the surrounding environment.

Since the 1980s, ecological design and permaculture design have become intertwined. Permaculture is taught at colleges and universities. Permaculture designers and teachers have integrated various schools of sustainable and ecological design into their work. In turn, the field of ecological design has borrowed from permaculture concepts.

In this book, the terms *permaculture, sustainable design* and *ecological design* are used interchangeably. Both permaculture and ecological design are young fields. As new understanding of ecology and nature emerge and new insights into sustainable resource management develop, permaculture design continues to adapt and expand. Principles and concepts of sustainable design are tools, rather than dogma. Humility regarding the limits of our knowledge about nature's processes is perhaps the most critical principle in permaculture design.

Sustainability

I once heard a Pennsylvania state energy official tell a group: "Sustainability is a society living in harmony with nature forever." But what does *sustainable* really mean and how can we achieve it?

Webster's defines "sustainable" as relating to a way of using a resource that does not permanently deplete or damage the resource.

In 1987, The United Nations' World Commission on Environment and Development (known the Brundtland Commission) presented this definition: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Sustainable design, therefore, is design that focuses on sustainable *resource management* for any development project. Planning for sustainable development requires an understanding of the ecology of the region and the human impact on the local and planetary environment. In our global society, daily choices we make in our consumption can affect the entire globe. In a search for sustainability we have two needs: first, to live within our region in a manner that honors and protects its diverse ecology; and second, to choose goods, technologies and fuel that will keep the global ecology healthy. As the developing world seeks a Western lifestyle, it falls on Western countries to lead the way to a more ecological, truly sustainable way of life. As environmental educator and author David Orr has shown, we would need four planet Earth's for all humans to live as we do in the United States. We have a choice: to fight a global battle over diminishing resources, or to join a global effort to seek sustainable and self-renewing forms of agriculture, technology and development.

The unfortunate truth is that national governments will not act to protect and restore the environment nor will they work hard to develop sustainable systems unless citizen groups continue to demand and promote these alternatives. Industry, business interests, politicians and facilities managers are only beginning to take into consideration the need to reduce their impact on the local and global environment. The best way to promote a broad-scale sustainability movement is to join with others into influential blocks of voters, to engage with groups doing good work in the area, and to use the power of your purchases to support the development of sustainable societies.

Concepts for a Sustainable Design System: Care of the Earth

Following the logic that human well-being is totally dependent on the health of our planet, the ethic of care of the earth is basic to permaculture design. This ethic of stewardship requires the permaculture designer to

cultivate intensively and with ecological methods, allowing, as much as possible, for native wildness to return to the rest of the land. Wildness promotes the health of the farm system and enhances the health of the bioregion — and the planet we live on.

Gaia

The Gaia hypothesis, developed by James Lovelock (with contributions from microbiologist Lynn Margulis) in the late 1970s, proposes that life on earth interacts with the chemical, geological and energy cycles of the planet (and perhaps the solar system) to maintain conditions necessary for life. Lovelock and Margulis suggested that certain "functions" of ecosystems are vital for the stability of earth's climate. These functions include carbon sequestration in the oceans, tropical forests and temperate soils; recycling of nutrients; oxygen cycling; and climate modification. Each bioregion is thus one of the many faces of Gaia. For example, mid-latitude temperate forests and grasslands and tropical forests act as reservoirs of biodiversity and modify the climate and atmosphere. As stewards of the earth, we must consider the impact of our lives on all different levels: on our local environment as part of a bioregion; on the ecology of other bioregions through international trade; and on the Gaian system through our impact on earth.

The most critical regions of the biosphere, including forests, wetlands, coastal estuaries, and the atmosphere, are also the most impacted by human activity. The damage to the planet's forests is well documented and continues. Our impact on the atmosphere is also becoming widely recognized. Our impact on the seas and oceans is from several fronts, primarily overharvesting of seafood and continuing pollution of our waters. Climate change is altering the acidity, salinity and the temperature of the oceans. And there is ongoing damage to biologically rich polar seas from excess ultraviolet rays because of ozone depletion. In each area, human activities are measurably weakening these systems, and therefore their ability to respond to climate change and overexploitation.

The March of Civilization Continues

Modern agriculture is the result of a misguided science that cannot see the whole while peering through a microscope. The compartmentalization

of disciplines and the war against nature raged by modern agriculture is a downward spiral, leading to further disruption of the natural world. We in the "developed" world are still on the path of environmental over-exploitation that our ancestors started down 10,000 years ago.

Good stewardship of resources and our environment is ultimately the only way to develop permanent agriculture and permanent cultures. Following the teachings of the Iroquois Nation, we must begin to think of the seventh generation to come. This is the generation we will not live to see. People living now are the receivers of choices made seven generations ago, when the petroleum era and Industrial Revolution began. So, now we face global climate change, overpopulation and mass extinctions. What will our great-grandchildren's great-grand children face? We hope it is a legacy of renewed respect for Mother Earth and a truer understanding of our place in the larger web of life.

Concepts of Ecology

Certain concepts of ecology are essential to the understanding of a permaculture farm. Below, I examine some of the key concepts in ecology applied to the farm: community, flows and cycles, diversity, succession, patterns, edge effect, and entropy.

Community

All life on earth exists in communities. To the ecologist, a community is a *group of organisms living in dynamic relationships in a shared environment.* Between the microenvironment of the garden soil and the community of customers the farm serves lay an intricate web of interactions. The goal of the farm manager is to establish, encourage and nurture these interactions so as to both reap an abundant harvest and enhance the health and stability of the total community. Each species has needs to be met by its community and yields that it contributes.

A permaculture farm is created with an awareness of its relation to the larger environment; it is itself an ecological system nested in the web of life.

Flows and Cycles

Sunlight strikes the leaf. A photon's energy is absorbed and stored by the plant as sugars and other carbohydrates. The plant, assisted by symbiotic

fungi, gathers nutrients from the soil. Plants process this energy and the nutrients into an incredible variety of compounds and substances. Animals, including us, consume plants to build tissue and fuel our lives. Animal waste, dead plants and bodies are broken down by a succession of fungus, animals and bacteria that feed off the remaining energy store, returning the nutrients to the soil. And so the cycle continues as a new day's sunlight strikes a leaf and the roots reach into the living soil. The seasons come and pass in an endless cycle, generating other cycles of birth, growth, decline, death, decomposition and renewal.

Nature has evolved within a complex of flows and cycles. Limited nutrients and erratic cycles disrupt the health and stability of natural systems and agricultural alike. With the ongoing changes to global and regional climates — and the local instabilities they cause — our ecosystems are under increasing stress.

An understanding of the flow of energy and cycling of materials through the landscape and through the year is the essence of permaculture. As Bill Mollison has repeatedly stated, the goal of good design is to maximize useful stores of energy, water and nutrients in a system.

Diversity

Diversity ensures balance. Ecological communities are most stable where a diversity of native species co-evolve within an environment. A community of plants, each in its niche, mobilizes a full range of nutrients, keeping essential soil minerals available to the whole community. Diversity of animals gives resilience to a web of foragers, predators and parasites; diversity of fungi, bacteria and other decomposers ensures thorough reprocessing and return of nutrients to the soil. A diversity of niches and microclimates allow for the diversity of organisms to find their place in the system. On the farm, a diversity of crops provides security against disease and weather extremes and allows the farmer to exploit each season. Placing crops in purposeful relationships and arrangements can further increase yield or the health of the system.

Diversity is even relevant to farm economics. Diverse marketing strategies help stabilize farm income; diverse activities on the farm, including production, processing and education events can balance the farm economy.

Succession

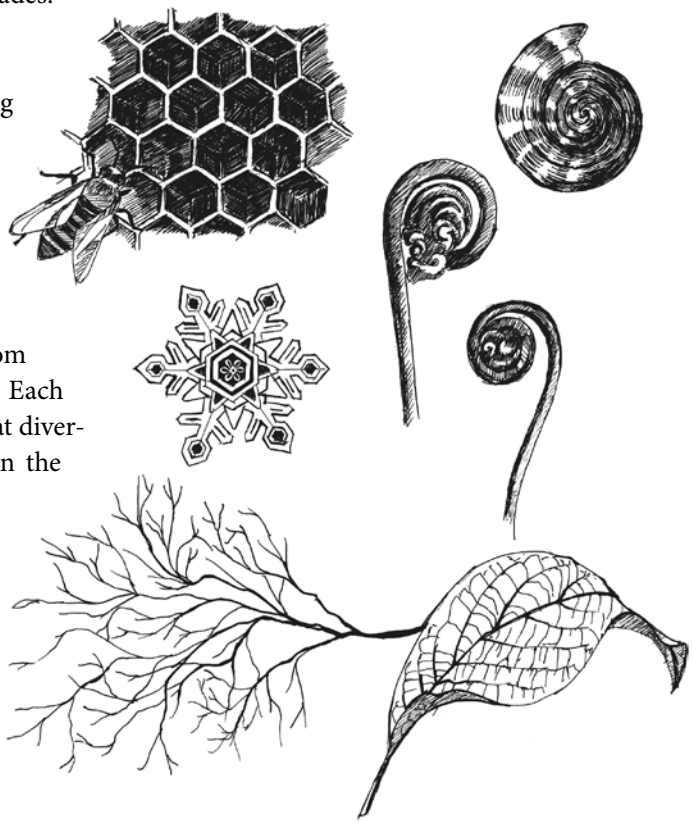
After fire levels a forest, pioneer species take root and flourish because of decreased competition. Grasses succeed to brambles, brambles to shrubs and pioneer trees. Young trees create conditions for more shade-tolerant species. Through the year, a succession of flowers and fruits feed a succession of insects.

Permaculture designers use succession in crop rotation and soil building. They also use succession on a longer timescale by implementing designs in logical sequence. Gardens are protected from wind by berry bush hedges as perennials succeed annuals. Tree crops are established and the farm is steadily diversified into a network of gardens, hedges, wild areas and orchards. Succession is also managed to maintain a specific ecological state as desired. Some meadow species, such as goldenrods, suppress the germination and development of other plants and can keep a field relatively tree-free for decades.

Patterns

Patterns are forms created by energy interacting with matter. Nature is manifest as patterns: Spirals of tropical storms and galaxies, branching of trees and rivers, hexagonal beehive cells and snowflakes, sine waves of rivers and radiant energy, elliptical orbits and fractal coastlines — these are all patterns of nature. Nature gathers and scatters, random chaos leads to new order, new order to chaos. Each ecosystem is nested in larger systems. The great diversity of life is, at its base, simply variations on the patterns set by the ladder-bonded double helix of DNA.

Time is also an element in patterns of nature and design. On the farm, interlocking patterns of daily routines, seasonal change, and ecological interactions define our world. Much of good ecological design is working with these patterns in order to increase both the productivity and stability



Pattern illustration.

of the farm ecosystem. The patterns of our days and seasons and the pace of our lives make or break the success of the permaculture farm.

Edge Effect

Edges are the interface of two or more systems. Whether it's the edge of the forest or the edge of the sea, the edge is a dynamic and productive place. Some species live only in the forest or the meadow, some move across systems, some inhabit only the edge. Habitat fragmentation by development can create *too much edge*. For example, some forest species require large areas — sometimes thousands of acres — of uninterrupted forest. When gaps appear and edges increase, there is an inevitable decline of native species within the forest. In permaculture, we try to use our understanding of edge to inform our design. An increasing edge can be a good thing in the permaculture garden when useful plantings of herbs, brambles, shrubs, trees and vines are used for windbreaks or at the edge of woodlots.

Humans evolved on the edges of forest and grassland. Our original habitat, the savannah, gave us access to the resources of the grassland and the fruits and shelter of the forest. The permaculture landscape can mimic the savannah, providing us with a mix of trees, shrubs, pastures and croplands to forage and tend.

Entropy

One definition of entropy is "a measure of unavailable energy in a closed system." In the world of physics, entropy tends to increase. Entropy is related to the tendency of the universe to move toward a state of equilibrium. For example, life on earth feeds off the dissipating energy of the sun. As this energy moves through the chain of life — from capture by plants, to herbivore to carnivore and finally to the soil through decomposition — a quantity of energy is lost with each transaction. Every resource we use is diminished and degraded to some extent in the process. A micro-example: with each rainstorm, a small amount of soil is lost to erosion.

We generally do not see the disorder that industry has inflicted on the environment; in recent years, North Americans have literally made it invisible by shifting industrial production and its accompanying environmental damage to developing countries. From mountaintop removal for coal mining, to accumulation of plastic in the oceans, to

excess nutrients in our waters and the decline of native habitat, our attempts at creating order in our world is creating greater disorder in the environment.

In his comprehensive examination of the role of entropy in all endeavors, Jeremy Rifkin describes life as a form of *negative entropy.* Life creates and builds order and structure from the process of decay. The community of life works together, in the face of entropy, to maximize the cycling of material and the use of available energy. A permanent agriculture must consider the physics of entropy and negative entropy to sustain the health of the farm and its environment. Our struggle with entropy includes complex tasks, such as using biological resources to build soil, but it also includes simpler acts, such as properly storing tools to prevent rot and rust.

Integrating Concepts

Permaculture design applies these ecological concepts to farm design and planning. Farm components are examined for needs and yields. Crops and animals are chosen to fit local conditions. Plants and animals are linked to promote natural, beneficial interactions. Buildings are integrated into the landscape with earthen berms, windbreaks and other climate control plantings. Resources of climate and microclimate, soil, wind, water and sun are viewed in terms of their ecological associations. Native biodiversity is promoted by allowing as much area as possible to be left in, or restored to, a natural state. Farm components are laid out to maximize production, conserve time and energy and to promote good patterning and nutrient cycles. Building materials and supplies are chosen to minimize environmental impact. Materials with low embodied energy (the energy used to create the material) are preferred. When possible and practical, alternative forms of energy are developed and used. Planning allows for site evolution and maturation.

Permaculture Planning

Zone System

The zone system is a conceptual tool to help place elements in the system to save time, energy and labor. There are six zones ranging from Zone 0, the interior of the home, to Zone 5, uncultivated wildlands. The plants, animals and structures visited or managed daily are placed in

Zone 1 to allow the easiest access. Zone 2 has plantings and structures visited every few days or weeks. Zone 3 includes orchards and pastures, visited or managed seasonally. Zone 4 includes managed woodlots and low-maintenance perennial plantings. In a foraging sense, Zone 5 is the larger world; many resources can be gathered with permission, or purchased, from other people's land.

Sector Planning

Sector planning deals with energies from beyond the site that affect the site. Wind, sunlight, streams, rain, brush fires and wildlife all can enter, affect and then leave a site. Understanding the dynamics of these energies allows us to design our buildings, farms and landscapes to control and effectively use these energies. Sector analysis also includes assessing views, sound, privacy and pollution. Farm planning using sector analysis gives an understanding of place and leads to design that capitalizes on special features of a specific location.

Other Concepts

Several other concepts are common to permaculture and good design in general. These are concepts gleaned from many sources, including observation of nature, traditional wisdom and common sense.

Multiple Functions: Most elements in a system provide more than one function. A tree may provide fruit, shade, nectar and pollen for insects, a windbreak, nesting sites for birds, medicine and inspiration. Poultry provide body heat, CO_2, fertilizer and much more besides eggs and meat.

Stacking Functions: Every use of time and energy should be planned to integrate more than one purpose. A trip to town for the shopping one day and the bank the next and the post office the next is simply wasteful. Combining trips saves time and money.

Relative Location: Placing elements in the right relationship to each other, through zone and sector analysis is a concept related to function in that it similarly increases efficiency and productivity of the system. Our namesake, the three sisters — corn, beans and squash — as companion plants, exemplify this concept.

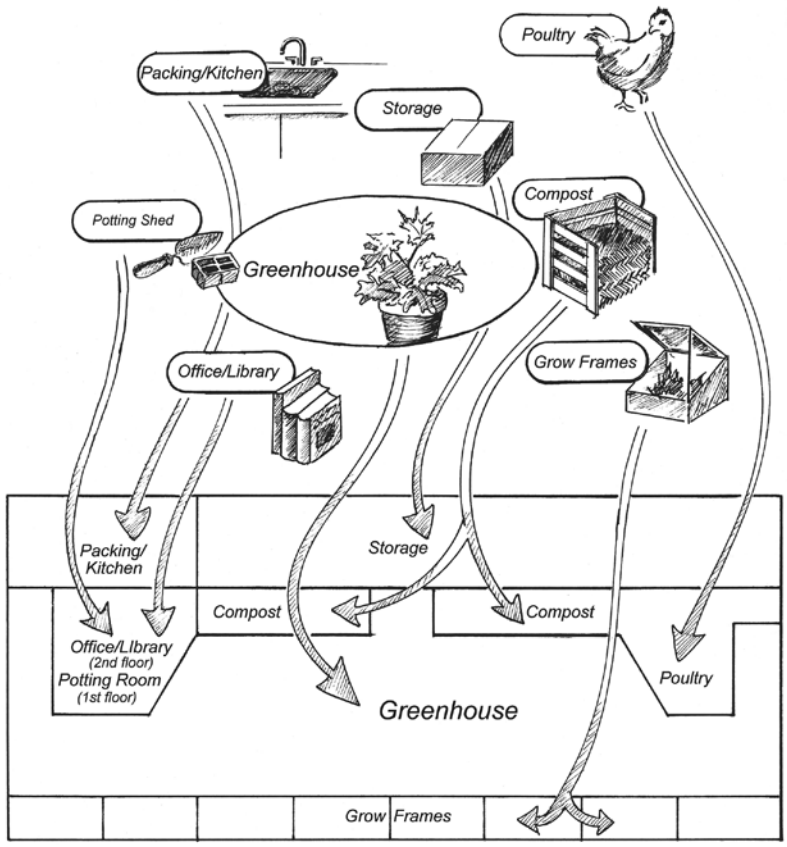
Redundant Systems: For any important farm product or resource, we should have multiple ways of providing for it. The bioshelter has

multiple and backup heating systems and various ventilation modes. Diverse crops ensure harvest if some crops fail. Wells, ponds and rain barrels all provide irrigation.

Appropriate Scale: Whether we garden with a trowel, shovel, tiller, or tractor depends on the size of the garden and the scope of the work. Appropriate tools are important design considerations; every tool is appropriate for a garden of a different scale.

Biological Resources: Permaculture tries to make use of biological resources whenever possible. For example, a windbreak reduces heat loss and thus fuel costs; recovering heat from compost in a hot bed can get seedlings off to a great start in the spring; and poultry can add CO_2 to the greenhouse.

Energy efficiency and time efficiency are always considered in the planning stages and are reflected in choice of building design, materials and building management. Again, the aim of placing design elements with the zone system is a tool for enhancing efficiency.



The integration of various farm components under one roof allows for efficient use of building materials and for efficient farm management.

Permaculture and Agriculture

When permaculture design is applied to the small-scale intensive farm, the result is an evolving, diversified, ecologically integrated agricultural system. Permaculture farms are as varied as the landforms and bioregions of the earth because ecological design is site specific. Farm design begins with an assessment of resources and a survey of the factors impacting the farm. The farm's relationship to the surrounding community and ecosystem is reviewed. Farm

products are chosen to make the best use of the specific soil types, aspect and exposure of the land, climate and microclimates, and other factors. Farm products are also determined by the tastes and demands of the farm's customers.

The word "sustainable" as applied to agriculture can be confusing. In the broadest sense the term includes everything from certified organic production to integrated pest control (which seeks to reduce rather than eliminate the use of synthetic chemicals in agriculture). The National Campaign for Sustainable Agriculture defines sustainable agriculture as being "economically viable, environmentally sound, socially just and humane."

To be permanent and sustainable, a culture must be able to interact with the Gaian system by maintaining a healthy ecosystem. This involves restoring, preserving and protecting natural areas of plants and other species unique to the bioregion. Farms can play a vital role in this preservation. When designed as part of the mosaic of the regional ecology, permaculture farms can provide habitat and restored ecosystems, protect groundwater and fix carbon by building soil — all while producing products for market.

The permaculture farm is an organism: the various systems (the inside propagation areas, animal housing, compost chambers and growing beds; and the outside gardens, nurseries, orchards, windbreaks, beekeeping and poultry forage) interact for the benefit of the whole by gathering, transforming and storing available energy. Life on earth is manifest as a vast network of systems within systems. These systems interact in a web of biochemical and energetic feedback cycles. A permaculture farm tries to develop and feed these cycles and work within them to promote the health and productivity of the farm. The compost piles, soil ecology, garden ecosystems, buildings and relationships to the larger community all interconnect.

Attainment of a permanent agricultural system requires understanding local conditions and which crops are suited to those conditions. Observation, design and labor are used to establish and guide the farm organism through a natural evolution of crops and enterprises to a steady state of mixed perennial and annual crops. Developing a seasonal cycle of cultivation and harvests brings steady income year-round while spreading the workload evenly throughout the year.

Farm Ecology

The permaculture farm is set in the matrix of nature. This concept is the first of the major ecological design principles presented by John and Nancy Todd in their book *From Eco-Cities to Living Machines*. Ecological design proceeds from a study of natural systems and Indigenous cultures that at are tied closely to their ecosystems. Crops are selected to suit the local climate. Microclimates are identified or developed to extend the crop selection and growing season. Beneficial insects, birds and other predators are encouraged with habitat plantings. Soil life is nurtured.

The Story of the Three Sisters

According to Iroquois legend, the three sisters — corn, beans, and squash — were gifts from the Great Spirit to the Native Americans. The three sisters are traditionally grown together as beneficial companions. The corn provides a trellis for the bean vine; the bean replaces nitrogen in the soil; and the squash's large leaves provide a living mulch, shading the ground and conserving moisture. Grown in this way, the three sisters are an excellent example of a sustainable agriculture system.

Corn, beans and squash can also be the basis of a healthy bioregional diet. The Iroquois knew them as "sustainers of life." When combined, the amino acids in corn and beans provide balanced protein, and both are good sources of vitamins and minerals. Squash is high in vitamin A and potassium and provides a complex carbohydrate that is low in calories. Squash seeds are high in protein and minerals.

Together, the three sisters were the basis of a nutritious, low-calorie, high-fiber diet for the original Americans.

The farm is viewed in its relationships to other systems: The neighborhood heron visits the farm pond on its regular rounds; the hummingbirds that live at our farm in summer spend winters in Central America; the source of our morning coffee can impact the hummingbird's winter home; the monarch butterflies born here in September winter in Mexico; rain comes from the west and drains via Mill Creek and French Creek to the Allegheny River, through the Ohio and Mississippi rivers and on to the Gulf of Mexico.

Three Sisters Farm

Three Sisters Farm was first conceived in the early 1980s. Our friend and neighbor, John Schmidt, purchased ten acres of farmland and we purchased ten acres of forestland several miles away in Mercer County, Pennsylvania. We all intended to establish our respective homesteads on our two properties; Linda and I had vague plans to develop five acres of the Schmidt property into an organic permaculture farm.

The first step was easy, but very important. We simply allowed the land to remain fallow for, as it turned out, six years. During this time, a

natural diversity of plants was allowed to grow. Red clover, yarrow, goldenrod, grasses, biennial taproots such as wild carrot, docks, dandelions, and other plants worked to heal the damage done from conventional agriculture. Inspired by the book, *Weeds: Guardians of the Soil,* by Joseph Cocannouer, and by Masanobu Fukuoka's writing on natural farming, we trusted in nature's ability to regenerate the soil. Both writers said that damaged land is best regenerated by a mix of what are usually considered weeds. From Cocannouer, we learned that annual and biennial plants such as purslane, ragweed, lambsquarters, amaranth, dandelion, docks and Queen Anne's lace will rejuvenate depleted soils. With their various root systems penetrating the soil and accumulating minerals, these and other weeds will, over time, increase fertility, loosen compacted soils and support a diverse soil ecology.

Allowing mixed species to grow started the process of healing the land. Decades of plowing, herbicide application and continuous cropping of corn or soybeans had depleted soil nutrients and damaged the soil structure. The clover provided nitrogen and organic matter. The biennial taproots delved deep into the soil to improve drainage by breaking up the plow pan and bringing minerals back to the surface. The successive increase in the field's diversity nurtured an increase in soil health. We also allowed the tree line to expand. Native dogwood shrubs and other plants seeded by birds or the wind became established and spread.

Following discussions with Bill Mollison at a weekend workshop in 1982, the concept for Three Sisters Farm became clear. Mollison suggested that a person wanting to bring permaculture to a region should collect useful plants and establish a permaculture nursery. Following his lead, we reasoned that market gardening would bring income while we waited for perennial plantings to grow into windbreaks, hedgerows, forage, habitat and crops. A permaculture farm could evolve to follow a seasonal cycle of cultivation and harvests that would bring steady income year-round while spreading the workload over time. Such a farm would serve as a demonstration of permaculture design, a resource for nursery stock, and a teaching center for the community.

Resource Survey

The study of available resources is another important first step in designing a permaculture farm. Identifying a site's unique features and

resources reveals a site's potentials and limitations. In our case, assessment of our local resources revealed the availability of massive quantities of horse manure and waste hay and straw from surrounding stables and farms, and sawdust and bark mulch from local hardwood sawmills.

The farm site was a five-acre field that sloped gently to the south and was bordered by a country road to the west. There was a mature tree line with shrubby understory to the north and east; and a young woodlot and wet floodplain and stream to the south. The rich, sandy loam glacial soil was ideal for gardening. With a natural pH of 5.5, the soil would only need an occasional application of pulverized limestone. The field had a pond site fed by a spring on a neighboring property. Groundwater was plentiful, with well depths of 30 to 60 feet in the area. When the most recent ice sheets plowed across the Lake Erie basin from Canada, they literally plastered northwest Pennsylvania and northern Ohio with sand, gravel, clay, rocks and boulders. At the site of Three Sisters Farm, this layer of compacted glacial till, 60 feet thick over bedrock, holds a pure freshwater aquifer.

We also counted as a resource our growing knowledge of intensive cultivation, agronomy, permaculture design and our desire to develop a model system.

Once we had performed our resource survey, we took several years to think over our plans and do the necessary research. During this time we collected plants, established homes, had children and practiced our designs on smaller scales.

Darrell Frey

Interior view of planting in the Solviva Bioshelter, built by Anna Edey on Martha's Vineyard, MA.

Early Stages and Planning

From 1981 through 1987, we collected, purchased and planted various useful plants for trial. These included pea shrubs, honey locust, bamboo, hazelnuts, rosehips, currants, apples, pears, grapes, plums, numerous berries, herbs and other plants.

All the while, we studied and discussed permaculture topics. We were particularly inspired by Anna Edey's Solviva Bioshelter on Martha's Vineyard and the New Alchemy's Institute's work with bioshelters and composting greenhouses. Our plans began to coalesce around the idea of building a composting bioshelter. With freely available horse manure (and our 4WD dump truck), we could use compost to enrich a passive solar bioshelter with supplemental heat and CO_2. Finished compost would then be used to fertilize crops in the bioshelter and outdoor gardens.

A Bioshelter for Three Sisters Farm

After six years of study and planning, we were ready when a funding opportunity came along. Federal courts had ruled that the major oil companies needed to refund profits from oil overcharges in the 1970s. The US Department of Energy was charged with distributing the funds through qualifying state agencies. The Pennsylvania Energy Office requested grant proposals for projects demonstrating ways to save energy in agriculture. We responded with a proposal to build our bioshelter.

When we received the grant to build the bioshelter, we were thrust into doing what we had so long studied and planned for. The bioshelter is the center of farm activities. It's where seedlings are started for the garden, tools and equipment are stored, and produce is processed for sale. A complete description of our bioshelter's design and management is given in subsequent chapters.

Crops

Our basic crop is a salad mix chosen for our particular bioregion. Self-seeding wild edible greens are part of our mix. These are combined with cultivated greens and lettuces to create a salad unique to our farm. The diversity of seasonal ingredients provides crop security and keeps customers interested. Our other crops include herbs, cut flowers, edible flowers, fennels, radicchio, lettuces, tomatoes, greens, root crops, peas, beans, squash, and potatoes. This crop mix has evolved as we attempt to cater to the needs of our customers: chefs, caterers, grocers and household subscribers. We use a system of sales of mostly pre-ordered produce; this reduces unnecessary plantings and crop waste. Excess produce is either consumed, sold or given away. Recently, we started selling berries, crab apples, pears and apples.

Gardens and Landscape

The bioshelter is built on the highest and most level part of the field, roughly centered on the property. Its central location allows for easy access to the main production gardens. Each year since 1988, we have

expanded our gardens and our production, so we have also used some of the adjoining land available to us. Today (2010) the bioshelter is surrounded on three sides by gardens. Each garden is composed of raised beds laid out on contour. Pathways between beds collect rainwater or can be flooded with water pumped from the pond. Wide central paths allow access to the contour paths. As we develop gardens, we allow uncultivated areas of goldenrod and wildflowers within or near them. These biological islands, together with herbs and flowers and other insectary plants, provide a healthy balance of predatory creatures. Birdhouses, rock piles and perennial plantings of fruits, nuts, berries, vines, shrubs and flowers are added each year. Plants create windbreaks and shade zones.

Darrell Frey

Garden beds laid out on contour at Three Sisters Farm.

As we continue to develop our plant nursery enterprise, we are enjoying our trial varieties of filberts, hazelnuts, currants, grapes, plums, apples, pears, Juneberries, rosehips and more. Other fruits are wild-crafted from neighboring properties. Our ten-acre woodland, with three diverse forest systems, provides forest products for farm use and contains some of our plant collections.

Energies

Sun: Much of the sunlight entering the bioshelter is absorbed — by plants, surfaces and materials (as thermal mass) — to provide our primary heat source. We also capture the sun's energy by using a photovoltaic panel to power an irrigation pump.

All our gardens receive full sun. Adding shade trees and shrubs to compost areas and some gardens is a continuing endeavor. Along the bioshelter's north wall, we have established a 2-foot-wide shade garden of native woodland wildflowers, ferns, vines and other useful plants. Fruit trees are mulched and planted with an understory of herbs and

flowers. Other shade zones include a visitor's camp, picnic area and hammocks in the tree line. A kiwi arbor near the bioshelter kitchen provides a cool place to work or rest. A 600-square foot barn adjoining the bioshelter provides 4,800 cubic feet of shaded space. Cool air from this space is drawn into the bioshelter, naturally cooling the structure during summer months.

Wind : Wind is a major factor at Three Sisters Farm. Situated on the western slopes of the Allegheny Plateau, our site receives daily wind, often steady and strong. Reduction of garden level wind is a priority. The tree line to the north provides our primary windbreak, sheltering the bioshelter and our gardens from the northwest winds. We have added a secondary windbreak of roses, shrubs and small trees 100 feet west of the bioshelter. A third, mixed species windbreak provides extra shelter to the herb and flower gardens next to the bioshelter. The trellised kiwi arbor between the bioshelter and herb garden provides a fourth wind deflector for the bioshelter.

Water: The pond provides irrigation for the gardens via pumps and sprinklers. The pond also provides fish, cattails, duckweed, algae and other useful plants. We continue to add useful species. Snakes, toads, turtles, dragonflies and many wild birds make the pond their home or feeding ground, as do muskrats. Generally, we receive 40–45 inches of rain each year. Roof run-off is caught in swales and contour paths to recharge our well. The 60-foot-deep well provides water for the bioshelter and our home.

Strategies

Good implementation strategies are imperative for successful permaculture design. Primary among these are staging and timing. We knew when we started that it would take up to five years to see income. Rather than go deeply in debt (beyond a loan for matching grant funds), we chose a more natural pay-as-you-go expansion. Each year we have expanded our gardens and increased sales. For the first ten years we averaged 20 percent growth in sales annually. After that, we began to diversify our activities to include more educational outreach. The bioshelter developed as we earned cash and learned more. Generally, bigger construction projects are planned for fall, when more money and time is available.

Our landscaping strategies follow Bill Mollison's suggestion that it is better to plant only what you can care for each year rather than overplant and lose trees. We've found that limiting our spring planting of new tree and shrubs to ten per year works well with the demands of our annual gardens.

Season Extension

Season extension is creating and using microclimates and structures to extend the growing season. Spring season extension allows the gardener to get a head start in crop production by starting seedlings for the spring and summer gardens. Fall season extension expands the production time for summer and fall crops. Winter season extension allows the year-round production and harvest of crops.

Season extension has been an important tool for market gardeners for centuries. In northern climates, the ability to extend the growing and harvest season is vital to the development of sustainable regional food systems.

Season extension can be as simple as mulching your carrot beds so you (and the voles) can harvest fresh vegetables from under the winter snow; it can be raising a bit of salad or cooking greens in a cold frame; or it can be winter gardening in a bioshelter.

Outreach

Fritjof Capra, writing in *The Web of Life,* declares the *network* to be the basic pattern of life. Networks of systems within systems form the basis of our biological existence, from the micro flora and fauna of our bodies and the soil to the biomes of the whole of the biosphere. We see our farm as part of several networks: sustainable agriculture in our bioregion; regional outlets for organic products; sites demonstrating sustainable practices; and the many farms and citizens in our region exploring sustainable organic gardening.

Since 1988, several hundred people have visited Three Sisters Farm. They come for tours, workshops, internships and celebrations. They come to buy produce and plants. We hope they learn a little about ecology and permaculture.

Three Sisters Farm is a working model of permaculture design. It is not a model in the sense of a completed project, but a model of the

living laboratories needed to fully develop sustainable permaculture farms in temperate climates. We see bioshelter market gardens as a key to sustainable living in our climate. As we continue to observe, create and implement our designs, we move closer to the idea of permanent agriculture.

Back to the Earth

The best way to describe the changes permaculture development has brought to our farm is to compare it to what came before. A small field that was previously plowed each year and planted in corn or soybeans now contains many dozens of species of plants. It is home to a thriving natural diversity of animal life. Bats, moles, mice voles, and weasels live between our gardens and along the edges. Swallows, orioles, bluebirds, catbirds, wrens, redwing blackbirds and many others songbirds nest here. Herons, ducks, geese, owls, and hawks forage our pond and fields. Turtles, snakes, frogs, toads, spiders, bees, wasps, and other native creatures live here as well. Wildflowers and new insects constantly amaze us as they join our evolving system. Together the gardeners, gardens and nature manifest the essence that is greater than the sum of its parts.

PROFILE

Homescale: The Jenkins Homestead

While the garden at Joe and Jeanine Jenkins' Homestead evolved and grew as a result of their own ideas and planning, it is laid out in a classic permaculture landscape, from a Zone 1 kitchen garden to the Zone 3 orchard and Zone 4 and 5 woodlots beyond. Fifteen paces from the kitchen door, after passing through a tree-shaded dining deck, one enters the garden. The 4,200 square foot space has one side facing the house and three sides surrounded by a double-fenced poultry run.

The east side of the garden, bordering the house, is edged with flowers, ferny asparagus and small shrubs. A cooking pit and picnic table are placed under the shade of a friendly young maple tree. A slate-roofed chicken house, sheltering a small flock of hens, is in the northwest corner. The chickens have free access to a 6-foot-wide run, where weeds and unusable produce are tossed for the chickens to forage. Two fences provide double protection from deer,

rabbits and woodchucks, and they give the chickens the chance to intercept slugs and other crawling garden invaders. Joe Jenkins explains that the poultry run design evolved from a need to keep deer out of the garden. He had read that a deer would not cross a double fence. Connecting the area between the fences to the poultry yard was a logical way to keep the weeds down in the space and to use the birds' natural foraging habit to keep the fence lines clean. The inner fence doubles as a trellis for beans, peas and flowers. Grapes hang from the outer fence. The northern third of the garden, adjoining the chicken house, is weeded and fertilized by foraging chickens during the fall and winter months. Each summer, sweet corn and companion crops grow well in this annually renewed plot.

Darrell Frey

Jenkins' zone one garden.

Darrell Frey

Jenkins' garden with grape arbor.

Apples, peaches, peonies, gladiolus and other perennial flowers are planted along the outer garden fence. Gates through the fences provide easy access to compost and mulch stockpiles and to the orchard area. The half-acre orchard includes apples, pears, hardy kiwi, plums, peaches, hazelnuts, raspberries, blueberries and chestnuts. Mulberries are located near the chicken house, where newly hatched chicks can peck at the fallen fruit each June. Native patches of Joe Pye weed, ironweed and jewelweed are encouraged in the few wet spots in the orchard, creating excellent habitat for butterflies and beneficial insects. The orchard and yard area is surrounded by forest edge to the north and west and a perennial border to the south. Dogwood, and other shrubs and trees provide winter forage for birds. A dwarf hydrangea on the garden border gives summer shade for understory plantings of daffodils and other spring flowers,

and provides seeds for cardinals, juncos and doves well into the winter. The birds are also provided with fully stocked feeders most of the year.

When Jeanine Jenkins describes her garden, she mentions the *I Ching,* in which stable lines move to change, and a balance is achieved between natural wildness and cultivated beauty. Jeanine explains that the garden, developed and worked by both her and her husband, Joe, is a result of the dynamic tension between garden labor and the organic evolution of the growing space. Her plants form a natural balance instead of being forced from a plan. Beauty and bounty meet in simple grace and elegance. Self-seeded scarlet poppies and biennial purple-throated foxgloves intermingle with cabbages and beans. Permanent, stone-edged beds line a gravel path leading to a garden bench. These stone beds protect alyssum, yarrow and thyme, marigold and sage, calendula and cosmos, gladiolus, and daisy, as well as kitchen and tea herbs. Branching off at right angles from this central path are smaller paths and beds of various sizes. A second bench and small grape arbor are placed in the southwest corner of the garden.

Most of the beds are fluid, changing size and shape each year as crops are rotated. Wild edible purslane, lambsquarters, and other plants self-seed. Large, crispy cabbage, sweet kale and broccoli, tangy tomatoes, peppers (both sweet and hot), eggplant, potatoes, summer and winter squash, cucumbers, peas, beans, carrots, onions, garlic and beets trade companions and positions annually and seasonally in a colorful fairy dance of succession, season and gardener's whim.

Jeanine Jenkins gives a tour of her poultry forage area along her zone one garden.

DARRELL FREY

From numerous birdhouses and nests, wrens, phoebes, robins, bluebirds and swallows patrol the gardens and orchards for caterpillars and other pests. Bees and other beneficial insects forage on the succession of flowers in the stone-lined beds and garden borders. Ducks, fenced out of the main garden, forage and fertilize the orchard. The ducks also love to clean up fallen fruit, helping to break the life cycle of pests and keep the orchard clean.

This garden and landscape evoke a sense of balance, bounty and wholeness.

Its encircling symmetry and colorful beauty combine to give the gardeners and their guests a feeling of satisfied well being. Sitting on the deck, sipping iced herb tea in the dappled tree shade and afternoon sun, while hummingbirds flash past to sip the gladiolus or foxglove, is as relaxing an experience as one may find, and it is just outside the kitchen door.

A Nutrient Cycle — Full Circle

Readers may be familiar with the Jenkins's garden from Joe's book, *The Humanure Handbook,* wherein he details the humanure toilet and safe composting of human manure: A toilet receptacle (usually a five-gallon bucket) containing feces, urine and sawdust is added to the wood-framed compost pile every few days. Each addition to the pile is covered with straw, garden weeds or other fibrous organic material. The compost generates sufficient heat and micro-biodiversity to destroy pathogens as it composts and ages. One bin is filled over the course of a year. The two-bin compost system ensures a bin will age for a year after the initial one-year thermophilic composting period.

The finished compost is used to fertilize the Jenkins's garden and landscape each spring, returning nutrients to the soil. Every summer solstice, a new pile is started in the emptied bin. The Jenkins' continually monitor the temperature and biological activity of their composting system and have developed an elegant and effective system to ensure the safety of their crops and the quality of their compost. The result is thriving, healthy gardens; thriving, healthy people and a wondrous and magical garden ecosystem. (Note: Most farms and facilities with composting toilets restrict humanure compost use to trees and other Zone 3 and 4 perennials. One reason for this is to prevent misunderstandings with customers who buy produce. At Three Sisters Farm we do not use humanure in our production gardens.)

Permaculture principles are very well demonstrated in the Jenkins's Homestead garden. Every element is in a good location relative to the house and each other. The poultry house and run are designed to serve multiple functions and make good use of the biological resource of chickens as foragers and recyclers. David Jacke, writing in his book *Edible Forest Gardens, Vol. II,* calls this type of double-fenced chicken run a "chicken moat." The poultry house, fencing and border plantings break the wind and create a sheltered, sun-trapping microclimate. As mentioned above, the entire landscape is laid out in a zone system. Everything is designed for efficient use and management. The fencing and chicken house are built to last (the slate roof on the chicken house mirrors the

care taken on all the Jenkins's buildings). Nature is nurtured, even celebrated, with birdhouses and feeders and natural art. Living space and garden have been integrated into one system. The nutrient cycle between gardener and garden is complete. The Jenkins's home embodies the sense of permanence we seek in good permaculture design.