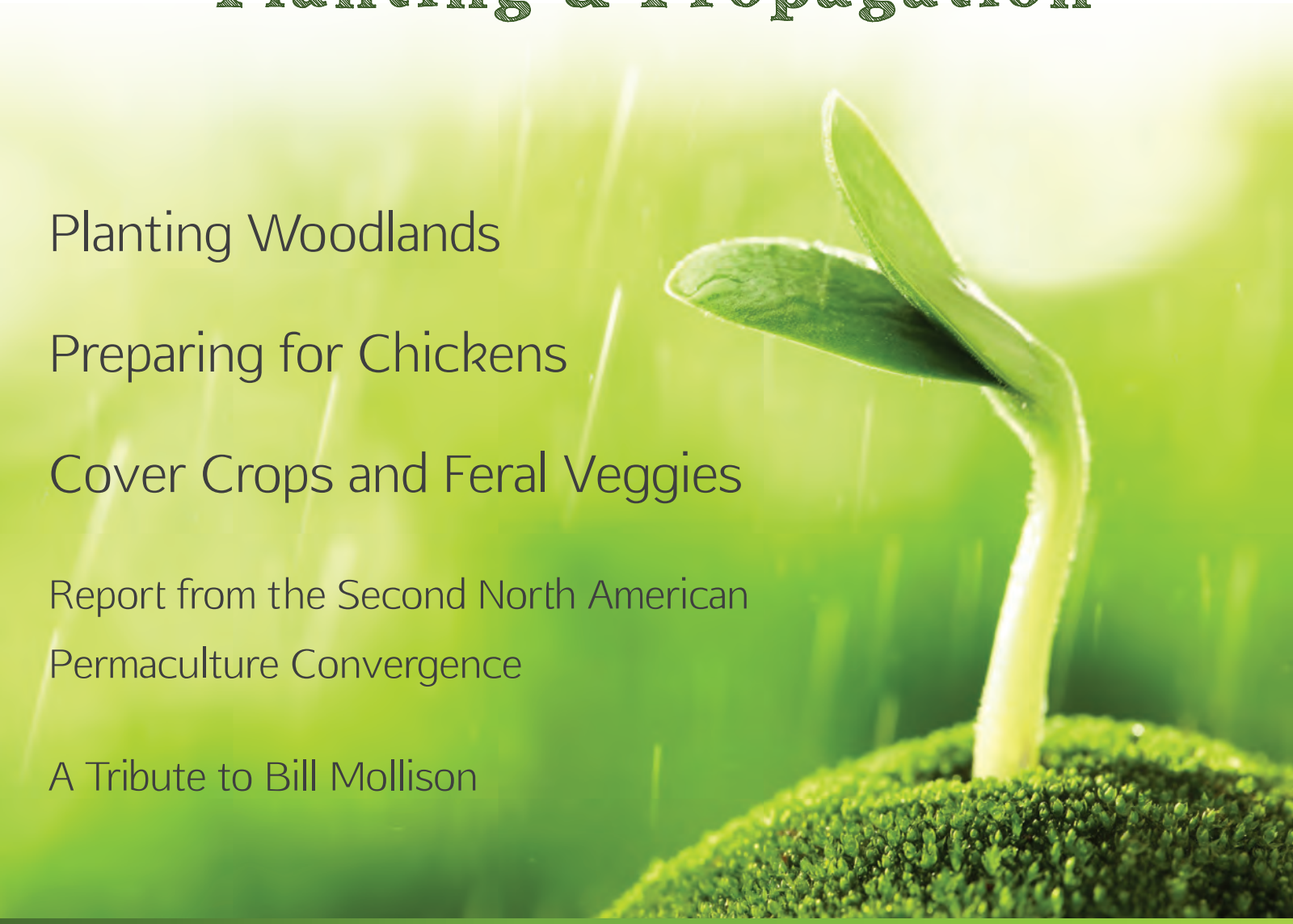
Permaculture Design

Regenerating Life Together

Planting & Propagation



Planting Woodlands

Preparing for Chickens

Cover Crops and Feral Veggies

Report from the Second North American Permaculture Convergence

A Tribute to Bill Mollison

Energy, Ecology and Alternative Agriculture

Carbon Farming: Plant Development with Eric Toensmeier

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Upcoming Issues, Themes, & Deadline

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#105	**Plant Breeding**	**June 1**

Building Skills, Building Bridges

Rhonda Baird

IT HAS BEEN MY PLEASURE to work with Keith Johnson on this issue that presents important skills and ideas relating to permaculture design. Truly, the experiences with people at the Second North American Permaculture Convergence with its theme of "Building Bridges," a permaculture design course in Chicago (the first one within the city limits!), and a retreat with the staff of *Permaculture Design* at its new home in Mississippi reflect the power of people who share a vision. I'm proud to be a part of this publication that weaves together the insights of so many experienced permaculturists and which informs us about the emergence of new contributions to permaculture design.

First, the focus on this issue, Plants & Propagation, reminds us of how important this particular skill is to our future happiness on the planet. Plants mediate between earth and sky, connect us deliciously to water, and provide for our needs in many other ways. Learning the secrets of their propagation is THE fundamental strategy for growing abundance and regenerating our landscapes. In a moment of profound uncertainty about our future, the practical nature of carbon farming (see Eric Toensmeier's piece) or planting woodlands (see Peter Bane's contribution) gives us down-to-earth work to do. The articles around carbon farming balance with a perspective piece contributed by R. Alan Wight and Braden Trauth: "Ecology, Energy, and Alternative Agriculture." The two, read together, give us an overview of what we've done with agriculture and the potential of carbon farming going forward. Diana Sette and Rick Valley delight us in truly working WITH nature to minimize work, develop our home systems, and let nature surprise us. John Roger's review of the benefits of seedling fruits fits right into this approach to propagating plants.

Readers seeking experiential knowledge for starting with chickens will appreciate John Wages' sharing about his experience with chickens at both a domestic and commercial scale. Susan Grill's piece on how to become more savvy about local economies—especially for those of us who are skilled with fiber arts and other traditional crafts—will give us pause for thought.

This has also been an important moment for permaculture in the passing of Bill Mollison in late September. His footprint around the globe was felt personally at the North American Permaculture Convergence, where many of the first people to adopt permaculture were able to gather. There was no one moment of recognizing Mollison, and yet his influence was felt everywhere throughout the conversations. The weekend that he passed, the Chicago course was graduating new members, and we felt charged with the need to take up the work, wherever we are, of healing our planet and our communities. The staff are appreciative of those who wrote to share their tributes to "Uncle Bill."

It is definitely a time of action. Standing Rock and the access pipeline are also strong in our minds as this issue comes together. The power of extractive industries to act counter to the ethics of permaculture presents opportunities for community discussion and action in many places. Jeremy Lynch's article introducing the action and community at the Tavaputs Plateau invites us to the beginning of a conversation—and perhaps to become more active in our own communities.

November marks the beginning, in the northern hemisphere, as the dark half of the year—a time of in-drawing in cool temperate climates. It is a perfect time to take stock of the yields the year brought, survey the landscape, consider your planting goals for 2017 and pick up a new propagation skill. Take the time to build a new bridge with like-minded people. Take up the vision that Bill Mollison and others have been developing over the past few decades and make it your own. Δ

Frequently Asked Questions: Digital edition

How do I get the digital issue if I'm a print subscriber?
When you register and subscribe, your site request is approved by the store manager, after which you can download the current issue using your username and password (the ones you set up when you registered). Note—beginning with this issue, the password is no longer on your mailing label.

I waited too long to download my copy, and now it's gone!
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How do I subscribe to only the digital issue?
Select the "Digital" option on the Subscribe page.

I noticed that the digital and print issues aren't the same.
One difference is that the digital issue is in color! Aside from this, the articles in the digital version may include hyperlinks, and there may be extra (bonus!) articles that we were unable to include in the print edition. So, even our subscribers who prefer hard copy may want to check out the pdf as well.

When will the archive of all back issues be available? We've been waiting for over a year!
We are still working on this project.

How much will the archive of all back issues cost?
We have not yet set a price for the archive, but it will be less than the cost of a full set of printed back issues ($450 in the US). While some magazines have made their archives available to subscribers for free, *Permaculture Design/Activist* content is quite amazing, and the early issues share accounts of convergences and meetings in the 80s that are also of historical interest. This content will be well worth the asking price, for serious practitioners of permaculture.

Why Propagate Plants?

Propagation Basics

Rhonda Baird

Plants are fascinating—their colors, textures, relationships, and the complexity of insects that interact with them. Natural patterns educate us about practical physics—such as the branching patterns of trees and lungs. Of course, plants themselves are the basis of all life on the planet. The thin green peel of life mediating between rock and air—along with that precious substrate, soil—is to be appreciated. No wonder Europeans celebrated the Green Man even as they denuded the forests of the continent. Plants are our food, our fiber, and our homes. They clean our water and air, and provide medicines in all forms.

Growing up with plants

Whether we're talking about perennial plants, annuals, or biennials, effective propagation requires us to become savvy to plant life cycles and needs. The basic work of cultivating restorative systems and encouraging natural emergence of regenerative systems relies on our familiarity with plants.

When my daughter was going through her Rite of Competence at age 9—a point marking a transition from early to middle childhood—a mentor told me that at this developmental stage, an indigenous child would typically know 450 different plants—where to find them, how to identify them, how to use them, how to harvest them, and ideally, how to propagate them. I am sure that included a respect for the plant communities and a desire not to over-harvest or disrespect the power of that plant. (Anyone who doubts that plants have power should connect with poison ivy.) Knowing and working with 450 different plants IS competency—something anyone might aim for as a baseline literacy.

We are all somewhere on a spectrum of experience with plants.

We are all somewhere on a spectrum of experience with plants. Some people are very afraid of plants and unfamiliar with them. Many people will need to learn gardening, seed-saving, and propagation from the very beginning. If you were fortunate, you might have grown up gardening or working with family members in forestry. For some, parents were back-to-the-landers. Others, like my parents, had been born into families that maintained a foraging, fishing, or forestry connection due to economic situations and cultural heritage. It wasn't until I began teaching permaculture design 11 years ago that I cared that stinging nettle was also called *Urtica dioica.* Others of us absolutely love knowing the Latin names, putting tags on trees in our forest gardens, and delving into breeding programs. I aspire to become such a person, and fully respect the contributions they make to localizing plant varieties through propagation.

Greenhouses are valuable spaces for plant propagation. CC0 photo by Unspalsh.

Indeed, plants—and specifically their propagation strategies—are the organs by which we might aim to repair the damage done to our home systems. With the help of fungi and bacteria, plants can and will nourish life on this planet. We have to become more knowledgeable about how to support their game. Of course, sometimes this story gets told as the story of agriculture on the planet—the 10,000-year-old project that has removed forests to create grain fields to create deserts to create war (1). This article narrows the focus to the basic competencies with which we must become familiar in order to work with plants and propagate them in permaculture systems.

How to start

Developing competency with plants—like much of our complex permaculture undertaking—can be overwhelming. Where should we begin, or which thread should we pick up once we're down that rabbit hole? Fortunately, we can design a path to competency using design and permaculture principles. The model in Figure 1 shows one mental model for organizing our approach. (For more on this model, see reference note 2.)

Our aim might be to gain competency identifying and work-

ing with a palette of plants that are successful in our bioregion in a way that fits our ethics and provides for our own needs and the landscape around us. These plants should serve multiple functions for the earth and provide for people whenever possible (except in zone 5 where the primary need is to repair the earth). We might apply the third ethic any number of ways: use plants that self-seed; start nurseries; give plant starts to friends and neighbors. It's actually an empowering concept—because that is how permaculture can become exciting and go viral. Bill Mollison was onto something with the title of his film, *In Grave Danger of Falling Food* (3).

When you're starting out, your palette might be five plants you really love. Begin with what excites you. Find your learning edge and push a little further. One of the best bits of advice Keith Johnson gave to his students was to buy a used copy of a propagation book. The information doesn't really change, and you can refer back to it often as you come up with new challenges.

Plants are bound, generally, by firm patterns in their life cycles. Growth patterns, patterns of plant communities, niches, harvesting and processing patterns… all these patterns are found in nature and culture and will help us get the right plants in the right place for the best yields.

If we use the permaculture principles articulated by David Holmgren (4) and arrange them in a circle (Peter Bane was the first person I saw do this.)—we recognize that the first six are how nature will respond to and reorganize itself. Nature, indeed, uses all twelve principles, but number seven (Design from patterns to details.) is probably more in human hands. Ecosystems mediating light, atmosphere, and soil incorporate the principles through succession and the evolution of systems over time in response to variations in limiting factors (light, temperature, etc…). Applying the principles as a process from the first (observe and interact) through to the end allows us to mimic the natural patterns in system development. In a nutshell, this is our permaculture practice.

We can't neglect cultural patterns relating to plants. Family choices around food, gardening, preparation, and storage determine our aims. In a forest gardening class, we start by listing fruits people enjoy which will also grow within our region. Mangoes don't grow in Indiana. But planting pears all day long is also a waste if you don't enjoy them or if no one knows what to do with them.

Our aims and permaculture ethics are informed by natural and cultural patterns and the principles of design and practice. Now we can get into how to reach our aims over the long term. Plant knowledge and propagation skills come in handy when we want to develop a system (and maybe build some social or financial capital through plant starts). With a bare property, we can start with a few plants and propagate them—breeding or cloning the best, most adapted varieties to develop the system slowly. Another approach would be to take cuttings or other propagation units from desirable species and bring them into the system to be improved upon over time. If you are working with anything other than a grass monoculture, your strategies should include learning the value of the species already inhabiting the space. Then add the species that you value for other yields.

We can't forget cultural patterns relating to plants either.

There are many strategies to meet multiple aims, manage our time, and design in abundance. In an urban environment, container gardens, vines for fences or buildings, community forests, and other planting strategies make sense as a design response. Broad-scale techniques such as hedgerows on contour or savannah grasslands for grazing cultures repair rural environments. Forest gardens in the suburban system make sense. Once we have the right planting strategies mimicking the best of nature's potential in our region, and we understand the strategies to develop them, then we can move into the details and techniques of plant propagation.

Nasturtium started from seed in paper pots. Photo by Bluehillies, CC0.

Techniques

Thomas Elpel's *Botany in a Day* (5) is the place to begin your understanding of plant families. Don't let the name fool you! It will take more than a day to work through this book. An even easier and more fun way to learn plant families is his book for children, *Shanleya's Quest* (6). Knowing the plant families gives us valuable information about how the plant reproduces and how to recognize other members of the family in our environment.

Some seeds save themselves for you right in the garden and volunteer from year to year.

Seed saving

Propagation fascinates me—how iris corms are different from tulip bulbs; how air plants can send runners; how pawpaws spread in an area. Plants often have more than one way they can be propagated. So, if you are not fortunate in your cuttings, try growing from seed or layering.

Seed-saving is one of the best ways to actually breed varieties adapted to your specific location. Harvesting seed and processing it from vegetables, fruits, and flower heads requires knowing how the plant reproduces best. As a kid, we always saved some "seed potatoes" for planting the next year. Right now, the marigold flowers are fading, and I'll separate out the seed from the other organic matter in the flower head to be planted out next year. Likewise, the gorgeous cockscomb flower seeds will be shaken out and held in an envelope for next year. Tasty squash that have not been exposed to cross-pollination with other winter squash will have their seeds washed and dried for next year.

Some seeds save themselves for you right in the garden and volunteer from year to year. This year, dill, kale, lettuces, fennel, tomatoes, and squash did this. Other plants that regularly volunteer include garlic and potatoes (though they are volunteering from roots, not seeds).

The best reference for seed-saving is *Seed to Seed* by Suzanne Ashworth (7). Saving seeds and breeding plants is one thing. Knowing how best to treat the seed and start it successfully is another. I found out that goumi doesn't do very well from cuttings (see below). It does much better from seed—but that seed needs to be stratified (kept at cold/freezing temperatures) for 12 weeks. It also apparently does well with layering (see below). Other seeds, like pawpaw, need to be both stratified

Goumi fruit ripening. Seeds in the making will be saved and started in the following year.

and scarified. This can be done with a knife or a stone to mimic the corrosive effects of an animal's digestive system. Again, plant propagation manuals and databases are helpful for learning which approach is best for a given species.

Cuttings

Cuttings are a simple and useful way to use trimmings from your plants to start new individual plants. Houseplants are simple. Currants are easy to propagate this way. Many woody perennials and some annuals, like tomatoes, are simple to get started. Use clean pruners (so you don't introduce diseases) to remove a portion of the plant. I like to use a length of about

Figure 1. One way to help us prioritize our approach to permaculture design.

10-12" in most cases. Strip the leaves from the bottom half to two-thirds of the cutting and put it in water mixed with rooting hormone or directly in moist soil to begin the new plant. (Again, a propagation manual or database would guide you as to whether you want to use a rooting solution or soil.)

Root divisions

Other plants, like comfrey, are usually propagated by dividing the roots, corms, or tubers. Some bulbs which reproduce (like daffodils) can also be dug up and re-positioned in the garden. In the case of comfrey, a tiny sliver of root can quickly produce a new plant. This also makes removing comfrey from an area problematic, because the roots are often hard to remove entirely.

Layering

Layering involves rooting a section of plant before cutting it away from the parent—sort of taking a cutting in reverse. A variety of methods can be employed. Generally, a pliable branch is bent to the ground and buried three to four inches below the soil surface with a heavy rock on top of it. It helps to strip away leaves from the section of the branch in connection with the bare soil. Over a period of months, some of the buds in contact with the soil develop roots. When the new root system is in place, the connection to the original plant can be severed and trimmed neatly, and the new plant can be transplanted to an ideal location. If the branch is long enough, it can be made to connect with the soil in several places—providing several new plants at the same time. This is called complex layering.

Black raspberries and blackberries, while delicious, are notorious for utilizing tip layering to spread throughout an area. The beautiful arcs of the canes grow until they touch down on new, fertile soil—where they root and create new plants. I use this behavior—guiding it close to the support I have for them—weaving them back and forth over each other. In the spring, I pull out the old, dead canes carefully, and wait for the snowy blossoms to show up. I used to try and find new homes in other gardens for all of the new plants, but there are so many now, I end up composting a fair number in the spring. Nature is abundant.

The nursery stock at Central Rocky Mountain Permaculture Institute provided, in 2006 when this picture was taken, a signiciant portion of the income from the site.

If running a nursery isn't your calling, then participating in a scion wood or seed swap might be just the ticket for you.

Stooling

Similar to layering is a method called stooling—where a tree or shrub is trimmed back to a few inches above the root mass in the dormant season. In the early spring, new shoots emerge, which are covered loosely with several inches of soil. Later in the year, the new shoots—along with their attending root masses—are carefully separated from the original stock and replanted.

Remember that only selective breeding and seed-saving bring new genetic diversity. Cuttings, layering, and other vegetative propagation methods are cloning techniques that replicate the genetics of the parent material. After a breeding project yields individuals with desirable traits, replication techniques are used to expand their numbers. Or, a small farm can import a number of varieties, see which ones perform best, then propagate the most successful plants.

Building up capacity

So far, the "why" of plant propagation has been couched in terms of personal economy: make a small investment in plants and use your skills to fill your landscape niches with the species and individuals you want. An ecological argument is also made: incorporate new plants inexpensively from other natural systems to increase diversity and provide yields throughout the system.

Plant propagation, it turns out, is also one of the more lucrative ways to use a small piece of land and your time to earn a living. Nurseries for unusual and perennial-based systems can be a great way to improve your home's economy. If running a nursery isn't your calling, then participating in scion or seed swaps might be just the ticket. Either way, in order for us to grow more food and provide for our needs using permaculture, communities need skilled people educating the public about the uses and behaviors of hundreds of plants. Communities need gardeners and seed-savers to breed MORE varieties of plants and create new lines that will adapt to the changes we all face. Getting into propagation is working WITH plants. Remember Michael Pollan's idea about the plants farming us (8). We need MORE diversity, more resilience, more colors, more flavors, more fruit at different times, and certainly more FUN with everyone. Δ

Rhonda Baird is an accidental plant breeder and occasional seed saver and plant propagator at her home in Bloomington, Indiana. She mostly propagates permaculture design practice through education and mentoring students and design clients. She hopes someday to grow up and be as good with plants as Keith Johnson. Contact her at shelteringhills@gmail.com.

We dug up and planted everbearing red raspberries from my garden in a friend's garden this spring as part of a demonstration. Rather than gift the friend with black raspberries, which can overwhelm a garden quickly, we chose a more modestly propagating species.

Notes and References

1. My first exposure to this concept was with Chellis Glendinning's book *My Name is Chellis, and I'm in Recovery from Western Civilization* (Boston: Shambhala Publications, 1994). While her premise and tone were too strident and not academic enough for my instructor's liking in the graduate "Modernization" seminar, I find her perspective instructive to this day.
2. I taught this model—probably starting in 2008—which can be applied to many situations. The priorities were articulated by my teaching mentor, Peter Bane, He convinced me to put aims in the ring with strategies—making them subordinate to our ethics, principles, and patterns. However, I originally placed them in the center, recognizing we bring much to the process. This model likely co-originates among many people as Bridget O'Brien had a similar model in the beginning phase development of her design game as shown to me in March 2016 and I've seen similar configurations among other experienced teachers. My only contribution, perhaps, is the visual arrangement. I will point out that many people mistake the techniques for permaculture without duly considering the rest of the model--and this is where the graphic becomes a bridge to deeper understanding.

How we attribute and honor the ideas and contributions of others is an important question as teaching lineages, books, and other media develop. Permaculture is such an amalgamation of subjects with fresh perspectives, that attribution is glossed over too often—particularly with regard to the contributions of indigenous peoples.

3. *In Grave Danger of Falling Food* (dvd, 1989, Australia). www.youtube.com/watch?v=IRy0FXd-1QA. [Also available from the *Permaculture Design* bookstore.]
4. Check out www.permacultureprinciples.com.
5. Elpel, Thomas J. *Botany in a Day, 6th ed.* (Pony, MT: Hops Press, 2013)
6. Elpel, Thomas J. *Shanleya's Quest* (Pony, MT: Hops Press, 2005)
7. Ashworth, Suzanne. *Seed to Seed: Seed Saving and Growing Techniques for Vegetable Gardeners.* (Decorah, IA: Seeds Savers Exchange, 2002).
8. Pollan, Michael. *The Botany of Desire* (New York, NY: Random House, 2001).

Working at Scale

Planting Woodlands

Peter Bane

MANY PEOPLE HAVE PLANTED A TREE, or two or five, but have you tried to plant a hundred or a thousand? It would be nice to think that if everyone in the world planted a tree or two every year, that we could regreen the world. Such schemes have been suggested from time to time, and while hopeful thinking might inspire us, the formula barely scratches the surface of what must be done. Collective action is important, of course, but we need to match the scale of the problem with an appropriately measured response.

Planting trees is arguably the best strategy for mitigating dangerous climate change, and the only hope for cooling our over-heated planet. Fossil fuel reductions are important but alone cannot reduce carbon already in the atmosphere. Nor can they modify land use to cool the earth's surface, except perhaps by suppressing or rationalizing vehicle traffic and thus reducing the growth of roads. Nor does the slowing of population growth, which is occurring, lead directly to a reduction in the coverage of land by pavement, as cities are expanding at an ever greater rate.

Four-row hedge/windbreak is planted parallel to north boundary, which lies between powerline and neighbor driveway. Tote (shown, 1 of 4), supplies gravity-drip irrigation at weekly intervals. Young trees are each given a flag to help identify and protect against mowing errors.

A change away from tillage-based annual agriculture would help, but even that is likely to involve significant tree planting, as a whole design revolution is involved in replacing our current disastrous system of food production.

So how can we up our game? And how many trees must be planted?

Major accidental reforestation during the early Columbian period of the Americas has been shown to have corresponded with a significant and prolonged cooling of the atmosphere—a phenomenon that reversed a centuries-long trend of warming during the Middle Ages (1). But achieving widespread reforestation of areas not now covered in trees and at the same time suitable for establishing them is not a trivial project. The post-Columbian atmospheric cooling came about as an unanticipated result of mass human die-offs among native Americans, a method we neither condone nor wish to see happen again.

The planet has about 57 million square miles (about 150 sq. km) of land surface. Some 9 million sq. mi. (20 sq. km) are covered in ice sheets or occur at high latitudes or high elevations such that trees will not grow there in the next few decades when action must take place. Of the remaining surface area, perhaps 15%, or about 4 billion acres, may be available. But these areas are not open fields, well-watered by rain and protected from the depredations of wildlife, wind, winter, and withering drought, waiting for trees to be lovingly planted in them. Those "available" acres are boulevard strips, field edges, highway margins, burnt-out farm fields or poor pastures, semi-arid rangeland, empty suburban lots, remote stream valleys, deserts, and denuded upper slopes of perhaps once-forested mountains. Getting trees established will take careful thought, planning, and persistent action across many sectors and cultures.

Permaculture designers need to grapple with these issues now, to provide leadership for the next decade.

Increasing global tree cover by about 50% would lead to a medium-term (30-80 years) addition of 800 billion trees, which would require upwards of 3 trillion trees to be planted.

With that in mind, and respecting the wishes of the late Bill Mollison that his students plant trees as a memorial to his life and work, I want to report what I have learned recently about planting woodlands.

Our learning curve

My partner and I reforested about half an acre of suburban

grassland in southern Indiana over the past decade—a few trees at a time, and now we are working with larger properties—our own and those of others—in western Michigan.

We have acquired ten acres (4 ha) in the middle of the Lake Michigan coastal region, of which some four acres were largely open. The land is relatively flat, easily accessed by vehicles and carts. The soil is almost pure sand with a very thin scrim of organic matter in the top 8" (20 cm), and the climate is cool temperate with a rainfall of about 32" (80 cm) per year, much of which falls as snow in winter. The growing season is about six months, from late April to the end of October. Winds coming from most points of the compass, but predominately from the north and west, are a significant climatic factor, and this inspired us to establish a windbreak on the open west and north sides immediately after we bought the property.

Though we have observed the place for only three years, we see considerable variation in moisture from year to year. Years 2014 and 2015 were cool, but also the growing season was dry with light and variable rainfall. This past year has been warmer and also wetter. Tree growth has been considerably better as a consequence.

I began this experiment knowing that diversity would matter....

Scaling up

In 2014, we planted 600' (almost 200 m) of four-row windbreak, using about 20 species of trees of varying heights. The rows were planted 10' (3 m) apart and the trees about 6-7' (about 2 m) apart in the rows. The present count of surviving trees is about 300, but we have planted nearly 400 to reach this number, including 15-20 in the last few weeks. I imagine that we will ultimately thin the planting to one-third that many, as the trees mature. The total area being reforested is about half an acre (0.2 ha).

Losses have been significant, despite the proximity of our dwelling and thus the opportunity to provide special care and attention. In the first year, we were not able to live on-site very much of the season, and tree losses amounted to about 20%. We replanted the gaps from surplus nursery stock during the first autumn, and spent more time on site during the second year. However, by August of 2015, and despite the extraordinary help of a nearby friend who came during our frequent absences and hand-watered the trees almost weekly for three months, it became apparent that the sandy soils would not sustain root-level moisture without regular irrigation in any but the wettest years.

High-performing trees cluster in this unlikely area (poor soils, little shade). From l to r: black locust, jack pine, Tartarian mulberry, white spruce (near low flag), golden alexanders, willow. Brush in front of back row acts as a snow fence and mulch.

Unwilling to lose more trees and unable to devote four hours a week to holding a hose, I established a drip irrigation system based on five 300-gallon (1200 L) totes (food-grade polyethylene tanks encased in metal frames). These were plumbed into short stretches of 1" (2.5 cm) black poly mains which in turn fed longer 1/2" (about 1 cm) flexible irrigation lines. In the interest of saving money, and because the system was gravity-fed, with tanks being refilled by hose from the well, I punctured the irrigation lines with an awl at each tree to supply water. This worked initially but had the problem that the black plastic lines, exposed to sun, would swell and shrink, causing the holes to close up over time. The lack of filtration in the system may have contributed to some plugging as well. About every three weeks, I found myself on hands and knees, groping the lines and poking new holes or re-opening old ones.

This year, I bought gravity-adapted emitters and installed them almost everywhere, using 2- and 4-gallon/minute rated plugs. This has seemed to obviate the need for re-establishing emitter holes.

What did we know?

I began this experiment knowing that diversity would matter, because 1) climate is variable and shifting; 2) we did not know the response of different plants to the soil and moisture regime; and 3) a good height variation would be required to optimize windbreak function. A good windbreak lifts up the oncoming wind gradually to avoid downwind turbulence.

The design called for multiple rows to ensure that wind would be deflected and slowed, a basic criterion for windbreak design. The outer and inner rows were planted to shorter species—generally those topping out at 20-40' (6-12 m), while the inner two rows were dedicated to taller species which had the potential to reach from 50-100' (15-30 m) under optimal conditions. This will create the "airplane wing" configuration in

West section of hedgerow along road frontage is planted beneath existing sassafras and black locust trees. Grass growth here is more lush, and tree losses have been few, but growth is slower in the shade of an overstory. Hugel mound shown in foreground. Post with sprinkler (to left) is one of six hooked intermittently to a hose for extra watering.

profile that can best lift and gently lower the wind. The tallest trees in our existing woods appear to be less than 60' (18 m) in height, so I don't expect we will see our hedge reach any higher than that.

We chose a mix of primarily deciduous species with two conifers: white spruce and jack pine, both in the center rows. At least four of the species at different heights were selected to fix nitrogen: Siberian pea shrub, grey alder, honey locust (thornless), and black locust. The rest (plums, mulberries, chokecherry, crabapples, mountain ash, larch, serviceberry, willow, maples, hawthorns) presented a range of wild fruits, saps, or other potential yields, including of course, firewood and poles.

The trees were sourced from a large wholesale nursery supplier and most were 2-yr saplings less than 24" (60 cm) in height. I tried to get material at least 12" (30 cm) and preferably 18" (45 cm) tall so that the young trees would be visible above the surrounding grass and forbs.

The dominant vegetation in this area is Russian knapweed with a few clumping grasses.

We expected that our poor soils would need amending, but didn't take the time or have the means easily to plant a cover crop over the area. (Indeed, recent efforts to sow covers have been relatively futile, with buckwheat establishing only sparsely near the trees and in the imported mulch.) Instead, we gave each planted tree a handful of mixed rock minerals in the soil returned around the roots: limestone, phosphate, and greensand, along with a bit of humate mix, and some peat into which had been infused the spores of mycorrhizal fungi.

We also top-dressed the plantings with aged horse bedding over a bit of newspaper or cardboard to suppress the nearby weeds and hold soil moisture. To this small collar of mulch—about 2'x2' (5x5 cm) around each tree—we have added grass clippings, straw, splashes of urine, and sometimes cow manure. I augment these finer mulches with small twigs and snapped branches from the existing trees.

What have we learned?

As a result of these halting and evolving methods: planting, mulching, hand-watering, replanting, re-mulching, irrigating, fertilizing, and generally fretting a good bit, I have come to appreciate the difficulties of establishing larger plantings of trees.

Water is essential, must be applied regularly in our light, droughty soils, and cannot be over-done. Fortunately, the cost of pumped water is rather low. Only when we got a wetter summer in Year 3 did the trees begin to show marked growth, but I also was irrigating weekly despite our more frequent and heavier rains this past summer. And I began irrigating in April with almost no letup til September. Of course, the tree root systems were likely also bigger and better able to use the water.

Tree planting is an essential skill for the survival of humanity and for the restoration of the planet.

Mulch helped greatly but took a lot of time to apply. In clearing a nearby area for a building site, we generated a good bit of tree and shrub tops, brash, and small stems. We piled this into a low windrow "snow fence" along the north-most row of trees, but just to the south of them. This shaded their hot sides, increased moisture retention, pulled in and held more winter precipitation and also provided a measure of protection against browsing animals. There have been virtually no losses in this 300' (90 m) stretch of trees, despite their being on some of the worst soils. Among the other rows, it took most of two seasons to get really good mulch on all the trees, and those which were slighted showed stress.

Tree cover was helpful but brought some problems. Along the west frontage of the lot, some existing sassafras and black locust trees provided shade, resulting in the best grass growth. Because of better soil and moisture retention in that area, tree losses have been low, but growth has been slower due to shading. Also, the presence of small shrubs beneath the existing trees (bush honeysuckle, sassafras regrowth, and other thickety vegetation) harbored rabbits which enjoyed eating particularly the mulberry leaves. This does not seem to have killed those trees, and regrowth is now outstripping predation.

Species adapted to wet environments have fared poorly.

Grey alder is almost extinct in the windbreak: only six of 25 planted remain alive. Maples did not take well to being planted out in full sun. Larch have performed indifferently—not dying, but neither growing very fast. Surprisingly though, willows have done fairly well. And on the other side, jack pine *(P. banksiana),* which we were sure would be a rugged pioneer in our poor soils, experienced heavy losses. Only 8 of 40 planted survive today. They are, however, among the tallest of the trees remaining.

Time favored most species, but not all. Year 3 saw much better growth amongst almost all species, and those trees that survived to the third spring have done well this year. Alone among the early survivors, white spruce is showing some belated losses, despite tender treatment and adequate moisture this year.

Irrigation systems are something of a nuisance, and they seem particularly ironic east of the rain line (longitude 98°W), but here we are in mid-Michigan pouring water on young trees and seeing better results. The system, which cost about $500 and maybe 40 hours of work to install, has saved an even greater amount of time, and more importantly has significantly improved tree survival. I can now release the five tanks, which irrigate 300 windbreak trees and 40 more in the orchard, overnight, and in about one hour of work moving hoses the next day, spread out over six or seven hours of fill time, can replenish them. The 1,650 gallons (6,600 L) released give each tree nearly five gallons (20 L) of water once a week. Added to rainfall, this has resulted in good growth at last.

Weed control has been a small problem. We mowed between the rows with a self-driven lawnmower. This has led to a few incidents of clipped irrigation lines, but these are easily repaired. However, water and mulch have also stimulated growth of the existing weeds and grasses. It's been necessary to pull or chop these a few times a season.

Heat stimulated growth but only because moisture was adequate. Late summer of 2016 saw local temperatures exceed 90° F. (32° C) intermittently for several weeks with sometimes warm nights—an unusual phenomenon for the area. With good rain during the same period and steady irrigation water, the growth of many species in the windbreak surged, even in August.

Ordering more trees than we needed initially was a fortunate mistake. We placed about 100 trees in a small nursery, where they flourished in a dense planting. These transplanted fairly well in Years 2 and 3 to fill gaps caused by death of early planted individuals. Some of the nursery stock had very long roots (more than 4' or 120 cm in the case of some willows).

Double planting in each hole was a reasonable speculative effort, which we did with less than 10% of the tree placements. In most cases, at least one of the paired trees has survived, lessening the need for replanting.

Lessons for the designer

Tree planting is an essential skill for the survival of humanity and for restoration of the planet. We must become adept at growing young trees in nursery conditions, both from seed and from cuttings, and must develop nurseries in all locales as a vital resource for community development. This implies collection of seed, identification of elite trees and shrubs as seed and scion sources, and gaining familiarity with necessary processes of scarification and stratification. A tree nursery need not take up a large area, and so the cultivation of trees could be done on quite a small property, at least initially.

Site preparation is helpful, and mechanical support may be important on large areas. We might have used seedballs for cover cropping, but a machine to disturb the soil surface (with a harrow or small disc) would have increased the germination success of basic soil-improving cover crops. We did not have this set of tools, and so depended on more labor-intensive application of gathered mulch.

Planting on a wide front is going to be common for opportunistic plantings (road and field edges, contour plantings on sloping ground, etc.), but it increases the labor demand. Block planting, where possible, offers many advantages: mutual support by the trees, reduction of weed pressure, and ease of applying water and fertilizer. Canopies also close sooner.

Our grass pressures were low, due to low fertility and limited moisture, but in many areas grass will be one of the chief difficulties in establishing trees. Under these conditions, even tillage or one-off shots of herbicide might prove helpful in moving the system toward a higher level of stability.

Tree planting needs to be directed to areas where water and biomass can be grown or gathered. There is little point in trying to grow in the harshest conditions. Rather, plantings should spread from areas where they can be sustained. However, if water and a little soil cover can be provided, even in hot and droughty circumstances, trees can be established. Under these conditions, clump and guild plantings become even more important.

I encourage all designers and activists to include tree culture in your repertoire of practices and skills. We may find ourselves in short order called upon to organize teams for large-scale planting in the face of deteriorating climate conditions. Knowing how and where to plant, and how to gather and germinate tree seeds should become common knowledge. Δ

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Self-Seeding in the Garden-Farm

Diana Sette

THERE IS NOTHING MORE LIFE-AFFIRMING than witnessing a seed that you didn't plant sprouting in the garden. An old gardener friend once told me, "Life wants to live," and I believe that cultivating self-seeding in the garden is one of the best practices in trusting Nature's ability to self-organize and thrive. Allowing and encouraging plants to self-seed is a practice of resilience for the permaculture garden farm, and offers many benefits in addition to many avenues to explore. Below, we will look at why cultivating self-seeding is a form of resilience; how to encourage it in the garden; and some edible and medicinal self-seeding plants with which to make an acquaintance.

Why self-seeding?

There are so many reasons to cultivate self-seeding varieties of flowers, herbs, and vegetables in the garden. In addition to getting to know the nature of the plant in its fullest expression, you can save tremendous amounts of time by working with nature, instead of against it. Perhaps I am a lazy gardener, but this is one of my top reasons for cultivating self-seeding varieties. I also enjoy the surprise and play of chance; what emerges is a dynamic process outside of my control. Planning and maintenance are interlinked. A cultivator of self-seeding varieties works with a more free form design of the garden—allowing for plants to move around of their own volition as opposed to expecting plants to stay where we put them. As authors Jonas Reif, Christian Kress, and Hank Gerritsen write in their book *Cultivating Chaos: How to Enrich Landscapes with Self-Seeding Plants* (1), "seeding is a vital way in which plant communities thrive and survive… a way of the garden becoming an ecological system."

...the self-seeding plants emerged because they have something to offer and the conditions were right for them to offer it.

Many people refer to self-seeded plants as "volunteers," and that is because the self-seeding plants emerged because they have something to offer and the conditions were right for them to offer it. Take the self-seeding dandelion for example. Dandelions growing in a vacant lot with hard, compacted soil demonstrate one of the highest benefits of volunteers, because they can provide a direct ecological function and service. The strong taproots of dandelions work hard to break up the compacted soil; draw water and minerals from soil sublayers; and work to restore and regenerate the land where they grow. Self-seeding dandelions also provide a hardy and nutritious, quick-turn-around pollen source for pollinators in an area of land where many other plant ecologies have not yet been established. In this way, I see self-seeding volunteers as offering us some form of restoration and renewal at a higher level of knowing than we might see at initial face value.

All the potential of the starburst-shaped seed of the pollinator-friendly cosmos

Self-seeding volunteer plants typically beat me out to the garden to plant seeds in the ground. In this way, volunteers save the garden-farmer's time by initiating the growing cycle when the conditions are right, as opposed to having to wait until the garden-farmer can get around to planting them. The seed of a volunteer has an intelligence that waits for just the right conditions—just the right soil temperature, moisture, nutrients—to get the growing started. It never ceases to amaze me how borage is already a few inches high before I set out sowing in the spring!

Self-seeding varieties that have early germination periods, and therefore an early onset of flowering, can be a crucial pollen and nectar source for beneficial insects. The benefit of food and habitat for pollinators and birds continues throughout the life cycle, as many seeds left on the plants become forage for garden friends. By providing food and habitat for beneficial insects, self-seeding plants help transform the garden-farm into an ecological system. They work with nature so that the garden-farm

can create resilient ecological relationships.

Cultivating volunteers is in direct opposition to the segregated model of agriculture that imports its seed; sows it when the farmer is ready rather than when the seed is ready to grow; harvests the plant for its crop; then clears the field before the plant can set seed; and repeats. In permaculture, a key principle is "integrate, don't segregate," and self-seeding integrates the sowing, harvesting, designing, and planning, as opposed to segregating those acts into isolated moments of human intervention.

Which brings me to a primary benefit of self-seeding varieties, and that is seeds! As seeds develop on a plant, they are adapting to the specific microclimate of your garden, and will produce more resilient offspring for the next year. Barbara Pleasant in her article "Self-Seeding Crops You'll Never Need to Replant" (2) says "one of the characteristics of a truly sustainable garden is that it produces at least some of its own seed." By cultivating self-seeding varieties in the garden, you're allowing for your plants to produce more resilient future generations, as well as, producing more seeds in general. When I allow my greens to go to seed after I've harvested them, I end up with exponentially more seeds and with more potential plants than I had when I started. Not only the garden-farmer but also wildlife can use these seeds in the garden. While some farmers may view letting plants go to seed as wasteful, the permaculture garden-farmer sees the myriad of benefits to letting a plant live out its full life cycle—encouraging niches to the overall benefit of the ecosystem.

Finally, the cultivated chaos of self-seeding is extremely beautiful and life-affirming. The garden-farmer plays a role in creating the garden plan. As a self-seeding cultivator, her interaction is primarily centered on observing Nature's beautiful design layout without constant intervention and making choices to encourage what you find beautiful. Could that be more life-affirming?

...the cultivated chaos of self-seeding is extremely beautiful and life-affirming.

How self-seeding works

The practice of cultivating self-seeding in the garden begins with observing a plant's full life cycle of birth, death, and decay as it transitions from seed to germination to leaves to fruit to seed to dropping its seed, to wilting, and the forthcoming birth of the next generation. This observation process is a constant reminder of, and a vital way to tune into, the cycles of Nature.

The more you become aware of the plant's life cycle, you also start to notice its habit and shape. Does it send out runners, form a mat, sprawl, clump, or climb? It is possible to do some background research (3) into the habit and form of the self-seeders of interest. What is most informative is the hyper-localized observation process of watching the growing patterns of self-seeding plants on the land where you are. Whatever you learn about growing you are learning about growing where you are. This is true because of microclimates, and the fact that each piece of land has slightly different soil, wind, water, and sun exposure. So what might thrive in one place, doesn't in another, and *visa versa.* The best bet of someone who wants to cultivate self-seeding in the garden is to dive right into it. One encouraging thing about the practice—there's no such thing as failing! Whatever will grow grows, and lessons can be learned!

Several elements in self-seeding plant communities are worth attention because they support the cultivation of a desired design outcome. For example, what is the population density of the volunteers—is it thick, sparse, or sporadic? How quickly after germinating do they set seed? Many varieties will set seed more quickly when the temperature rises, or when they are grown in proximity to other seeds. What is the dispersal pattern of the seeds? Do they drop straight to the ground, or are they moved by animals or by the wind?

Having a sense of how specific self-seeding plants grow in your garden allows you to make more informed decisions when intervening. Intervention in the self-seeding garden-farm includes selective weeding and thinning to make room for the plants you want. You can support the spreading of plant communities by dropping the seeds yourself in weeded soil.

If you're cultivating self-seeding flowers versus self-seeding greens, you may have different approaches. For example, with self-seeding greens I start by seeding them heavily, like a carpet in the spring. After harvesting baby greens a few times, I allow them to go to seed. The stress of competition for space increases the speed at which most greens will go to seed. By end of sum-

Self-seeded sunflowers, Echinacea, and cherry tomatoes make themselves at home.

mer, I will have another round of greens sprouting up with little to no work. On the other hand, if I were cultivating self-seeding flowers like calendula or borage, I might thin or transplant volunteers to their suggested growing space to allow each plant to reach their maximum growing expression. It's really up to the garden-farmer and depends on his highest priority: leaves, greens, seed, color, or something else. With those design goals in mind, intervention is simply a curated process.

Volunteers include self-seeding annuals, self-seeding biennials, and self-seeding perennials. A self-seeding annual will grow, flower, and set seed in one year, and that's it; the parent plant will not grow back the following year. So a self-seeding annual has brand new plants that come up every year. The general growing location of that plant variety may be in a similar location, but they are new plants. Self-seeding biennial varieties take two years to reach full maturity and set seed. Depending on what you want to use the plant for, self-seeding biennials may require a little more patience, with one year not being as productive as others. Finally, self-seeding perennials are plants that will continue to grow every year. They may grow through their full flowering and seed cycle every year, and also set seeds for new plants to grow. Self-seeding perennials may require more thinning or transplanting in the spring, but not necessarily. Different plants grow at different rates. Also, some plants may be perennial in a warm climate, but in colder climates they may be treated as annuals. Frost or freezing kills the plant, but during the growing season, there is enough time to harvest leaves, fruits, roots, or shoots. Knowing their pattern in your area helps you select just the right combinations and give them each the slightly different care required.

Finally, self-seeding works best if you let plants live their full life cycle all the way through the wilting stage, when the foliage dies back, and all the plant's energies have gone into its seeds. While many gardeners feel it is a necessity to clean up the garden at the end of the season, leaving many plants standing in the garden-farm long after they set fruit can be the most important moment when self-seeding happens. Again, this is why it is so important to understand how the self-seeding plants you want to encourage seed themselves. For example, I always leave the sunflower stalks standing in the garden through the snowy months. Typically the seeds are gone by late fall, but I leave it to the birds to eat and distribute the seeds for next year's sunflower crop. Leaving sunflowers to stand in their wilted state supports their self-seeding.

A multi-generation patch of chard, collards, borage in baby stage while the mustard greens are going to seed ready for next season's harvest.

...leaving many plants standing in the garden-farm long after they set fruit can be the most important moment when self-seeding happens.

Where to start

Below are a few of my favorite edible and medicinal self-seeding varieties, with a little about how they can be used in the various parts of their cycle.

Herbs

There are so many herbs that will happily self-seed in your garden-farm: calendula, chamomile, chives, fennel, borage, oregano, basil, cilantro, dill, parsley, and horseradish, to name a few. Some are self-seeding annuals, other self-seeding perennials, and it is useful to know the difference. Either way, herbs are oftentimes the heavy hitters for attracting and supporting pollinators. Including some self-seeding herbs is a must in any garden-farm.

Sunflowers

Sunflowers are perhaps one of my favorites, because they seem so happy to sow themselves. With edible seeds for humans and birds alike, immense beauty, cutting flowers, healthy oil producing potential, edible baby sprouts, and consistent food for beneficial insects, sunflowers can't be beat!

Potatoes

Once you start growing potatoes, it can be hard to stop growing them, unless you find every single little potato that was growing in that soil. Forgotten potatoes are one of the best ways to start next year's crop early. Watch for blight, and don't let any potatoes stay in the ground if they show any signs of blight. Also, in order to get optimal growth of each plant, I occasionally will transplant them in early spring to give them a little more space. This great source of Vitamin C is one of my favorites!

Tomatoes

Unless you keep an immaculately clean garden, and pick up every single fallen vegetable and weed, you probably have encountered the volunteer tomato. One thing that makes for an interesting self-seeding tomato plant is that it already has done the work for you of saving some of its most viable seed from the year before; so in theory, your self-seeding tomato is going to produce some of your most resilient varieties for your particular climate. Also, because self-seeding borage is such a great companion for tomatoes, the two plants can continue to reseed themselves in partnership.

Greens

There are so many tasty and nutritious greens that are self-seeding. Arugula, chard, collards, kale, lettuce, mustards, spinach, and sorrel are just a few of the awesome options of self-seeding greens. I like to add self-seeding radish and turnip into my bed of baby greens as well. Seeding a bed early in the spring, then taking a few harvests before letting them go to seed, will provide a fresh bed of baby greens come late summer/fall. And depending on how densely you seed the initial bunch, you may be able to eat some of the spicy flower heads. For the ones that set flower, you will see many beneficial insects coming to share in a harvest while you admire and wait for the next crop.

Squash

Anyone with a compost pile who has put the remains of a squash in it has experienced its awesome self-seeding potential. I've seen many a compost pile that just leaves the squash plant growing out of the pile all season. I've also experienced building a lasagna bed using some 80% finished compost where squash came up in the beds. I've left its sprawling vines as a ground cover to keep out the weeds until the other things I've planted get more established and able to shade out the weeds. I've also eaten self-seeding squash. The trick about self-seeding squash is that the fruit that grows very well may be a hybrid if the parent were grown close enough to a different variety for cross-pollination. Check out seedsaving distance requirements to get a full-bred variety so that you can plan for how to best space and cultivate your self-seeding squash patch.

Wild edibles

And where would we be without the wild ones? The wild self-seeding plants are some of my favorite because they are so incredibly informative about the needs of the soil and what the next stage of ecological succession looks like. Wild edibles are often medicinal or provide high nutrient levels. Good examples of self-seeding wild edibles that you may consider cultivating in your garden-farm are dandelion, burdock, wild lettuce, lambs quarter, purslane, and plantain.

The above list is just a selection of self-seeding possibilities and by no means exhaustive. There are many more flowers, vegetables, and herbs that will make a happy home in your garden-farm if you let them. Once you get started, you can experiment with more and more. Nature is abundant, and life wants to live! Growing self-seeding varieties will keep your garden going long after you're done sowing, and with a little cultivation and attention, it can be one of the most resilient and productive gardens you've seen. Happy self-seeding! Δ

The remains of the day—the sunflower reveals its seed ready for self-sowing, saving, and food.

Diana Sette is a passionate community cultivator, gardener, writer, facilitator, and mother. She is a Certified Permaculture Teacher and Designer and the Co-Founder of Possibilitarian Garden (Facebook: Possibilitarian Garden) and Possibilitarian Regenerative Community Homestead aka PORCH (buckeye-porch.org) in Cleveland, OH. Diana serves on the board of The Hummingbird Project (hummingbirdproject.org) and Green Triangle (greentriangle.org). She has been a regular contributor to Permaculture Design *magazine since issue #98. More at dianasette.wordpress.com.*

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3. Jacke, David, Eric Toensmeier. *Edible Forest Gardens*, *Volume 2: Ecological Design and Practice for Temperate Climate Permaculture.* White River Jct., VT: Chelsea Green Publishing (2005). This book is a great resource for gaining additional insights into plant's ecological behaviors, and considering how best to cultivate their nature. See the "Architecture" (Appendix 1) and "Form & Habit" (Appendix 3) sections of the tables included for more insights.

Surprised by Seedlings

John Rogers

DELIGHTFUL DISCOVERIES can pop into view when you're looking for other things. I've been busy collecting and over-planting a wide assortment of avocado seedlings into my suburban forest garden. I am hoping for numerical and genetic advantage to resist laurel wilt disease as it spreads through Florida and the Southeast. In my bioregion, laurel wilt is killing the native red bay trees and many mature avocados. Yikes.

My mission was to "Johnny Avocadoseed" my suburban gardens and any nearby yards where the caretakers had half an interest. These were all seedling plants from a wide variety of mother trees—both local and far flung. During the first few seasons of laurel wilt decline, I scoured the county for the fruits and seeds of survivors—a rewarding, tasty hunt on several levels.

The surprising discovery was that most of these seedling plants soon outgrew my adjacent grafted avocados that had been planted about five years earlier. The much younger seedlings towered over the older grafted trees and supplied the canopy coverage I had hoped would come from the older grafted trees. This is big. Someone alert the media! I sing in a chorus of fruit explorers that love, love, love grafted fruit trees. It has been our constant duty to warn people about the pitfalls of planting seedlings.

I sing in a chorus of fruit explorers that love, love, love grafted fruit trees. It has been our constant duty to warn people about the pitfalls of planting seedlings.

The way I explain this head-turning growth is that seedling plants go through juvenile and adolescent stages where prodigious growth is normal and necessary. All systems are focused on growing tall and strong. Flowers and fruit will come years later, when the plants are well established and have staked their claim to a sector of sunlight. Young seedling plants seem to have the single purpose of reaching their natural height as soon as practical.

Once this height is reached, the girth of the canopy spreads to its genetic and cultural guidelines. This wider form ratio marks the stage where juvenile growth has matured into an adult pattern—that of establishing and maintaining a fuller horizontal reach in the garden setting. Kids grow tall quickly. Adults grow wide slowly. Only now does it make sense for the tree to start snorting pollen. Before this time there had been no flowery distractions to the important task of growing big as if your species depended on it.

Mangoes on the trees. Photo by sarangib, CC0.

What I observed is a new-found design strength that can be harnessed from seedlings. The juvenile growth spurt equips seedlings to perform as pioneers in certain applications, like extensive mob plantings. And there's quite a savings of time, effort, and money compared to grafted stock planted as densely.

When I gang-planted about a quarter acre (0.1 ha) of a fruit tree polyculture, it seemed appropriate to place 60-70 juvenile seedlings into one area of the new space all at once. Most of them are growing well together—enjoying each other's company. They are in almost full sun and reaching for more as they create shade under themselves. Is it competition or cooperation? Yes.

The penalty, if you want to call it that, of planting so many tree seedlings, is delayed fruiting to prove out your efforts. A precocious avocado can produce in six years. Some will take twice that long. Also, there is some mystery in the details of size, skin color, texture, shape, season, flavor, oil content, and seed size. You would, however, expect some alignment with the mother's characteristics (and the father's too, if only we knew him).

The reward is a diversity greater than you started with and a chance at valuable surprises. Regional food-sheds are uniquely positioned to develop and celebrate resilient varieties of woody perennials from the canopy down to the shrub layer. Sexual propagation is exciting.

Most gardening articles worth their pulp occupy that rich space between science and culture. (Isn't that a decryption of permaculture?) Culturally, the strength and strategy of planting selected seedling fruit and nut trees is more useful in extensive,

outlying swaths of the homestead or village. Those edges can be genetically productive without the economic pressure we place closer to our centers of activity. Smaller, intensively managed dooryards will likely value grafted clones of known varieties because every square meter counts. Also, in that small space you're not seeking a taller canopy to manage and harvest.

Where I garden, tall avocado trees drop their firm, mature fruit onto the mulch below—often with the help of squirrels. Damage is rare, but timely observation is helpful. Mangoes high in the canopy are more susceptible to injury and just as thoroughly managed by squirrels. Tall seedling longan trees will be rare on my acreage, because of the harvest challenge. Tall canistel trees will drop the fruit that I cannot reach within a day or two of peak ripeness. I can deal with that. Each species has its own cultural needs and preferences with respect to its place in your systems. Experimenting on your allotment like a mad scientist is a welcome curiosity. Just ask the neighbors.

How much you experiment with seedling stock depends on how large an area you are trying to populate....

Mango seedlings seem to mature to a fruiting stage sooner than their avocado canopy mates. In mangoes I have found less of a contrast between seedling vigor and the fast growth from a grafted robust cultivar like, say, Valencia Pride or ST Maui. But another advantage of planting seedling mangoes, especially in a low maintenance regime, is the reduced risk of the rootstock overgrowing a freeze-damaged grafted tree. Seedlings are on their own roots, of course, and what re-grows will be the same plant. The widely used mango rootstock in Florida is called Turpentine, a perfect flavor descriptor seldom used by food writers.

Peach seedlings share this early fruiting ability, squared! A university test trial took advantage of this and saved space in a low-chilling-hour program that planted bred seedlings 12" (30 cm) apart. You had to bend down to pick the fruit that was being evaluated to enhance the breeding lines. So there is quite a range of fruiting times between the species.

I've focused mainly on avocadoes and mangoes because they offer the most promise for filling out my canopy and because they have earned many fans here in USDA climate zone 9b. How much you experiment with seedling stock depends on how large an area you're trying to populate and your specific management practices—small and intensive or larger and extensive. Seedlings have vigor and mystery. Grafted trees have a market share and steady reputations. My garden has both. Δ

In the early 90s John nudged his edible landscaping hobby toward a forest polyculture after reading a Mollison interview. His suburban laboratory is in Melbourne, Florida, on the freezing edge of the coastal subtropics where microclimates are savored. His neighbors think there may be a house back there.

Red peach grown out from seed. Photo by Rhonda Baird.

Mobile compost piles as seed incubators

Cover Crops and Feral Veggies

Rick Valley

THIS IS A REPORT BACK from "the field" as it were. Long ago, I figured out that what I wanted to do was eliminate infernal combustion engines from my horticultural endeavors, and really learn hand tools and something like Fukuoka's "no work farming" for my land. I've been at this for over 35 years now, and I feel I've just reached the downhill side of the learning curve.

I heard lots about cover crops from my organic ag friends: I got the raps about soil improvement and weed suppression and "filling the unoccupied niches in time," and I tried variations on these things. Now, I'm developing the soil on my half-acre which was once an orchard, then a junkyard, then an Armenian blackberry patch. I'm in Year Five on land that chose me—my partner bought it, and in just over a year, I inherited it when lung cancer claimed her. There have been a lot of transitions on the land, and we are still learning.

The challenge is that I'm trying to repair well compacted clay soil. How will I do this with limited cash reserves and a bias towards hand tools only? And I want to eat regularly too! My primary advantage is admittedly a huge one: I have a location where trucks can drop chips and street leaves, although competition for these bounties is stiff in a city of gardeners. Sometimes I have three truckloads; sometimes I have none.

My system is developing through a combination of reseeding crops, edible weeds, staple crops I've developed for years, and cover crops that I can harvest for more cover crop seed. I've learned parsnip, cover crop mustards, turnip greens, kales, fava beans, radicchio, radish, *Sonchus,* tarweed *(Madia),* evening primrose, and salsify will reseed on this soil so I allow all these edibles to set seed. I harvest some seed, leave some for the birds, take some on the stem to the chickens, and put whole seedy stems in my compost.

With all the woody plants and vines I've planted, I have lots of brushy carbon to build into compost piles. The piles are loaded with good seed that I don't want to go to the chickens. My compost piles cover entire beds: when it comes time to get compost for planting, I chop/drag the loaf to the next bed, working it with tined hoes and fine-tuning the move with forks, so that I'm not lifting tangled sticks with a fork and my back. Please understand that I'm about to turn 65, have a wicked scoliosis problem, and I don't like pain. The human body can drag stuff better than it can lift! Add to that, the chopping and pulling and lifting causes the fine, finished portion of the compost to sift DOWN where I can sort it out and use it well.

Unfinished sticks are easier to move to the adjacent area and serve as aeration, carbon, and inoculant for the new compost loaf: sifting is necessary only for small amounts of seedling mix, and I can sift compost that's already been sorted. This rapid sorting and stirring and moving also mixes useful seed in the compost—seed which was placed into the pile on mature plant tops at different times. If I never plant anything else, the new bed where the pile was sprouts a carpet of edible plants. If I want, a simple scuffle with a hoe kills them and I can plant new starts or particular seeds. I can chop the surface with a broad hoe, spread coarse mulch, and make hills with sorted but un-sifted compost which I plant with large seeds like corn, beans, squash (Ah the three sisters!) or sunflowers, which can deal with a few (edible) weeds coming out of the compost. Lots of yields, lots of options.

So: I can plant saved seeds on a bed as a cover crop, much of which is edible, or simply turn a compost loaf to the next bed: the seed load sprouts and the spot where the compost was sprouts a thick cover of edible plants. If the feral veggies and edible weeds try to choke out the eggplant or whatever special transplant I put there, no problem. I eat the offending plants or pass them to the chickens.

Learning from drought

In desperation, I realized that my compost loaves were another form of macromulch: and in my dry-summer climate, I always need to water my compost piles. So I planted squash in finished compost right next to the pile, and once the little squash plants got going, I stopped watering them. They had to send their roots into the watered compost pile. This worked great. Then a pile had some discarded potatoes sprout out of the top…

Seedlings popping up out of compost. Learning to recognize and use these plants can save time and money, while letting the system evolve. Photo by GAD-BM, CC0.

so now I put some soil and finished compost on top of a completed pile and plant potatoes in it.

My garden has a patch of flour corn every year; patches of low greens, tomatoes tied up on bamboo, bean trellises, and rambling squash vines like most. There are differences too: evening primrose, parsnip and raddichio flowering in yellow, pale yellow, and blue on stems taller than I am, scattered randomly all through the garden. Hummingbirds dart about, and families of rosy finches eat the seeds.

In recent years, I've watched as more and more birds spend time here. Butterfly diversity has increased three-fold. Garter snakes are more plentiful than when the land was a blackberry patch, and even when I'm disabled (like last year) and haven't planted much, I can hobble out, get down on hands and knees with a small pick or knife and harvest nutritious things I did not directly plant—filling a basket for dinner. I'm digging less, and the soil is getting softer. It's more often I can find areas where I can comb out a seed bed instead of laying sifted compost on top like at first. I have seed of all sorts to share, and I'm seeing that I can increase the perennial margins and have more perennials than I thought. I can see the light at the end of the tunnel: decreasing work to develop soil. I will have more time to experiment with new crop species and process the harvest. I'm excited to once again make my own tarragon mustard from scratch—only this time the vinegar will be from my own apple cider. Δ

Rick heard about permaculture while looking for grassroots ways into applied ethnobotany in 1981. He began by exploring hand tools and useful bamboos, and currently is keen on assisted migration for key western plant species. He's a PINA teacher and designer who prefers working in mixed gender teams and with animal allies. Living in Eugene and Deadwood, Oregon, he implements permaculture designs as a licensed landscape contractor partner in Earthkeeper Landscaping LLC.

Eggplant among other garden plants. Photo by MabelAmber, CC0.

(from page 59)

in exactly the same way Alexander might, both during the conceptualization stage and even, and perhaps more strikingly so, on the ground during the implementation stage, let us consider, say, the introduction of a small dam into a wetland "whose size is imprecise, and with imprecise edges," to quote Dan quoting Alexander describing a cloudy volume: a meandering watercourse passing through slightly undulating land on a gentle slope of terrain comprised of many small irregular pits and mounds. This one component, the dam, in effect serves to "crinkle" the landscape in three dimensions, thus creating a number of smaller, more defined parts: a pond of various depths, much crenellation, marshy areas, small islets. Next, the designer may alter this further by digging out some of the pits, adding height to some of the mounds, incorporating fertile soil in places, broadcasting dolomite lime in certain areas, and deciding where to sow a cover crop. Next, he may decide where an orchard should go, and the fencing to create connected pastures for poultry in rough proximity to where fish could be raised and water plants grown. All these additions are components adding complexity to the system, helping to making the "vague cloudy pattern" of the wetland "more precise" "by placing other smaller patterns, which define its edge and interior." So far, no species or varieties of trees, shrubs, vines, groundcovers, or perennials have been decided upon or introduced, even though, once the third stage is completed, one may be able to choose and locate many precise individual components. This possibility of early and quick "complexification" is especially true, and especially necessary, once one has established the location of the doorstep, and has actually begun living there, and often conflicts time-wise with the simultaneous necessity of broadscale developments such as earthmoving and windbreak establishment.

Finally, Alexander's analogy for his approach—the growth of an embryo starting from a single cell—is fundamentally flawed, although in fact, the single cell perhaps more accurately describes both sides of this design debate and may illustrate nicely the complementary nature of the two approaches rather than their mutual exclusivity. The cell is not some blank whole without parts waiting to be transformed by cell division, as Alexander portrays it. It is, rather, an incredible composite of components—atoms, molecules, and compounds—assembled one by one for billions of years. Some of them support the life of the cell itself; others completely preordain, before even the first division, exactly what will be produced. In fact, the evolution that led to that human egg is a perfect illustration of two permaculture design methods: Design from Nature and Design by Random Assembly. (Nature too learns from its mistakes—most configurations don't work!) Evolution also proceeds from the simple to the more complex, with no knowledge of, or relationship to, any future created outcome. Increasing complexity arises from an increase in the number of components. The entire design process of evolution which finally led to a human germ cell is a perfect example of, in Alexander's term, "design as a sequence of acts of complexification."

In summary, I find no difference in permaculture's approach to design and Christopher Alexander's, and conclude that any imagined differences have arisen because of an incomplete and imprecise reading of both; a failure to make distinctions between different uses of the word "whole" and different stages of the design process; a lack of differentiation between components every time they are mentioned; a false understanding of how permaculture design starts; and a confusion between the process and the finished product. Δ

"Deer Eat-Not"

Cultivating with Bambi

Robert Kourik

SINCE FENCING ADDS considerable cost to a landscape, a design with no fence at all would be the most cost-effective. But are there really landscape plants which are truly unpalatable to deer? Yes... and no.

Deer-browsed (or -grazed) plants are the most noticeable and frequent landscape casualties. When a client asks "what plants aren't damaged by deer"? the proper response should be: "Which kind of damage do you mean? The kind that results from their eating? Or from walking around, reclining, or antler-rubbing?" What deer *do* or *don't* eat is just a part of their total behavior pattern, and to have a landscape that coexists with deer means tolerating a certain amount of damage—forever.

Too many landscape designs and installations are assumed to be final and fixed. One of the greatest lessons deer have to teach us is that nature is far more dynamic than we often acknowledge. Deer are capable of constantly adapting. Over a decade's time, dozens of plants that were once deer-resistant will have become palatable or even preferred salad-bar options—count on it. Consequently, the only realistic deer-tolerant landscape is one that is partially redesigned and replanted almost every year, and a good designer is always testing new plants to find replacements for those being added to Bambi's menu.

Here are some very rudimentary guidelines for deer-resistant plant material, based on specific plant examples from my home landscape (which may or may not work with your deer.)

• *The first guideline is that there are no concrete guidelines.* For instance, the same species of white-tailed deer will eat very different plants from state to state, city to city, and even in different areas of the same county. For all practical purposes, there are hundreds of subspecies or "clonal herds" which have developed their own diets. So, get to know very well what your local deer eat; no "official" list will match your reality.

• *There are almost no deer-proof plants;* any plant will be damaged if a 200-lb. mammal lies on it or uses it to preen its antlers. Even plants not usually on the menu may be nibbled in a hungry year, so deer-resistant plants are a more reasonable goal. Over a period of seven years in my landscape, some completely uneaten plants include: all varieties of rosemary *(Rosmarinus spp),* all species of santolina *(Santolina spp)* (choice mattresses, however, for sleeping and resting deer), all lavenders *(Lavandula spp)* and Jerusalem sage *(Phlomis fruticosa)*.

• *Higher deer populations greatly increase the number of plant species that deer will devour.* Since most urban/suburban deer herds are continuing to increase, count on designing for the worst-case scenario—and an ever-dwindling repertoire of tried-and-true plants. Until three years ago, the lily-of-the-Nile *(Agapanthus africanus)* in my landscape was safe from hungry ungulates; now its buds are regular midsummer fodder. Forty miles south of my house, this plant lost its deer-resistance ten years ago.

The author's deer-resistant garden is beautiful and productive.

• *Exotic, non-native plants are usually less ravaged than native varieties,* possibly because the deer haven't evolved with these plants and so learned to tolerate or digest their matrix of chemicals, toxins, and fibers. One particularly deer-tolerant group of exotic plants for my area are the Australian grevilleas: *Grevillea lavandulacea, G. 'Canberra,' G. rosmarinifolia, G. 'Noelii,'* and *G. lanigera*.

• *Thorns are no guarantee of protection*. Rose plants, covered with big or little thorns, are preferred deer forage throughout the country. Only certain thickly thorned cactus are deer- (and people-) resistant.

• *Silver, gray, or glaucous foliage is not a sure indicator of deer-resistence.* Witness the Dusty Miller *(Senecio cineraria),* wormwood *(Artemesia absinthium),* and Matilija poppy *(Romneya coulteri)* plants I've lost from my test plot. However, Pride of Madeira *(Echium fastuosum),* woolly thyme *(Thymus pseudolanuginosus)* and santolina *(Santolina chamaecyparissus)* all have gray foliage as well as reasonable to high deer-resistance.

• *Plants of the same genus aren't necessarily equal in their deer-resistance factors.* The deer have never eaten my common culinary thyme *(Thymus vulgaris)* or the lemon-scented *Thymus citriodorus,* but after August, when the native California landscape is dry and crusty, they'll feast on well-watered woolly thyme grown in a container. The resistance or palatability factor is highly variable between species and named varieties of wild

lilacs *(Ceanothus spp)* and rockroses *(Cistus spp)*. *Ceanothus* 'Julia Phelps' isn't eaten, but seems to be a favorite for antler-rubbing; some rockroses are safe in my garden, but most aren't.

• *Prostrate growth habit is no guarantee of protection from these so-called browsers.* Prostrate plants which have been eaten at my house include: 3-4-inch-tall *Ceanothus hearstiorum* (but only in late summer, after blooming), ornamental strawberry (*Fragaria spp*, is a favorite) and bearberry or prostrate manzanita (*Arctostaphylos uva-ursi*, a native 2-4 inches high). Prostrate successes include: most thymes *(Thymus spp), Myoporum parvifolium* (1-3 inches) and California sagebrush 'Canyon Gray' (*Artemisia californica,* 6-8 inches).

• *Never count on aromatic herbs to be deerproof.* Notable aromatics favored by grazing deer include: sweet marjoram *(Origanum majorana),* mints (many members of the *Mentha* genus), garlic chives (*Allium tuberosum*—good until four years ago, now a regular late-summer snack), *basil (Ocimum spp)* and bronze fennel *(Foeniculum vulgare dulcee, var. rubrum)*.

I prefer "crusty," woody, and undergrown plants....

Beside the herbs mentioned earlier in the article, I've had success with: some sages *(Salvia officinalis, S. clevelandii,* and *S. leucophylla*), society garlic *(Tulbaghia violacea),* and chives *(Allium schoenoprasum spp)*.

• *Bulbs and tuberous-rooted plants are hit-or-miss.* Narcissus, daffodil, native Douglas *iris (Iris douglasiana),* Dutch iris, and hyacinth blooms are reliably deer-proof, but the hoofed connoisseurs eventually seem to learn to love tulip flowers. Old-fashioned daylilies *(Hemerocallis fulva)* are often ignored, but the flower buds on hybrid daylilies are sometimes eaten before they open.

Observe your neighborhood and community to see what's thriving without protection. When purchasing plants for California landscapes, I try to avoid those which are well fed and amply watered. Deer love to feast on the succulent new growth found on lush nursery plants. As a result, I prefer "crusty," woody, and undergrown plant material for deer-scapes. Before planting overstimulated nursery plants at a deer-plagued job site, I take them to a fenced area near my house for a few weeks' hardening off by means of reduced watering and skipping all fertilizers.

Any transplant, by virtue of the water necessarily added at planting, is vulnerable for the first few weeks or more. When installing plants that are marginally deer-resistant, or where the deer population is high, use a deer-repellent spray. University-sponsored tests have shown the best sprays to contain either rotten (fermented) egg solids, ammonia and fatty acid soaps, or Thiram™ (a chemical repellent) as the primary ingredient. Hot red pepper and Tabasco™ sprays have a strong reputation, but they don't always measure up in controlled field and orchard trials. A contractor using them should spray the entire foliage and some of the mulch around each new plant before leaving the job site each day. Warning: if mixed too strongly, all of these sprays may burn the foliage of plants—read the labels, and use hardened-off plants where possible.

Designing for a landscape that can coexist with deer is a constant learning process for the landscape architect or designer. The best deer-resistant landscapes are often designed by very local landscape architects, not out-of-towners. And, since deer are busily adapting even at this very moment, no designer can rest long on his/her laurels. From observing how deer interact with landscapes, we can learn much about the persistent flux and adaptability of nature. These wily ungulates can teach designers to work with native realities, rather than the latest sustainable-growth theory or environmental paradigm. Not bad for a "dumb" animal! Δ

Robert Kourik started his organic maintenance and landscape design company in 1975—long before the word sustainable "existed." He is the author and publisher (Metamorphic Press) of Designing and Maintaining Your Edible Landscape - Naturally, Drip Irrigation for Every Landscape and All Climates, Roots Demystified: Change Your Gardening Habits To Help Roots Thrive, No-Dig Gardening, The Lavender Garden, *his most recent book*—Understanding Roots: Discover How to Make Your Garden Flourish, *and nine more horticultural books.*

Carbon Farming

Broad Issues in Plant Development

Eric Toensmeier

OUR PLANET IS HOME to approximately 250,000 species of plants. Approximately 20,000 are edible for humans (1). Approximately 6,000 are cultivated for food, fodder, materials, chemicals, and energy (2). Fully domesticated crops tend to show reduced toxicity, better flavor, greatly increased yields, and easier harvest. They also usually become more dependent on irrigation, pest control, and weeding. Of the 6,000 cultivated species, few are fully domesticated—perhaps 100 food plants and 30 industrial crops (1).That means we're relying heavily on only 0.5 percent of the plants we could potentially be using (1).

Plant domestication is a process of people—whether consciously or unconsciously—selecting for useful traits. In return, the plants become increasingly dependent on us for their survival and dispersal. For example, an individual tree might produce larger nuts with thinner shells, higher and more consistent yields, and more concurrent ripening relative to other individual trees (1). These traits might make it less suited to survival in the wild, but if it exhibits these traits on a farm it may be protected from pests, may have competing plants weeded from its neighborhood, and may even be irrigated and fertilized. In this way domestication is a two-way street, a mutually beneficial arrangement between humanity and our crops. When it goes far enough, both species become dependent on the other for survival (3).

A Cameroonian nursery offering elite fruit tree varieties selected by the participatory, farmer-led breeding work described in the text. Photograph courtesy of the World Agroforestry Centre.

Climate change mitigation has a tight timeline.

Climate change mitigation has a tight time line. We have only a few decades to retreat from the tipping point to 350 ppm or below (4, 7). The question of plant breeding and how long it takes to domesticate a new perennial crop is important in this context. During World War II the United States found itself cut off from imported rubber supplies. A search for a domestic rubber source identified a promising candidate (a goldenrod). Not surprisingly, it proved impossible to start with a wild, completely undomesticated plant and domesticate it to the point of serving as a commercial rubber source in just four years (5). Mass-planting a crop that is not yet ready for release, as happened with the industrial oil crop jatropha, which was planted for biodiesel production, can lead to disappointing yields and economic disaster (6).

It looks like there are three waves of perennial crops coming to our climate rescue. First are those that are already in production, such as our global, minor global, and regional crops. Most could benefit from additional breeding work to improve yields and mechanical harvest ability, but there are already good varieties in production. This wave of perennial crops is ready for widespread planting now. It is for this reason that this book places such a strong emphasis on regional and minor global crops.

The second waves may take five to ten years. This includes crops such as perennial rice that researchers and plant breeders have been working on for decades, the results of which are nearly ready to release. It also includes some crops that require some more basic research or market development before they're ready for broad-scale adoption by farmers, or they may perhaps require innovations in harvesting or processing equipment. Breeders estimate that developing and releasing a new variety of an established crop can take between 8 and 20 years (7).

The third wave may take decades. Perennial maize could be ready in 10 to 40 years if funding were available (8). Although this might seems like too far in the future to be of much use from a carbon farming perspective, all climate projections I've seen indicate that we'll need to continue sequestering surplus carbon through this century and beyond, especially since the current rate of fossil fuel emissions is likely to continue or increase. In other words, this third wave doesn't offer a short-term solution, but that doesn't mean we should abandon our efforts just because we won't see the fruits of those efforts for decades. We may still need them at that point.

International law does not currently have a mechanism to protect the intellectual rights of indigenous people and poor farmers who make contributions to plant breeding (9). Plant Breeders Rights (PBR) are rights granted to the breeder of a new variety that give the breeder control over the propagation and harvest material of a new variety for 20 years (and 25 years for trees and vines), but these rights are typically granted by

Land Institute staff emasculating sunflowers (removing the male flower parts) as part of perennial sunflower breeding efforts. Photograph courtesy of perennialgrains.org.

national offices to large seed companies, creating a tension not only between the well-funded patent efforts by large corporations and the rights of individual smaller farmers, but internationally as well (10). In fact, corporations have patented numerous species and varieties that were developed by poor farmers. Perhaps the most famous such biopiracy effort was a Texas company's outrageous attempt in the 1990s to patent basmati rice, a set of varieties developed by farmers in India over thousands of years (11). A fair trade group called PhytoTrade Africa is helping farmers develop markets for agroforestry products without losing intellectual property rights (9). For example, they helped a women's marula oil producers cooperative in Namibia develop a shared patent for their product that protects their rights and secures them a market (9).

There are ongoing efforts to develop an intellectual property model suited to small farmers, rather than a model that only serves the interests of large corporations, but to date no agreed-upon model has emerged. A modified form of PBRs would provide a 25-year patent to farmer groups. NGOs may be able to assist farmer--breeders by creating a registry of varieties that includes the GPS location of the original tree, the history of the variety, and a tree's "genetic fingerprint" (9).

Three standout breeding efforts

Some perennial crops are not yet competitive with annuals, particularly in cold climates. Around the world, plant breeders are hard at work improving yields, harvestability, and other key aspects of up-and-coming perennial crops. These scientists, farmers, and backyard breeders are unsung heroes of carbon farming. Here we profile three outstanding breeding efforts.

Propagating the "Trees of Life"

Roger Leakey is a global expert on agroecology, tree domestication, and sustainable development who spent five years as the director of research at the International Centre for Research in Agroforestry (today the World Agroforestry Centre) and was a coordinating lead author in the International Assessment of Agricultural Science and Technology for Development (IAASTD). His book *Living with the Trees of Life: Towards the Transformation of Tropical Agriculture* was published in 2012 and offers a strategy for a transition to tree-based agriculture based on his decades of experience.

Although breeding is typically performed in government, university, or corporate labs, Leakey argues that it makes more sense to base domestication work on farms and in communities. He envisions crop-improvement work as a "participatory, self-help process in the community, done by the community," with the assistance of scientists (1). Farmers know that without a market, new crops will be limited to household use only, so Leakey argues that breeding should be "farmer-driven and market-led" (1). At the World Agroforestry Centre, he and his colleagues developed a simple, reliable vegetative propagation technique that requires no electricity for misting. It is a marvelous example of appropriate technology (1). This allows the rapid multiplication of exact clones of the best individual trees found in the wild or on farms.

Leakey describes "Cinderella trees," which offer important foods but are ignored by formal science (1). These species need a "fairy godmother" to assist farmers in domesticating them for a "woody plant revolution" (1). Because wild plants have high genetic diversity, the best individuals ("plus-trees") can be selected for propagation. Leakey has found that local communities always know exactly where the best individual trees are (1). Almost everywhere this farmer-led domestication process took place, farmers prioritized nuts and nutritious tree fruits for their breeding efforts, although they could have picked any wild plant species they wanted (timber, vegetables, medicinals, and so on) (1).

...selecting superior individuals of a species and vegetatively propagating them is an ancient practice that continues to this day around the world.....

Once a plus-tree is successfully cloned in a nursery, it can be mass-propagated and widely planted. In Leakey's system each village domesticates its own local varie-ties, so that even if many villages undertake this work, a wild crop's genetic diversity is not lost (1). Typically, these plus-trees are planted as components of diverse farms, not in large-scale monocultures. Crossing these elite plus-trees with one another can "[give] rise to tree cultivars that are as distinct as dog breeds …" (1). This kind of tree improvement is not widely practiced because it is slow—trees can take years to start producing and showing the positive or negative traits needed to select the following generation (1). But selecting superior individuals

TABLE 10.3. Estimated Number of Years Before New Perennial Grain Crops Will Be Field-Ready

Method	Years to Achieve 1 t/ha if Started Today[a]	Years to Achieve Competitive Yields with Major Grains if Started Today[a]	Years to Achieve Parity with Highest Grain Yields
Domestication of wild perennial grains	8–12	15–25	50–75
Wide-crossing of annual grains with perennial relatives	5–20	10–40	50–75

[a] "If started today" because enough has been learned in the development of the partially domesticated perennial grains we have today that, if we started today with what we now know, this is how long it would take. We do in fact have some crops quite a bit further along than this already.

of a species and vegetatively propagating them is an ancient practice that continues to this day around the world, often by dedicated individuals and clubs lacking funds and government or institutional support. As more farmers learn the techniques, they can begin to domesticate other species. Participatory cultivar development is also much less expensive compared with a Green Revolution–like approach. Leakey would like to see governments, NGOs, and businesses play a positive role in participatory plant domestication in the future (1).

Leakey's work offers the prospect of "waves" of new perennial crops. The first wave would contain the elite plus-trees selected from the wild. They become available quickly. The second wave would come from crossing these elite individuals to one another. Finally, these crops could be fully domesticated in a third wave in which they reach their full potential.

Massive investment in breeding would be required for any other crop to catch up to these few annual superstars....

Perennializing grains

Perennial grains have been a dream of the sustainable agriculture movement for some time. They promise to marry the carbon and agroecological benefits of perennials to the annual staples we know and love. The task of perennializing grains is a slow and laborious process, but thanks to visionaries such as Wes Jackson and his colleagues at the Land Institute in Salina, Kansas, we are relatively far along in the process with some crops because they began working on it decades ago with the goal of developing perennial cereals, pulses, and oilseeds. Likewise the Yunnan Academy of Agricultural Sciences in China has made incredible progress in efforts to perennialize rice. A big advantage of developing perennial grains is that, unlike cloned tree crops, grains are usually planted from seed and each plant is a genetic individual. This kind of breeding takes longer, but it means a given crop will have greater genetic diversity, resulting in relatively less pest and disease pressure than would be typical in an orchard or plantation of cloned crops.

There are a few different approaches to perennializing grains. One approach is to begin with promising wild perennial grains and select for desired traits for many years until they become domesticated. The Land Institute has used this technique to domesticate a perennial wheatgrass they call Kernza, which they project will yield the same as annual wheat by 2033 (12).

Another approach, referred to as wide crosses, involves crossing annual crops and their wild perennial relatives. So how long will it be before we have new field-ready perennial grains using the knowledge and techniques we have today? There are a number of factors that make this a difficult prediction. Some wide crosses, such as wheat, are very difficult, while others, such as sorghum, go rather smoothly. In fact, wide crosses of sorghum have been so successful that perennial sorghum looks poised to be the next perennial grain to arrive on the world scene. Some plants bear seed the first year, while others take multiple years to bear, slowing the process significantly. Available funding is also a key variable.

How long does it take to develop a new perennial grain yielding at least 1.2 tons per hectare (the Land Institute's current target, based on yields of quinoa and other marketable specialty grains)? How long to yield as well as its annual competition? David Van Tassel of the Land Institute was courteous enough to give me the short answer: "It depends;" and the long answer: "Remember that the yield of major annual grains also 'depends'." So, for example, achieving parity with grains in African subsistence agriculture could be much easier than achieving parity with corn or soybeans in Illinois. Rice and maize in particular have very high yield potential so that phenomenal yields can be obtained under high-input, optimal conditions. Average yield everywhere else can be quite different" (13, 14). Van Tassel's own words on where perennial grains are and are not likely to be able to compete:

It will take much longer to develop perennial grains that can compete with annual grains in both extremely productive environments and extremely unproductive environments. This is because very few grains (annual or perennial) have the yield potential necessary to take full advantage of extremely favorable conditions. [These "prime" areas represent about a third of world cropland (15).] Massive investment in breeding would be required for any other crop to catch up to these few annual superstars which themselves continue to receive the lion's share of agronomic investment.

Annual crops may also be difficult to displace in very drought-prone environments where soils are commonly left bare of vegetation for long periods of time (e.g., for a full year) until soil moisture has been recharged enough to allow a short-lifecycle grain to produce a single crop. Alternatively, crops may be sown each season with the expectation that they will

fail if the rains do not come. It may be very difficult to breed perennials to remain dormant for a full year or to green up only when the rains come.

In general, perennials adapted to environments with regular drought-stress are likely to be slower to domesticate because their adaptations (long roots, succulent tissues) are likely to require early investment that delays the transition to sexual reproduction. This implies longer breeding cycles and therefore slower progress. Moreover, finding and maintaining an optimum plant density for soil water management is likely to be more difficult than in less water-limiting environments (13, 14).

Van Tassel further clarifies that these estimates are "assuming we're talking about perennials that can set seed the first or second year (not trees that take five years to begin flowering), and assuming that we are talking about parity with major crops outside of the super--special breadbasket regions (i.e., maybe wheat but not maize in the upper Midwest, maize or sunflower but not rice in Thailand; any annual grain in Africa, any unirrigated grain in Kansas)." He notes that annual crop yields are a moving target since ongoing annual crop breeding is well funded and ongoing (13, 14).

With all these caveats in mind, Van Tassel ventured his best estimate. Starting today, with current knowledge, he estimates that to bring promising undomesticated wild grain yields to 0.2 t/ha would take between 8 and 12 years, and 15 to 25 years to bring them to yield parity with grains outside of the special breadbasket regions. For wide crosses of annual grains with perennial relatives, he estimates 5 to 20 years and 10 to 40 years respectively (13, 14). Van Tassel notes that the ranges are greater for wide crosses because they are more unpredictable than simply domesticating wild perennial grains (13, 14). Note that many perennial grains have already been worked on for many years, so we are not starting from scratch with crops, including rice, rye, wheat, and sorghum.

Breeding work alone is not sufficient to bring perennial grains to life. How will weeds, pests, and fertility be managed in perennial grain fields? Development of management and agronomy practices needs to go hand in hand with breeding to ensure sustained yields (13, 14).

Hazelnuts ripening in their husks. Hazelnuts are one of the most promising temperate cool climate perennial carbohydrate and oil crops in development. Photo by myfriso, CC0.

Hybrid swarm breeding

Back in the 80s breeder Phil Rutter of Badgersett Research Corporation in Minnesota decided to dedicate his life to developing woody perennial staple crops to fight climate change. He calls his approach "woody agriculture". Here I focus on Badgersett's remarkable breeding practices.

A hybrid swarm is a phenomenon found in nature when two or more species in a genus have overlapping ranges, and cross with each other and their hybrid progeny repeatedly. This creates an extremely diverse population that can form the basis of a new species (16). Rutter's vision was to create hybrid swarms of staple tree crops to develop new food sources, a process he calls "accelerated guided evolution."

"Clonal crops are a death trap" due to monoculture vulnerability to disease.

Badgersett began with interspecific hybrids of various nut crops, meaning each was the result of a successful cross between two related species. Their chestnut and hickory-pecan swarms each contain genes from five species, and their hazels from three. Rutter says that interspecific hybrids are "promiscuous," meaning they cross more easily than pure species, leading to exponential increases in diversity in the hybrid swarm (16).

In each generation, Badgersett selects for two desirable traits. This involves huge amounts of record keeping and culling undesirable plants. The first round of hazels selected for blight resistance and cold hardiness; the second selected for yield and annual cropping (producing good yields every year instead of every other year). And so on. Today they have planted out the fifth generation—bear in mind that it takes five years or more until hazelnuts produce nuts (16).

Rutter and his colleagues envision their neohybrid plants becoming totally new crops. To Badgersett, no temperate nut crops are properly domesticated yet, but it's possible. Already they have chestnuts with 7, 9, and even 12 nuts per burr instead of the normal 3 or 4 (17). And they are seeing interesting traits come up in their hazels. For example, they are finding shells with as many as four nuts inside, a step on the way to their goal of hazelnut clusters the size of ears of maize. Ultimately, they want to see hazels come as far from where they are now as maize has come from its wild ancestor, which had only a few kernels per head (16). These "hazelnuts on the cob" could transform the temperate food system. This transformation is Badgersett's goal.

All of Badgersett's crops are seed-grown (although the organization is beginning to select some individuals for clonal propagation). Rutter says, "Clonal crops are a death trap" due to monoculture vulnerability to disease. Genetically diverse plantings are also more resilient to climate change. Finally, seed-planted trees are much less expensive than their clonal counterparts, making it possible for large-scale farmers to

convert to woody agriculture (18, 19). Rutter also points out that, unlike perennial grains, nut trees are already edible and cultivated to begin with. Their higher market prices can offset their lower yields. Δ

Editor's Note: This excerpt is from Eric Toensmeier's book *The Carbon Farming Solution: A Global Toolkit of Perennial Crops and Regenerative Agriculture Practices for Climate Change Mitigation and Food Security* (2016). We thank the publishing team at Chelsea Green for supporting the inclusion of this article and, of course, the author for dedicating time to producing the book.

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Hazelnut catkins in spring promise a heavy crop for the coming year. Vegetative reproduction is the key to genetic health and system resilience even though it is slow going for plant breeders. Photo by Didgeman, CC0.

Permaculture Practice

Experiences with Poultry in the Mid-South

Chickens

John Wages

Disregard everything in this article, especially the part about electric fencing. You don't need it. Your chickens will be just fine. Wile E. Raccoon

I grew up with chickens. I can't imagine being happy without a yard full of chickens. My grandmother's chickens ran free. A fence kept them out of the garden, but they were otherwise free to roam around the front yard, the back yard, and out to the barn—even into the road or the woods if they were that unwise. A few times, they even went under the house if they could find a hole. This annoyed my grandfather, who was convinced they would die under there and set off a terrible stench. But they always came out. The only time those chickens were ever confined was at night. Every evening, as the sun went down, the hens went one by one into the chicken house, and one of my grandparents locked them in. There, they were safe from opossums, raccoons, skunks, foxes, and other predators.

Nowadays, there are many more predators. Unprotected "yard chickens" would gradually be picked off by hawks and especially stray dogs. There are more stray dogs now than in my grandparents' day. The hardest part about keeping chickens is actually keeping them.

Chickens have a prominent place in permaculture lore, but having 20 "yard chickens" running everywhere is not a very good example of design. These domestic descendants of the jungle fowl of Southeast Asia scratch the ground in search of food, as their ancestors searched the jungle floor. Constant scratching removes all vegetation, leaving bare soil. As anyone knows who has ever made the mistake of confining too many chickens on too little ground, they destroy everything. The second hardest part about keeping chickens is preventing them from destroying the landscape.

Chickens are induced to leave the comfort of the chicken tractor by feeding stations in the fenced yard where they day-range under the protection of electric net fencing.

Predator control

Chickens are most vulnerable at night, because they have very poor night vision. Animals like opossums could never chase down a chicken during the day, but at night, they can climb up on the roost and nibble away. Raccoons are particularly effective. They can reach through 1-in. poultry netting and grab a wing or a leg from a bird sitting too close to the wire. When we were setting up our backyard duck house in coastal California, the local farm supply warned us to use 1/2-in. wire (aviary wire), not 1-in. hardware cloth or poultry netting. With electric fencing, this isn't necessary, but if raccoons are able to reach roosting birds at any place without touching the wire, you should use 1/2-in. wire, either hardware cloth or poultry netting.

Without electric fencing, I doubt we would be able to keep chickens here at all without constant attention. There are just too many raccoons and opossums. Eventually, someone will forget and leave the door open or ajar at night. Just once is all it takes to lose a flock.

For purposes of discouraging small mammal predators, we used a 6V solar charger from Parmak. With nail-up plastic insulators and naked aluminum wire, we could encircle a stationary chicken house, a chicken tractor, or a brooder. We often heard the yelp of a stray dog or raccoon the first time it encountered the fence. Yep, they're out there.

Parmak also makes a 12V solar charger. To deter large predators like bears, more powerful chargers may be needed.

Guard dogs are a more traditional approach. Any dog that has access to chickens must be trained not to instinctively chase them.

Habitat destruction

Unlike other poultry, chickens scratch at the ground to

uncover insects, seeds, other bits of food, and grit for their gizzards. They constantly pluck tender green grass. This constant scuffling and disturbance is extremely hard on the soil cover. Depending on the stocking density, the ground immediately around a stationary chicken house quickly becomes hard-packed in dry weather and a muddy mess when it rains.

The problem becomes the opportunity with the chicken tractor (1). A chicken tractor is a moveable coop that is open to the ground so that chickens can scratch to their hearts' content. Before they've totally denuded the spot, the coop is moved to fresh grass (the Joel Salatin approach, 2). Alternatively, the unit is left in place, and fresh bedding (straw) is added so that the chickens prepare a richly composted growing bed before being moved (the tractor approach). There are many designs for chicken tractors, but a typical unit is around 4'x8' and is light enough to move with a hand truck or simply by pulling using handles installed for that purpose. Around 10 hens is fairly high density for a unit of this size. If you want quick tillage, add more hens. If you want to leave the unit in one place for a long time, add fewer. A general rule of thumb is one hen per 4 sq. ft. if constantly confined.

Of course, a chicken tractor can also have a small door, and hens can be allowed to free range outside the tractor. In this case, the same solar charger that powers the fence at night can charge an electric net fence (3). By encircling the coop with the net, one has the best of both worlds: keep the chickens inside when no one's around to watch them, then let them run free when you're home.

The permaculture chicken

Chickens are multifunctional. Not only do they yield eggs and meat, but also they offer custom tillage services. Under fruit trees (with suitable protection for the roots of young, vulnerable trees), they scout for insect pests. Importantly for urban backyards, they provide waste disposal services, transforming kitchen scraps into eggs. Their high-nitrogen, high-phosphate manure is ideal garden fertilizer. Enterprising young poultrymen (or women) may explore the uses of the feathers of certain breeds for tying flies for fly fishing. With all these advantages, chickens are logical components of most designs for self-sufficiency, whether urban backyards or remote homesteads.

A piece of vinyl roofing is wedged between the wire and foam insulation to prevent birds from reaching the foam. Note the single strand of electric wire that goes around the unit, about a foot from the ground.

I wonder how many people have gotten chickens without being prepared. When we decided to downsize our laying flock, we sold about 100 hens to a neighbor who already had chickens. Despite my warning about predators and the need for electric fencing, they put their new chickens into an insecure house because they hadn't taken the time to prepare a larger coop. The losses started the first night and continued until all the chickens were gone. This happened to someone who should have known better. Just a small hole is all it takes for a raccoon to get started. The novice imagines the raccoon will eat just one chicken. This may be true, but the meal itself may actually come from 5 or 6 separate chickens. Raccoons tend to be wasteful.

Be aware that commercial egg ration or custom mixed feed will spoil your birds to some extent.

So, prepare a careful design. Design a secure coop for night. Many books have designs and guidelines for various climates. In the South, we need good ventilation for the heat of summer, and some protection for the coldest winter nights. Design the best range system for your needs, whether a tractor or moveable fencing. Go a step further and plant chicken forage: fruiting bushes along permanent fence rows, crabapples, comfrey, and others (4, 5). Be aware that commercial egg ration or custom mixed feed will spoil your birds to some extent. Expose them to forages like comfrey from an early age. While picky eaters may have to be introduced to some foods, there will be no problem with insects. During the summer, a near-UV light (or any light for that matter) can be set up in the chicken yard. Many insects will be attracted to the light and will still be there the next morning when the chickens wake up. Other systems for raising mealworms, soldier fly larvae, and other insects for chickens have been described. Insects are the natural high-protein feed for chickens.

Getting started

There is a reason why permaculturists and homesteaders start with chickens. They're easy to handle, and yields are dependable. The first choice is often the breed. Some breeds

have been developed for high-yield egg production. A breed like the White Leghorn or related hybrids (California White) can approach an egg a day under ideal conditions. However, the body of an egg laying hen is too small to be very good for the table. For meat production, several large breeds are available, but only one is used in commercial broiler production: the Cornish Cross hybrid. These birds grow remarkably fast, reaching 5-6 pounds after just two months, under ideal conditions. Unfortunately, only ideal conditions will do. Without precisely mixed, highly enriched feed, the Cornish Cross tends to develop leg and joint problems. While pioneering pastured poultry producers like Joel Salatin (5) have developed systems that work well with the Cornish, others have developed more enthusiastic foragers like Freedom Rangers which are better suited to free range production.

For the urban backyard, egg production may be the only yield goal. While the Leghorn may be the best egg producer, it's not a good choice if you have neighbors, children, or dogs. Leghorns tend to be flighty and noisy, not a good combination for the city. Any good book on backyard chickens can tell you if a given breed tends to be nervous or calm, and there are many choices. Avoid roosters unless you and your neighbors don't mind early morning wake-up calls.

..his demand had outstripped his supply. So, we began to scale up....

For the homestead, a dual purpose breed is almost always the goal. To choose a breed, look around at what the old-timers have in your area. In my grandmother's day, White Rocks, Barred Rocks, and Wyandottes were popular, as were bantams. In areas with very cold winters, a breed with a small comb like a rose comb or pea comb (as opposed to the large single comb of breeds like the Leghorn) may be less prone to frostbite. Silver-laced Wyandottes are a breed with a good temperament, good egg laying stats, and reasonably fast growth. Although they don't grow as rapidly as Cornish, Wyandotte cockerels are ready to eat after a few months. Other breeds like the Buff Orpington or the Delaware make good dual-purpose choices as well. We tend to avoid bantams because they easily fly into and out of gardens and like to roost in trees rather than go into the safe house at night.

Ameraucanas are interesting for children and inquisitive neighbors as well. This breed lays green and greenish blue eggs. Developed from the true Araucana breed, which lays blue eggs that unfortunately tend to be rather small, a few Ameraucana add interest to a flock. In my experience, they have a reasonable rate of egg production. In the last five years, a British breed developed for blue egg production in the 1930s, the Cream Legbar, has finally been imported into the US. At the moment, only a few hatcheries carry the Legbar, but it offers yet another choice in multihued eggs.

Cornish Cross consume massive amounts of feed to sustain their ultra-rapid growth rate. This bird will hit six lbs. by eight weeks after eating 12-15 lb. of feed. "Should I go back for seconds?"

Our experiences

In 2001, we moved back to the small farm in northeast Mississippi where I grew up. Drawing on my recollections of my grandmother's chickens from the 70s, I started out with Silver-laced Wyandottes and hedged my bets with a handful of Barred Rocks and some Buff Orpingtons. These came from a regional hatchery, in southwest Missouri, that maintains production lines of several breeds. This is an important consideration—the goal of some hatcheries is to maintain the standard of the breed—feather color, comb form, and so on, which is meaningless for the producer. For really great production, a production line is needed. Also, this hatchery was close enough that our chicks arrived the next day after shipping. We rarely lost more than one or two per shipment. I could recommend that hatchery (it's in Springfield, MO), and they do have excellent stock, but it may be more appropriate for you to find a hatchery that's close enough to you that there are unlikely to be any shipping delays.

Those initial chickens were intended for our own personal use. Ultimately, we were interested in some farm-based income, so we began to experiment with chicken tractors. We located a feed mill about an hour south of our place, where the owner would mix as much or as little as we needed. I procured some empty, feed-grade 55-gal. plastic barrels, and we had the feed mill dispense the feed into these. Up until this point, we were growing in variations of the Andy Lee-style chicken tractor enclosed at one end with a hinged lid, with nest boxes and roosts, and using standard stationary chicken houses with fenced chicken yards. We raised up to 50 broilers at a time using these methods, and had about 200 layers (White Leghorns, New Hampshire Reds, and Issa Browns).

Then, in 2005, a grower approached us. He had found a high-end restaurant that would buy all the pastured poultry he could raise. He had built a processing facility, but his demand had outstripped his supply. So, we began to scale up, growing 100 birds, then 200, and finally 500 Cornish Cross broilers per batch. As we scaled up, we settled on a hoop-style chicken tractor built on a simple 2"x4" frame (8'x12'), connected by "hurricane straps" (joist hangers). A cattle panel (4'x16') was arched over the frame and attached at each end with several U-clamps (for pipes, conduit, etc.). The unit ends up being 4-5' high in the center. 1-in. poultry wire covered this, being attached in several spots with J-clip connectors (for making rabbit hutches). The ends were enclosed in poultry wire, as well, with a door being framed in one end. Between the poultry wire and the cattle panel, we placed reflective foam insulation (at a height the birds cannot reach—very important, as all chickens love to eat styrofoam). The insulation is important during colder weather, such as when young birds are first put on pasture in the early spring, and even more important during the heat of summer. Days that hit the upper 90s (°F) are common in July and August. Without adequate shelter from the sun, overweight broilers will die. We covered each unit with a reflective tarp. On the very hottest days, we parked the shelters under some small trees, set up our net fencing, and allowed all the birds to run free in the shade.

The pasture we used for this operation was not that close to our house, and there was a large, tall fence row serving as a sound break between us and the chickens. Predator control at night was absolutely essential. At the corners of each unit, a short (18 in.) post provided a place to attach the electric fencing about a foot above the frame. Powered by the 6V charger, this system was adequate to discourage stray dogs and other animals. A single charger could power the short perimeter wire, plus the net fencing, for several hoop shelters as long as they were close together. We ran the electric wire between shelters using insulated T-posts.

...almost anything can work in a mild climate.

These units were easy to move, adaptable to our mild winter/hot summer conditions, and very secure for the animals. For long-term durability, some sort of rot-resistant wood (locust, cedar, or treated) or light-weight metal must be used for the frame. The units are heavy, but moveable. With two hand trucks and two people, they are fast and easy to move. When the birds are young, moving once a day is fine, but as they get older, we preferred to move the units twice a day. We housed 100 birds per unit, but they were allowed to range during the day outside the unit inside an electric net fenced area. This system worked well, and we achieved the expected growth rate of the breed without too many of the reported problems with joint malformations.

The New Hampshire Red is a dual-purpose breed selected from the older Rhode Island Red. Docile and beautiful, they're a good choice for a backyard flock.

Unfortunately, the market dried up, the middleman went bankrupt, and we were never paid for the last batch of broilers—it was fun while it lasted.

Hover brooder

The hoophouse chicken tractor design made it possible for us to scale up. But how did we brood 500 chicks? Initially, we built a 10'x24' brooder house and hung metal light fixtures with 100W bulbs. This worked tolerably well for small numbers of chicks. In the early spring, we covered the brooder house in plastic at night, then uncovered it partially during the day, depending on the weather. With just a few chicks and a decent shelter (no drafts), almost anything can work in a mild climate.

Fortunately, before attempting to brood 500 chicks this way, we found plans for a hover brooder (6). This design, originally from Ohio State University (1940), is easy to build. A 4'x4' unit of ¼ in. plywood is equipped with two ceramic light sockets. In our climate, 100W lamps provide plenty of heat even in late Feb. In summer, 25W bulbs are sufficient. The brooder is 4-8" high, and chicks range freely in and out, self-regulating by moving closer to or farther away from the heat source. If desired, the top of the brooder can be insulated with 4" of pine shavings or wood chips. One brooder can accommodate 250 chicks.

Beyond chickens

Chickens are universally popular because they're so easy to keep. There's a reason why there are almost 20 billion chickens in the world. Even if your situation isn't perfect, you can still get a yield, as long as you protect your birds from predators. And, mistakes with a small flock of chickens usually aren't Type 1 errors.

Ducks are almost as easy as chickens. The same precautions against predators are necessary. While ducks don't require a

pond, anyone who has seen a duck encounter a swimming hole for the first time would have a cruel heart indeed to deny them their pleasure. Duck eggs are good for cooking (or eating, although they do taste a little different from chicken eggs). When choosing duck breeds, be aware that there are no true dual-purpose breeds. The Khaki Campbell and Indian Runner are the best egg layers, but they are quite small and bony. The Pekin is the traditional meat duck, and hybrids are available. However, these require high-octane rations and special care much like the Cornish Cross.

Our experiences with geese were hopefully atypical. Our Pomeranians were stunningly beautiful but destructive of our pond bank. They were vicious at times to other birds like an unfortunate Aylesbury duck, whom the geese cornered and proceeded to pluck.

Turkeys are hardy as adults, but strangely fragile as chicks. Old-timers claimed that young turkeys could drown because they'd look up at the sky too long when it rained. As adults, the main problem is protection from predators. We never successfully trained any of our turkeys to go inside at night. Their strong instinct is to roost on a fence or in a tree. Even though they're big birds, they're no match for coyotes, dogs, or raccoons at night. The problem of predator control for free-ranging turkeys is under-appreciated.

Guineas, like turkeys, are good birds for hot climates. Even more than turkeys, guineas simply won't go into shelter at night. If you were willing to take the time, you could physically drive turkeys into a coop every night, but guineas would simply fly away. In my grandparents' time, flocks of guineas roamed the area. If you wanted to eat one, you had to catch it at night, set a trap, or shoot it. Guinea eggs were found only by running across nests in hedgerows or hidden corners of the yard. Such eggs of uncertain vintage are not for the fainthearted. They're so hard to catch, and predator pressure makes one glad he has any guineas at all; hence, I've never actually eaten one. Other than for tick control, I'm not sure free-ranging guineas are really a good choice for the homestead. Better methods are needed for turkeys and guineas, in my opinion. Perhaps if I'd spent more time with my turkeys and guineas when they were chicks, things would have been different…. Behavior modification for these claustrophobic birds is a tall order, but training them to roost in a lone tree surrounded by electric fencing might be one approach.

Old-timers claimed that young turkeys could drown because they'd look up at the sky too long when it rained.

Given the many valuable additions of domestic poultry to a permaculture system, it is worth continuing to experiment and find the right solution for your household. Just remember to prepare well beforehand! Δ

John Wages completed the Permaculture Design Course with Peter Bane and Keith Johnson in Indiana in 2006. He has planted vegetable gardens in Baltimore and suburban Maryland, northern California, the Pacific Northwest, and the Mid-South, and has raised all types of poultry, from geese to peafowl, but so far no ostriches or emus. He and his wife, Gwen, are currently working on a design for his property in northeast Mississippi. He is the publisher of Permaculture Design *magazine.*

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Underside of the hover brooder. Baby chicks are free to move closer to or farther from the two lights, as necessary to regulate their body temperature. In draft-free housing, this brooder works very well.

Made Locally

Susan Grill

WHY PRODUCE LOCALLY? Because it's good for business, when the business helps people by helping the environment. People need things at reasonable prices. Goods manufactured locally, even in the same state, cut costs: financial to the business and environmental due to less distance to travel to the customer buying point. The consumer may find it reasonable to pay more than for a comparable product for the benefit of improving the health of the planet for him/herself. This is even more so when the product comes from materials grown locally as well. Products sourced from local natural resources make people more aware of the earth's limited resources, and the value of them.

A place to buy local goods can help people feel connected to people nearby; this could be a store, a website focused on the locality, or a traveling salesperson. A local distributor may be able to give feedback from local consumers to local producers. These crafters or manufacturers can be more connected to local trends in taste, and provide a means for artists to work with them. This can increase creativity and productivity, and create a strong base for employment and training, benefitting the health and thus the safety of the community.

Also, high production for our world population with limited resources can't last forever. A geopolitical change cutting off access to cheap labor or lack of cheap energy could mean we would need to depend on ourselves, working in community together. In the case of a local emergency, local ties means people may know where to get something from a business that is just outside the area and not impacted.

...it is much easier to reduce a price if needed compared to raising prices once consumers are used to a lower price point.

The window sign for clothing store chain Ross Dress for Less reads "You'll love the brands, the trends, and most of all the savings!" The emphasis is on price (and buying the latest) over the item itself. That doesn't attract all buyers, so Ross and Walmart are leaving out a segment of the population. "You have a better chance of success if you strive to delight a few people rather than just satisfy the masses," writes Stephen Harper in The McGraw-Hill *Guide to Starting Your Own Business*. A product that offers uniqueness that can't be mass-produced, or that offers higher quality, can have a higher price (or "price point") (1).

A throw made out of synthetic fibers in China for sale at Cost Plus World Market for $34.99. A similar item was at Pottery Barn for $39.00.

Price determinations and wholesale

A crafter or manufacturer should have two price points, one for selling to wholesale distributors and one for retail (often chosen to be twice the wholesale price, if it under the control of the manufacturer, but this also needs to figure in the price the market will bear). A wholesale distributor buys from manufacturers and sells to retailers (or sometimes to another distributor for another layer in the "supply chain"). When the wholesale distributor sells a product, it may be for an additional 20-40% of what they paid the for it (the "mark-up") to the manufacturer; the retailer then adds to that price to cover their own costs and to make a profit, to get to the retail price (2).

If the vendor only sets one price that is at a wholesale level, the maker and others like him or her will be competing unfairly with a price that one can't make a living on. So, a crafter at a craft fair open to the public shouldn't set a price low based on what he/she plans to expect as profit, but keep it higher at a retail price to allow wholesalers to succeed in selling it to retailers, who don't want to be undersold. Also, it is much easier to reduce a price if needed compared to raising prices once consumers are used to a lower price point (3).

The wholesale price is justified because the wholesale distributor can sell a lot, with advertising and outreach, than the vendor can alone, and so the vendor can multiply the slimmer margin, and in the view of Kari Chapin, spend more time on the crafting side of the business. She also advises, "Pricing and determining value for what you make has to start with you. If

Hannelore Cole, owner of Custom Handweavers of Mountain View, CA, with thick afghan blankets for sale at $250. She has owned the store for 35 years, and does custom weaving, gives lessons in weaving, spinning, and knitting, and sells weaving equipment and accessories.

you're afraid that customers will balk at your prices, think of other ways you can communicate to them what you're worth, rather than just lowering your price. Increase your perceived value. Tell your story. Educate the public about why your work is worth it" (4) However, the price can vary depending on your market (5).

Currently, handmade goods can be sold in a variety of ways, with perhaps the most remunerative being either with a brick-and-mortar store, which allows customers to see the goods in person and be more likely to buy, or having a company website with a lot of socializing to get on-line traffic. On-line marketing is done without regard to geography, so transportation costs are not saved, and there is no community enhancement of an area close to the producing business.

Other selling methods beyond your own store or website: Etsy is an on-line sales forum that is well known but may not be so useful because it is nationwide and so it is harder to stand out from the other sellers with goods of a full range of quality. Britain has a similar site called Folksy, which is much smaller although less well known, and one blogger found it more remunerative. It is best to have a link to these from a social networking page like on Facebook or Linked-In (6).

A hand-made crafting business that wants to sell wholesale usually doesn't use a distributor in-between, as there would be a small margin for the distributor because the market won't currently bear a high enough retail price to cover costs. To find a retail outlet to sell to at wholesale, a crafter may go to trade shows to be seen. The same effort must also be made by the retailer, such as a boutique owner. The producer can also contact the retail stores or other applicable markets individually.

Alternatively, for those wanting to sell wholesale, some brokering services have a website displaying the goods of subscribing producers (like crafters) and marketing them to store owners (such as boutiques), with the product then delivered by standard delivery by the makers directly to the stores. The middleman handles some of the paperwork but not the physical inventory or shipping.

Products can also be sold "on consignment," with the retail outlet keeping less of the retail price, but also being able to give the product back to the maker if it doesn't sell, and possibly not in as salable of a condition. There may be a rental fee for a display space. Cranberry Hill Mercantile, a 21-year-old consignment store in Sunnyvale, California, suggests its vendors to price their wares low enough to sell, but stores that are in a more upscale (and high-rent) areas may be able to position wares in a gallery-like setting so that customers who come in expect a higher price point.

Marketing and selling can also be done through joining with other crafters. Many examples of this already exist. In northern California's Eureka, the Old Town Art Gallery bills itself as "Humboldt County's oldest cooperative art gallery." The town also contains the American Indian Art & Gift Shop, selling the work of 40 local artists, and Humboldt Hardware, which advertises "100% Local Woodworking…Locally Made Locally Sourced Gifts Furniture and Decor" from over 30 local artists (7).

As there are a variety of ways to sell goods, some more eco-friendly than others, there are also choices in distribution and manufacturing, impacting the environment and people in turn.

We currently outsource not only work but also the effects of over-production, as to China.

Martin Christopher in Logistics & Supply Chain Management mentions several ways to reduce the carbon footprint, known as "transport-intensity" of the supply chain or network. One way is to reduce how often trucks drive back to their starting points empty, known as "empty miles," by sharing distribution, even with competitors (8).

To increase eco-friendliness, products can also be made from recycled materials. Local organizations sell leftover or used items at low cost, both county-run and private organizations dedicated to, for instance, helping teachers find materials, while reducing the stress on the landfill.

To find sources of recycled materials, try these, as well as asking your county if they have a recycling program beyond curbside pick-up:

The following website has descriptions for 13 San Francisco Bay Area organizations as well as for those outside the Bay Area in: California (Long Beach, Los Angeles, San Diego, and Santa Barbara); Michigan (Detroit and Lansing); Nevada (Las Vegas); New Jersey (Lambertville); North Carolina (Durham); New York (New Paltz and New York City); Oregon (Eugene, Mosier, and Portland); and Pennsylvania (Philidelphia): http://www.

scrap-sf.org/creative-reuse/creative-reuse-resources lists
For a variety of used objects, on-line resources beyond California are recommended by the California government's California Materials Exchange at:
http://www.calrecycle.ca.gov/CalMAX/default.htm.

The more we use our local natural resources and replenish them, the more we will have a reason to keep them there and not pave over the soil, keeping our urban landscape more natural as well. Even people in the suburbs have plants growing around them, often cut down by landscapers and sent away, when they are a resource.

When goods are grown, manufactured, and purchased locally, the population becomes aware of the resources needed to sustain itself, and gets a realistic view of the load the land can actually carry; it may then reduce consumption and buy more thoughtfully. We currently outsource not only work but also the effects of over-production, as to China.

The textile industry, for instance, is the second-biggest polluter of fresh water resources on the planet, just after agriculture, and in China they are the third-largest source as of 2012 (9). Over 50,000 textile mills were in China in 2012 (10). A year-long investigation of the world's largest dye factories found hormone disruptors alkylphenols and PFCs at toxic levels in China's two major river deltas; both substances persist in the environment and can accumulate up the food chain (11).

The non-profit Fibershed "envision[s] the emergence of an international system of regional textile communities that enliven connection and ownership of 'soil-to-soil' textile processes. These diverse textile cultures are designed to build soil carbon stocks on the working landscapes on which they depend, while directly enhancing the strength of regional economies…As each Fibershed community manages their resources to create permanent and lasting systems of production, these efforts to take full responsibility for a garment's lifecycle will diminish pressure on highly polluted and ecologically undermined areas of the world" (12).

Fibershed

Rebecca Burgess, the founder of Fibershed, started out determined to spend a year wearing only clothes made from the products of the land in her region. She contacted sheep farmers and artisians to help her, and out of that journey grew the non-profit founded in 2012. In the area called the Northern California Fibershed, defined as within a radius of 150 mile from the headquarters in San Geronimo (including some space on the ocean), there are now 75 farmers and 30 artisians who have connected via this non-profit.

Fibershed itself focuses on education, community building, and economic development. The organization's work linking the community enabled the creation of the separate entity Fibershed Marketplace, which sell wares on-line. Fibershed worked up a wool mill proposal, since only 0.03% of California's wool is processed in-state and often sheared wool is sent to landfills instead of being sold at a low profit margin on commodity markets for overseas production. The conclusion was that right now there is not enough of a demand from consumers for locally produced wool to make it viable (13).

Burgess said Fibershed is measuring carbon in farmers' soil, to be measured again for comparison after three to four years of practicing "climate beneficial agriculture" (including strategic grazing, conservation tillage, and a host of scientifically vetted methods), to publicly show its reduction of carbon compared to using conventional practices and lend support to the brands who source their product from such farms. This should lead to a revaluation of the price of goods in the marketplace and a higher price point to more fairly compensate the producers utilizing such practices (14).

Not only are the chemicals currently used for textiles hurting the ecosystem and us, but the sheer amount of clothing produced to be purchased is taking up land to grow cotton and then filling up our landfills unnecessarily. If we bought fewer items of clothing perhaps we could pay more for the ones we own, and lead to better compensation for those who make it in a safe way. Clothing buying attitudes changed greatly with the Baby Boom, with less attention paid to style and making the most of what one had. Compare views of today to those noted in the book *The Lost Art of Dress: The Women Who Once Made America Stylish:*

> *"The number of garments the Dress Doctors thought sufficient for any woman was stunningly small. Margaret Story suggested that she needed 'only three perfect outfits.' Women like Story owned fewer clothes than we do, but spent more money for each item and then took good care of their clothing. Much has changed since then. Young women today may not know the meaning of the word 'darning,' because they have never been asked to mend clothing. We are used to plenty, even to excess. Americans were buying clothing at the remarkable rate of one new item every five and a half days, on average, in 2005. This was possible because prices had dropped so low. Whereas Americans spent 13 percent of their incomes on clothing in 1902, they only had to spend 6 percent by 1997" (15).*

The urge to produce locally, oneself and/or with others,

An acrylic afghan priced to sell at $63 via consignment at Cranberry Hill Mercantile in Sunnyvale, CA, with a space rental of $55 per month and 10% commission to the store.

may be from a wish to have more control over whether one is employed or not; to own one's tools, literally perhaps, instead of having to rely on the vagaries of companies for work. This still involves finding paying customers or outlets, earning their trust, and dealing with the economy. However, some people enjoy making things. Perhaps some of them might agree with author Robert Penn quoting Roy Underhill, the American woodworker and author, as he looked upon someone using an ancient pole lathe: "We have spent millennia devising ways to avoid this sort of physical work, and yet we always return to it. It is a part of us" (16). Some people like to design, and there is even a popular "Maker" network and magazine brand for making all sorts of things.

People matter, both here and in other places, including places with very oppressive working conditions and environmental degradation. If we had a local making and buying economy, that would mean more smaller firms and more points of entry into manufacturing for Americans, versus manufacturing done somewhere else with none at all. Manufacturing could also provide a way for Americans who have high school level or less education to be gainfully employed and learn skills. It would also even the playing field, so that people in other countries could start to ask for and get fairer treatment from their employers.

What kind of local manufacturing?

At least one newly revamped textile mills in the US has a cost comparable to that of overseas because the work is mainly done by machines and robots. More is spent on power than paychecks. Parkdale Mills, the country's biggest buyer of raw cotton, reopened the Carolina Cotton Works mill in Gaffney, South Carolina in 2010. It now uses 140 people instead of over 2000 employees in 1980 to produce 2.5 million pounds of yarn a week.

For Bayard Winthrop, founder and CEO of American Giant clothing manufacturing company, this mill work was moved to the US from India in 2012 because the design phase is easier to coordinate when everyone is in the same room and there aren't delays waiting to see how the quality comes out, as well as a better ability to manage the quality of the product and worker safety. "When I framed the business, I wasn't saying, 'From the cotton in the ground to the finished product, this is going to be all American-made,' " he said. "It wasn't some patriotic quest." Instead, the road to Gaffney was all about protecting his bottom line (17).

The perception of the buying public when they see "Made in the USA" is the same no matter the number of workers used, as most people aren't aware of the difference in the fewer employees and the increased use of electrical power, plus they don't yet have a better alternative for a purchase at present, and so accept it as a feel-good reason to buy (as evidenced by some of the online comments to the article about this mill) (17). Δ

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Susan has a mechanical engineering degree from San Jose State University, San Jose, CA, and enjoys gardening (including an ever-evolving greywater wetland), producing things out of natural materials, and connecting with business owners for a local economy. She would welcome hearing from readers about their efforts to grow and manufacture and/or distribute locally in their parts of the world, and the challenges they have faced as well as the successes, as well as any formal business groups/associations. This information may be shared with others, in this or another forum, unless specifically asked not to. She welcomes reader insight at susansmercantile@mindspring.com.

Talk Local

Ecology, Energy, and Alternative Agriculture

R. Alan Wight & Braden Trauth

THIS ARTICLE ADVANCES A NEW SYNTHESIS and framework for understanding the relationship between ecology and ecosystem services, energy production, and two forms of agriculture. The choices we make in our agriculture and land management systems impact and influence other structures and outcomes in society such as: the health of our populations; labor and economic issues; energy production, extraction, and consumption; and the overall ecological wellbeing of the biosphere. It is crucial for the future health of all species and our planetary ecosystems that we change the way we extract energy and food from our environments. Our ability to comprehend and act on these connections will foster positive social and ecological changes for generations to come. To do so, our paper traces the development of four major ideas and practices over time: 1) annual tillage agriculture, 2) the application of inanimate energy, specifically fossil fuels (fossilized plants) to agrifood production, 3) alternative agroecological and perennial polycultural approaches (a major part of the solution), and 4) the modern food movement, which is popularizing the larger debate about our agrifood systems (also part of the solution).

Emergy is about how energy is created and stored....

While others (e.g., Vaclav Smil [1, 2], Pimentel and Pimentel [3], H. T Odum [4], and The Council for Agriculture Science and Technology [5]) have written about some of these themes and relationships, our attention to annual tillage versus perennial agriculture, as well as the concise, and hyperlinked nature of our article and timeline sets it apart. First, we discuss ecosystems and energy, defining key terms that provide a foundation to this framework. Second, we outline the relationship between annual tillage agriculture and fossil fuels (the use of inanimate energy sources). Third, we introduce a range of alternative agroecological approaches and discuss the modern food movement. Finally, we present a hyperlinked, color-coded timeline, which provides an interactive visual for understanding the development, application, and connections between these related fields. Given this format and the intellectual history presented in the timeline, our article is written for the agrifood movement; college students and professors in agriculture, food studies, and related fields, as well as interested members of the public.

Perennial shrubs on contour, pastured sheep in rotation, and many other small and large changes can improve on our agricultural systems. Photo by Braden Trauth.

Ecosystems and energy

Understand agriculture holistically requires us to talk about energy and energy production in its varied forms. This in turn means that we need to consider the energetic limitations and opportunities of ecosystems and ecosystem services, which are defined by the availability of rain, temperatures, soil, and sunlight. Photosynthesis uses these factors in various combinations to create smaller or larger quantities of plants and trees, also known as biomass. It is this daily conversion of sunlight, water, and minerals into carbohydrates that lays the foundation of the trophic pyramid of herbivores, predators and diseases. Ecosystem productivity, based on these factors, is known as **Net Primary Productivity** (6) or **NPP.** Humans manipulate these factors in order to enhance NPP in our favor. We do this through tilling (tractors, combines, etc.), irrigation, aqueducts, wells, swales, organic and synthetic fertilizers, and greenhouses to name a few important agricultural inventions and design factors. Many of these have been enabled by the application of fossil fuels.

Howard T. Odum, one of the grandfathers of Energetics, coined the term **Emergy** (7), which is short for Energy Memory. Emergy is a measure of the qualitative differences and historical inputs between types of energy that are consumed and the direct and indirect transformations needed to convert it into products or services. Emergy is about how energy is created and stored, whether it's plutonium, fossil fuel, wind, sun or biomass. This in turn, helps us understand energy renewability, wherein some forms of energy (like biomass) are constantly being created and stored through photosynthesis.

A third key element of energy theory is known as **Energy Return on Energy Invested (8)** or **EROEI**, which is defined as

how much energy it takes to harness an energy source. For example, when oil was first discovered it took as little as one gallon of gasoline to extract 200 gallons out of the ground (9). This EROEI for oil has dropped significantly over the last 50 years as we have exhausted the most accessible fields. We now must spend more energy to access petroleum in extreme environments (like the arctic and deep ocean water sea beds), or extract and process abundant, but less pure sources, like tar sands and pockets of fuel/gas scattered in tight rock formations through processes such as hydraulic fracturing. Regarding the EREOI for biofuels, it has been concluded that the processes used to turn corn, soybeans, sunflowers and other biomass into fuel uses much more energy than the resulting ethanol or biodiesel generates (10).

We urge the reader to explore other important terms and concepts in connection with ecology and food such as: **thermodynamics**, the **metabolic theory of energy**, and **trophic pyramids**, to name a few. The main point here is that healthy ecosystems, ecosystem services, and photosynthetic energy production are the basis for how traditional agricultural societies grow their food.

There is no one movement, but rather a wide-ranging constellation of actors, leaders, scholars, and pioneers in various fields....

Annual tillage agriculture and fossil fuels

The second major thread of this succinct synthesis is the long history and development of annual tillage agriculture. Briefly: humans have been cultivating fruit and cereal grains for over 23,000 years (11), although most evidence suggests that agriculture became wide spread in eleven different regions between 11,500 and 10,000 years ago (12, 13). Two early important innovations that advanced annual tillage agriculture were the plow and the use of draft animals (i.e. non-human, animate energy). The history of the plow goes back as far as 6,000 B.C., as its use was wide spread throughout the ancient world, and there were numerous developments regarding this technology over the centuries that have played critical roles in the success of tilling soil and the planting of annual cereal grain crops (wheat, millet, barley, oats, rice, maize, etc.) (14). While these innovations continued to be refined, new crops and animals were being domesticated, and other sources of energy (e.g. water and windmills) were being developed, the next groundbreaking advancement came with the introduction of fossil fuels and the mechanization of agriculture during the later periods of the industrial revolution.

This is where we can make the connections between ecosystems, energy, agriculture, and fossil fuels (specifically diesel fuel), and the development of synthetic pesticides and fertilizers, which are produced from petroleum and natural gas respectively. It was healthy ecosystems and the photosynthetic processes that created the carbohydrates that were eventually converted into hydrocarbons or fossil fuel over the past millions of years. The extraction and use of these hydrocarbons form the energetic foundation of our modern agricultural civilization, which burns approximately 37,000 years of those "stored carbohydrates" everyday (15). It cannot be overstated: fossil fuel has been the key enabling agent in our manipulation of agricultural production over the past 200 years. The use of tractors and other mechanized farm equipment along with the application of synthetic inputs (fertilizers and pesticides) has allowed farmers to increase farm size and broad-scale food production per acre. As a result, the average US farmer has gone from feeding 19 people in 1940, to 29 people in 1960, to 155 people today" (16). Another way to think about these changes is that in 1900, 38% of the US population were farmers, and by 2000, only 2.6% of the population were farmers (17). In addition to our farmers, the entire food service industry currently employs 9.3% of the US population. While many view this as progress, the negative ecological and human health impacts of these agrifood and social system changes are significant (18, 19, 20, 21, 22, 23).

The scientific community has identified the major issues caused by annual tillage agriculture based on fossil fuels: notably the finite availability of fossil fuels and the larger ecological impactions of anthropocentric climate change (24). Thus, the developments of tillage; annual crops; and the plow, coupled with the use of fossil fuel as an accelerant (embodying 500 labor hours/gallon gasoline, 25) have pushed farming methods out of ecological balance. Together, these practices are responsible for creating deserts across much of the planet today (26, 27, 28). This occurs because tillage reduces water storage capacity and nutrient cycling by breaking down the hydrological cycle in soil,

Peaches and figs are a delicious return on investment in the local ecosystem. Photo by Braden Trauth.

impeding and interrupting the regenerative processes. Specifically, tillage oxidizes soil matter and destroys macro and micro soil life (29) such as earthworms and mycorrhizal fungi respectively, which are important measures of soil health (30, 31, 32).

Our society has also seen the economic implications of the connections between annual tillage agriculture and fossil fuels. Given industrial agriculture's reliance on fossil fuel, as well as increasing links between the markets in food and fuel driven by biofuel production, the surge in 2008 oil prices led directly to spikes in the prices of key foods globally. This in turn sparked food riots in over 40 countries. The negative consequences of annual tillage agriculture's dependence on fossil fuel is also correlated with an increase in locally produced food, as more people grasp the nexus of ecological and energetic elements in the food system.

Alternative agroecological approaches

To remedy these crises, an alternative agrifood "movement" has been creating new approaches and practices for over a century now (33). There is no one movement, but rather a wide-ranging constellation of actors, leaders, scholars, and pioneers in various fields (34, 35). There are farmers, journalists, chefs, academics, public health and elected officials, and community organizers working to create ecologically and socially just agrifood systems. Farmer and growers, specifically, are creating ecologically sound and energetically productive agricultural methods—the kinds of practices that enhance ecosystem services while providing humans with food, fiber, fodder, and fuel (all various forms of energy). If we understand how nature harnesses and stores energy, and how traditional cultures using lower levels of energy managed their productivity, we can begin to understand the methods that are ecologically, energetically and culturally productive. This is critical, for it is these types of agrifood production methods that rely on immediate solar **Emergy** and have a high **EROEI**.

Alternative Agriculture denotes a wide variety of agrifood production and associated approaches, including sustainable agriculture, Keyline earth and water design and management techniques, restoration agriculture, conservation agriculture, natural farming, biodynamics, agroecology, aspects of integrated pest management and certified naturally grown, the historic understanding of "organic" agriculture, and importantly, permaculture. Some of these approaches overlap with each other and with aspects of annual tillage agriculture. Broadly, these alternative approaches fall under the domain of civic agriculture (36, 37), a paradigm that is locally oriented in its production, distribution, and consumption, and is based on the best ecological, economic and bioregional practices that place social and cultural values at the center of the food system. This paradigm is interested in cultivating a healthier human-to-human and human-to-Earth relationship. Civic agriculture is critical of and is contrasted with conventional or industrial (38) agriculture, which is oriented towards commodity production for national and global markets. Alternative Agriculture addresses the negative aspects of annual tillage agriculture, from the destruction of humus to the synthetic inputs we have developed based on this 200-year boon of fossilized sunlight. As more of us come to understand ecosystems and energy production comprehensively, we see more clearly the downsides associated with fossil fuel use. We are using these finite fuels to deforest our land, till the soil, and then add artificial inputs to enhance fertility. Over time, we see increasing costs and pollution accompanied by declines in overall productivity, resulting in desertification in the most brittle ecosystems (i.e. those without oceanic rainfall). The alternative approaches all attempt to intervene at various points in this decline, whether through integration and proper management of livestock, incorporation of trees and other perennials through agroforestry, or the elimination of tillage in organic agriculture.

Agriculture, ecology, and energy timeline

The weaving of this synthesis culminates with the color-coded timeline below. This interactive word graphic functions as a web-based encyclopedia, similar to Wikipedia, with links to a wide variety of sources and references, including Wikipedia, peer reviewed articles, foundations, non-profits, PDF copies of text, YouTube videos, and popular news stories. Here, we trace these four major threads over the past 250 plus years, which include the important innovations, inventions, and developments regarding:

1. Annual Tillage Agriculture and Fossil Fuel Developments
2. Evolution, Ecosystems, and Renewable Energy
3. Alternative Agroecological Approaches
4. Agriculture and Food Movements

Within our timeline, there are important events that are not thematically highlighted, but are listed because they relate to some of these developments. For example, World War II is a watershed event that led to the use of synthetic macronutrients (NPK) and was a precursor to the Green Revolution in the 60s and 70s. Another example is the development of the Land Grant Universities and Cooperative Extension in the US—which is primarily related to research and development of annual tillage agriculture, but also to alternative agroecolgical approaches. The timeline also includes statistics about the changing percentage of farmers in the US labor force.

Finally, we also acknowledge the sheer scope of this synthesis, and recognize that we are taking a broad historical view, where all the details are not fully examined or explained. Plus, given considerations of length, we have chosen to only chronicle those events since the mid-industrial era (late 1700s to the present). This makes sense given the interplay between energy (specifically the use of fossil fuels) and annual tillage agriculture. It is our goal that you read the timeline and keep in mind how these unsustainable or ecologically oriented developments have contributed to the creation of our global civilization today and the issues facing humanity. We ask each reader to consider how he or she can help share and proliferate these alternative agroecological approaches and practices.

1781 – James Watt produces the first steam engine (10 hours power) with continuous rotary motion that would be used in a wide range of industrial manufacturing. This engine could be powered by wood and coal, and would eventually be used to power tractors, threshers, trains, and even cars.

1786 – Andrew Meikle develops the first mechanical, horse

powered threshing machine, a precursor to our modern combine harvesters.

1790 –90% of US labor force are farmers.

1831 – Cyrus McCormick, using his father's design, invents the horse drawn mechanical grain reaper/harvester.

1834 - John Avery and Hiram Abial Pitts develop (patented in 1837 in the US) the steam-powered thresher.

1837 – John Deere produces polished, steel cast ploughs for sale.

1840 – 69% of US labor force are farmers.
– 5% of US energy is derived from coal.

1850 – Charles Darwin publishes *On the Origin of Species*, outlining the theory of evolution.

1850 - 1855 – Henry Bessemer develops a process for the mass production of steel, an important material for manufacturing steam engines, rail lines, tractors, plows, and other industrial machines.

1859 – Drake's Oil Well in Cherrytree Township, Pennsylvania, helps to kick-start the US oil rush, and the use of petroleum as a fossil fuel.

1861 - 1865 – US Civil War reduces access to "free" animate energy (slave labor) in agriculture.

1862 – The Morrill Act establishes the Land Grant Institutions in the United States, creating universities in each state that focus on agriculture and the mechanical arts, establishing affordable liberal arts education for the masses.

1866 – Ernst Hackle coins the term *Ecology* or Ökologie (in German), referring to the scientific study and analysis of the interactions among organisms and their environment.

1870s – The phosphate fertilizer industry begins. Today, most phosphate fertilizer is created through the acidification of apatite from phosphate rock. Phosphate is a finite resource.

1875 – Eduard Suess, an Austrian geologist coins the term *biosphere* to refer to the conditions promoting life on Earth, including key parts such as flora, fauna, minerals and matter cycles (hydrology, nitrogen, etc.) The term biosphere was popularized by Vladimir Vernadsky in his 1926 publication *The Biosphere.*

1877 – Karl Möbius coins the term *biocenosis*, also known as *biotic community* or *ecological community.*

1880 – 49% of US labor force are farmers.

1887 – The Hatch Act establishes agricultural experiment stations in each state. The Tuskegee Institute (founded by Booker T. Washington in 1881) was a model for these stations and was under the direction of George Washington Carver for 47 years.

1890 – The Second Morrill Act establishes and expands Land Grant programs in the southern states (without as much funding as previous programs in the North).

1892 – Gasoline/petrol-powered farm tractor is invented by John Froelich.

1882 – Julius Hensel, a German agricultural chemist publishes *Macrobiotic*; wherein he suggests that disease is a result of a lack of mineral substances. In 1893, he publishes *Bread from Stones*, exploring the application of rock dust to soils to increase mineral availability.

1899 – Henry Chandler Cowles formulates the idea of *primary succession*, an important piece of *ecological succession.*

1900 – 38% of US labor force are farmers.
– 50% of US energy is derived from coal.

1902 - The chemical process for making nitric acid (HNO_3) is developed and patented by Wilhelm Ostwald. Nitric acid is the main raw material for most fertilizer production. The Ostwald process is closely associated with the Haber process.

1909 – Fritz Haber and Carl Bosch successfully demonstrate the artificial process for creating ammonia, the key ingredient for making various forms of synthetic nitrogen such as anhydrous ammonium nitrate (NH_4NO_3) and urea ($CO(NH_2)_2$). The Nitrogen (N), Phosphorus (P), and Potassium (K) fertilizer package (NPK), along with fossil fuels, is one of the key inputs of industrial agriculture. Widespread use of these chemicals begins post-WWII.

1911 – Franklin Hiram King, know as the father of soil science, publishes *Farmers of Forty Centuries, or Permanent Agriculture in China, Korea, and Japan*, which is one of the first books to promote the idea of sustainable agriculture. King's work informs the field of crop ecology, a precursor to agroecology.

1914 – The Smith Lever Act of 1914 further establishes the Cooperative Agricultural Extension Services, which are then connected to the Land Grant University System.

1914 - 1918 – World War I

1920 - 27% of US labor force are farmers.

1917 – Henry Ford introduces the Fordson farm tractor, which by 1923 had captured 77% of the US market.

1924 – Rudolf Steiner, the founder of *Biodynamics*, begins to present his ideas in a series of eight lectures, titled *Agriculture Course*. This approach strives to create a diversified, balanced farm ecosystem that generates its own health and fertility. Preparations made from fermented manure, minerals, and herbs restore and harmonize the vital life forces of the farm. Biodynamic applications work in cooperation with the subtle influences of

the wider cosmos on soil, plant, and animal health.

1926 – Jan Smuts, South African author, publishes *Holism and Evolution*, coining the term *holism*, referring to the idea that systems, be they ecological, physical, biological, chemical, social, economic, mental, etc., should be understood as wholes, not as collections of parts.

1927 – Charles Eaton publishes *Animal Ecology*, where he popularizes the terms *Food Web* (originally coined by Pierce in 1912 and Victor Shelford in 1913), *Food Cycles*, and *Food Chains,* which formed the basis for Raymond Lindeman's future work on Trophic-Dynamics in ecology.

1928 – K.H.W. Klages formally links agronomy and ecology in his publication: *Crop ecology and ecological crop geography in the agronomic curriculum.* This is the beginning of the discipline agroecology.

1929 – W.P. Hedden coins the term *Foodshed*, in his book *How Great Cities Are Fed.* The term is then revitalized in 1991 by Arthur Getz.

1929 – J. Russell Smith publishes *Tree Crops: A Permanent Agriculture*, one of the pioneering books that examines the use of trees for food, soil conservation, and sustainable agriculture.

1930 – The Rodale Inc. Publishing Company is created by J.I. Rodale, one of the founders of the organic agriculture movement who was inspired by the work of Sir Albert Howard.

1932 – Max Kleiber's work on *basal metabolic rate* regarding animal and plant metabolisms lays the foundation for the *Metabolic Theory of Ecology*, which at the ecosystem level explains the relationship between temperate and total biomass production.

1935 – Arthur Tansely, a British ecologist, proposes the term *Ecosystem*. The ecosystem concept is then adopted by Eugene Odum and his brother Howard T. Odum, two important figures in the history of biology, ecology, and energetics.

Cincinnati permaculture design course graduates ready to launch into their next steps.

1938 – Dr. William Albrecht, a soil scientist and agronomist, publishes *Loss of Soil Organic Matter and its Restoration* wherein he makes the direct connection between soil quality, food quality, and health.

1939 – Evelyn Barbara Balfour, a founder of the organics movement, creates the Haughley Experiment at New Bells Farm in England. This is the first long-term, side-by-side scientific comparison of organic and chemical-based farming methods. In 1943 she publishes *Living Soils.*

1939 – Weston Price, a dentist by training, publishes *Nutrition and Physical Degeneration*. This book is based on Price's travels around the world and his investigations into the diets and nutrition of traditional societies. He concludes that processed (refined) flour, sugar, and vegetable fats (key aspects of the modern Western Diet are the main causes of nutritional deficiencies, dental issues, and health problems in western societies.

1939 - 1945 – World War II

1940 – Sir. Albert Howard, one of the founders of Organic Agriculture publishes *An Agriculture Testament,* which explores soil fertility and the importance of composting at a time where synthetic inputs where on the rise.

1940 – 18% of US labor force are farmers.

1942 – J.I. Rodale begins to publish *Organic Farming and Gardening Magazine.*

1942 – Raymond L. Lindeman publishes *The Trophic-Dynamic Aspect of Ecology*, related to the movement and transfer of energy through the food chain.

1944 – Ruth Stout pioneers a year-round mulching method, reducing or eliminating the need for tilling, plowing, irrigating, spraying, sowing cover crops, weeding, cultivating, or amending soil. These methods are described in her 1963 publication, *Gardening Without Work: For the Aging, the Busy & the Indolent,* which has influenced modern approaches such as Lasagna Gardening as touted by Patricia Lanza.

1947– The Rodale Institute, a 501(c)3, nonprofit is created by J. I. Rodale with the mission of supporting research into organic agriculture.

1949 – Aldo Leopold publishes *A Sand County Almanac*, putting forth the idea of a Land Ethic, that "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."

1950 – 12.2% of US labor force are farmers.

1950 - 1970 – The Green Revolution (officially launched in Mexico with private funding from the United States). The title is a misnomer, as these practices focus on the development and

of high yielding cereal grain varieties, an expansion of irrigation infrastructure, the modernization of management techniques, and the agribusiness distribution of hybridized seeds and their accompanying synthetic fertilizers and pesticides to farmers.

1952 – Edward S. Hyams, publishes *Soil and Civilization*, a historical review that examines and attributes the decline of civilizations to the destruction or loss of nutrients and organic matter in the soils they depended upon for food.

1953 – *The Australian Keyline Plan*, is published by P.A. Yeomans. The Keyline Design is an over-arching land and water management technique which is now widely used in permaculture and restoration agriculture approaches.

1953 – Eugene P. Odum, an American ecologist, publishes *Fundamentals of Ecology* (with his brother Howard T. Odum). Throughout his life, E. Odum integrated an understanding of energy flows (i.e., Ohm's Law, Thermodynamics, Energese, Emergy) into agroecology systems. This work lays the foundation for the development of permaculture.

1960 – 8.3% of US labor force are farmers.
– Petroleum surpasses coal as primary global energy source.

1961 – Julia Child, Louisette Bertholle, and Simone Beck publish *Mastering the Art of French Cooking*, introducing and creating a demand for high quality food in America at a time when our national cuisine emphasized hot dogs and apple pie. Marion Nestle considers this investigative book one of the roots of the modern food movement.

1962 – Rachel Carson publishes *Silent Spring*, where she systematically reviews the negative impacts and misuses of pesticides such as DDT. This book and Carson's activism helped galvanize the counterculture, the modern environmental movement, and inspired deep ecology and ecofeminism. Furthermore, the modern environmental movement is a precursor to the food movement of today.

1965 – W. Tischler publishes the first full book on *Agrarökologie*, which translates to Agricultural Ecology. See article on the history of agroecology here.

1967 – Alan Chadwick, a student of Rudolf Steiner and proponent of the French Intensive Method of gardening, establishes a student garden and apprentice-training program at the University of California, Santa Cruz. Chadwick's lectures and teachings have influenced many contemporary students, including John Jeavons, who went on to develop biointensive agriculture.

1968 – Robert Hart and J. Sholto Douglas publish *Forest Farming,* expanding the vision of J. Russell Smith for tree crops as a viable alternative to annual tillage agriculture.

1968 – P.A. Yeomans publishes *Water For Every Farm: A Practical Irrigation Plan For Every Australian Property* complementing and building on his previous work.

1968 – Garrett Hardin publishes *Tragedy of the Commons,* wherein he describes the social, economic, and ecological dilemmas regarding the use of shared resources. The paper describes how individuals acting independently based on their own self-interests end up depleting common resources (fertile soil, clean air and water, fish stocks, grazing land, etc.). Hardin popularized the work of William Forster Lloyd, an English economist, who published *Two Lectures on the Checks to Population* in 1833.

1970 – Norman Borlaug, one of the fathers of the Green Revolution, wins the Nobel Peace Prize and is credited with saving billions of people from starvation.

1970 – 4.6% of US labor force are farmers.

1971 – Alice Waters opens *Chez Panisse*, a restaurant in Berkeley, California, which specializes in organic and locally grown produce. The award-winning restaurant and chef are recognized as founders of the modern food movement.

1972 – James Lovelock and Lynn Margulis propose the *Gaia Hypothesis*, the theory that all organisms interact and are connected with their environment (both the organic and inorganic components). Thus, the Earth is a synergistic self-regulating, complex system that maintains and perpetuates the conditions for life on the planet.

1972 – Ecology Action, begins a biointensive agriculture research and education project under the direction of John Jeavons in Palo Alto, California.

1973 – Arne Naess coins the phrase *deep ecology*, an ecological philosophy that places value on living beings regardless of their economic utility to humans and calls for radical restructuring of modern human societies based on these ethics.

1975 – Alan Smith publishes research in Australia documenting the links between tillage and soil infertility and pointing to the mechanisms by which wild soils maintain fertility and cultivated soils destroy it. This work helps to inform permaculture approaches to non-tillage farming and gardening.

1976 – *One Straw Revolution* is published by Masanobu Fukuoka. This lays out the tenets of natural farming, or do-nothing farming, which aims to work with the complexities of nature and has influenced the development of permaculture.

1976 – Wes Jackson creates the Land Institute, a not-for-profit research, education, and policy organization in Salina, Kansas, with the goal of developing agricultural systems based on perennial crops that work with the ecological stability of the prairie ecosystem.

1976 – Orie L. Loucks publishes *Emergence of Research on Agro-Ecosystems*, a review of existing research on the subject.

1977– Wendell Berry publishes *The Unsettling of America*, which explores the theme that the health of the land and the people are inseparable.

1978 – Bill Mollison and David Holmgren publish *Permacul-*

ture One, a synthesis that applies ecological principles to energy, agriculture, engineering, water, topography, and habitat to create human dwellings and eventually human-scale communities.

1980 – The US Supreme Court case of *Diamond v. Chakrabarty* is the first time that genetic material of a living organism is patented for a bacterium that is capable of digesting crude oil. This opens the gates for the genetic patenting of seeds by agribusiness.

1980 – 3.4% of US labor force are farmers.

1980 – Bill Mollison begins teaching the *Permaculture Design Certification (PDC)*, a globally adapted 72-hour training in sustainable living and homesteading founded in agroecological principles. It is designed to go viral by being open-sourced, and encourages certificate holders to teach and share their knowledge. This process accelerates the dissemination of knowledge, bypassing other entrenched methods of information transmission such as our land grant and agribusiness systems of agriculture. Permaculture was designed to create a global grassroots movement that could address humanity's most pressing issues of energy, ecology, and food production.

1981 – Mollison teaches PDC in Wilton, New Hampshire, and Leicester, North Carolina.

1982 – Andrew Jevons and Bill Mollison teach PDC at Evergreen State College in Olympia, Washington.

1984 – Bullock Brothers begin offering PDC at their homestead in Orcas Island, Washington.

1986 – The Slow Food Movement begins in Italy, under the organization Agricola, as a protest to the opening of McDonalds near the Spanish steps in Rome. Under the direction of the Founder and President Carlo Petrini, Slow Food focuses on local and organic production and contrasts with the industrial, globalized fast food model.

1987 – M.A. Altieri publishes *Agroecology: the scientific basis of alternative agriculture.* Altieri defines alternative agriculture as any approach to farming that attempts to provide sustained yields through the use of ecologically sound management technologies. This is one of the earliest mentions of alternative agriculture.

1987 – Robert Hart, an English philosopher, coins the term (earlier in the 80s) and publishes a pamphlet on forest gardens. This begins to popularize the term for multi-story perennial polycultures adapted to the temperate zone from his studies of traditional tropical agriculture. His 1991 book, *Forest Gardening,* expands this thesis.

1988 – Bill Mollison publishes *Permaculture: A Designer's Manual*, which is aimed at teaching and implementing these principles globally, in various ecosystems around the planet.

1988 – Alan Savory and Jodi Butterfield publish *Holistic Management: A New Framework for Decision Making.* This thesis outlines a systems approach for managing resources and using livestock to reverse desertification and restore the world's grassland soils, which are a major sink for atmospheric carbon.

1988 – Marion Nestle is appointed Chair of Nutrition, Food Studies, and Public Health at New York University (she stayed in this role until 2003). In 1996, along with food consultant Clark Wolf, she founded the Food Studies program at New York University. In 2002, she publishes *Food Politics: How the Food Industry Influences Nutrition and Health* and with many other later publications, she becomes a huge influence on the food movement.

1989 – "In Grave Danger of Falling Food," a documentary film written and directed by Tony Gailey and Julian Russell focuses on permaculture, featuring Bill Mollison, who suggests permaculture is a solution to food security.

1990 – Stephen Gliessman, one of the modern pioneers of agroecology, publishes *Agroecology: researching the ecological basis for sustainable agriculture.*

1990 – 2.6% of US labor force are farmers.

1991 – The collapse of the Soviet Union forces Cuba to adopt more sustainable farming practices based on limited fossil fuels, synthetic fertilizers, and other industrial methods. Cuban agriculture is a model for agroecological practices.

1991– Arthur Getz publishes the article "Urban Foodsheds" in *Permaculture Activist* magazine. Getz helps to re-popularize the term *foodshed* to help people think about food sources and systems.

1991 – The term *ecovillage* is coined by Robert Gilman and is defined as "human-scale full-featured settlement in which human activities are harmlessly integrated into the natural world in a way that is supportive of healthy human development, and can be successfully continued into the indefinite future." Ecovillages draw heavily from permacutural practices.

1991 – "Global Gardener" documentary film series airs in Australia and helps to popularize Mollison's ideas on permaculture.

1995 – Sydney W. Mintz publishes, S*weetness and Power: The Place of Sugar in Modern History*, which examines the history of European colonialism, slavery, and sugar production. Marion Nestle considers this investigative book to be one of the roots of the modern food movement.

1996 – Alice Waters creates the *Chez Panisse Foundation* and the *Edible Schoolyard Program* at the Martin Luther King Middle School in Berkeley, California. She helps to raise the issues of school lunch reform and universal access to healthy, organic foods to the national level. Marion Nestle considers Waters and her work an essential part of the beginning of the modern food movement.

1996 – Mark Shepard starts New Forest Farm in Viola, WI, a 106-acre, keyline-designed, perennial farm.

1999 – Thomas Lyson coins the term *civic agriculture*, referring to a new agricultural paradigm that is locally oriented in its production, distribution, and consumption, and based on best ecological, social, economic, and bioregion practices.

2001 – Michael Pollan publishes *Botany of Desire*, a book that is made into a documentary film in 2009, which shows what we have done and are currently doing regarding plant genetic selection and cultivation.

2001 – Eric Schlosser, publishes *Fast Food Nation: Dark Side of the American Meal,* which traces the evolution of the fast food industry alongside larger social changes in America, including the automobile, suburbanization, industrial meat packing, and agricultural immigrant labor. Marion Nestle considers this investigative book to be one of the roots of the modern food movement.

2002 – The US Department of Agriculture publishes the National Organic Standards, the rules and regulations outlining the certification and process for labeling farms and their products "organic."

2003 – David Homgren publishes *Permaculture: Principles and Pathways Beyond Sustainability,* synthesizing much of the work of previous sustainability pioneers into a comprehensive energy analysis. It contains action plans and case studies guided by 12 new permaculture principles and works in conjunction with Mollison's ethics and principles, to create a symbiotic, productive future, beyond sustainability.

2004 – Morgan Spurlock produces "Super Size Me" a documentary film that highlights the negative health issues associated with a 30-day McDonalds-only diet.

2005 – Dave Jacke and Eric Toensmeier publish an expansive, two-volume set: *Edible Forest Gardens,* which lays out the art and science of putting plants together in woodland-like patterns, using the theory and practice of temperate climate permaculture.

2005 – Charles C. Mann publishes *1491: New Revelations of the Americas before Columbus* and highlights the role that the Europeans had in creating the modern Amazonian tropical jungle through the collapse of the first South American civilizations, who were not longer present to tend the forest. The book also draws attention to the first Amazonian practices of creating terra preta and the application of charcoal to soils.

2005 – The term locavore (or localvore) is coined by Jessica Prentice, referring to someone who eats food grown within 100 miles of where they live.

2005 – T. Colin Campbell and Thomas M. Campbell II publish the *China Study*. This report details the results of a 20-year study that examines the relationship between animal protein (animal products) consumption and chronic illnesses such as cancer, diabetes, and heart disease. This book and its authors are featured in the 2001 documentary film production of "Forks Over Knives," which makes the case for whole-food, plant-based diets (veganism).

2006 – Michael Pollan publishes the *Omnivores Dilemma*. Along with later books, such as *In Defense of Food* (2008), and *Food Rules* (2009), Pollan examines the health and environmental implications of our modern Western diets and points the finger at those who set the rules for our agrifood system (e.g. politicians, USDA, FDA, and agribusiness).

2007 – Joel Salatin publishes *Everything I Want To Do Is Illegal: War Stories From the Local Food Front,* which highlights issues within our industrial food system from the perspective of a small-scale farmer. Along with previous and later publications, as well as documentaries, Salatin has become one of the farmer faces of the modern food movement.

2008 – The documentary film "King Corn" is produced, which examines the production of corn and the negative influences it has on American society. The film highlights the role that government subsidies play in encouraging the growing of corn.

2007 – Stephen Gliessman publishes the textbook *Agroecology: The Ecology of Sustainable Food Systems,* which is a college-level introductory overview of the field.

2009 –The documentary film "Food Inc.," featuring Michael Pollan, Eric Schlosser, and Joel Salatin among others, draws attention to the many issues inherent in our modern agrifood system and helps galvanize the food movement.

2009 – First US Carbon Farming Course was held in Tennessee, training people in methodologies that sequester carbon, building humus to reverse climate change. Teachers and support include Dr. Elaine Ingham, Joel Salatin, Eric Toensmeier, and Holistic Management International.

2012 – Peter Bane publishes *The Permaculture Handbook: Garden Farming for Town and Country,* an analysis of the opportunities and methods for transforming American suburban households and landscapes into productive microfarms as a response to food and economic insecurity and the decline of cheap fossil energy.

2013 – Mark Shepard publishes *Restoration Agriculture: Real World Permaculture for Farmers,* wherein he draws upon Russell's *Tree Crops*, P.A. Yeomans' Keyline design, Masonabu's *One Straw Revolution*, and Mollison and Holmgren's permaculture approach, to outline broad-acre techniques for perennial agriculture. Shepard's New Forest Farm in Wisconsin is an example of these methods. Δ

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Unfulfilled promise: biogas systems

Bob Hamburg

WHY HAS PERMACULTURE NOT EMBRACED biogas systems? This is not an idle question! My involvement with the domestication of anaerobic microbes began with mid-70s participation in the Peace Corps in Nepal. Involvement with permaculture began in the early 80s with preliminary consideration of *Permaculture One*'s application to some West Virginia (North American, central Appalachian) hillside, upon which are a couple of shallow fossil natural gas wells. My PDC came from the notable 1997 event in Half Moon Bay, California… coordinated by Bill Mollison, Scott Pitman, and David Blume.

For decades, it's seemed to me that biogas systems offer huge potential to further permaculture's philosophy and ethics. (See Bill's *Design Manual.)* I do not understand why this has not happened. What is wrong with my reasoning?

Biogas systems offer a broad range of benefits:

- *Nutrient conservation.* All nutrients going into a digester are available in the effluents (except for a small amount of sulfur released as H_2S, and some N_2 if the digester feed is imbalanced), thus providing a full spectrum of plant nutrients and reducing or eliminating the need for chemical fertilizer input.
- *Soil regeneration.* Organic compounds in the effluents increase the humic content of agricultural soils.
- *Sanitation.* When allowed to go toward completion, anaerobic digestion results in total destruction of most disease vectors that may have been present in the feed materials and significant reduction of the most recalcitrant (e.g., *Ascaris* eggs). Also, the digestion process does not introduce any new pathogen vectors.
- *Production of natural gas.* With minor adjustments, biogas (generally 65% CH_4, 35% CO_2, traces of other gases) can be used in any way fossil gas is used. [Editor's note: biogas production has never been shown to pollute aquifers or induce earthquakes in Oklahoma.]
- *Reduction of indoor air pollution and respiratory problems.* Emissions from biogas combustion are similar to those from burning fossil gas. When biogas is used to replace biomass or coal as a cooking fuel, indoor air pollution and related health problems are greatly reduced.
- *Odor control.* Volatile compounds (what we smell in solid waste) are largely consumed by digestion.
- *Fly and rodent control.* Insects and rodents are generally not attracted to digester effluents.
- *Weed control.* The digestion process reduces the number of viable weed seeds in feed material.

I suggest that biogas systems offer more than a fair share for the effort.

There are basically two biological pathways for recycling organic materials: aerobic (composting) and anaerobic (digestion). In nature, they have much in common, and there is actually much collaboration.

The energetic difference is that aerobic composting releases organic material's embodied solar energy as heat, whereas anaerobic digestion releases it as natural, renewable methane.

The material difference is that organic material's embodied nutrients may be lost through volatilization and leaching during the composting process, whereas nearly all nutrients are conserved for reuse in the digester effluent. Both pathways prepare the organic material's hydrocarbons for long-term incorporation into the soil.

From its evolutionary beginnings, our species has had a very intimate symbiotic relationship with anaerobic microbes. We provide them a home in our guts, and they digest our food. Without them, our bodies would not be able to make use of the nutrients we consume. There also appears to be a quickly growing understanding that these beasties have much broader impacts on our health and our individual physiologies.

I continue to maintain that "externalization" of our symbiotic relationships with anaerobic microbes holds huge promise for a regenerative agricultural future. Dragon Husbandry (dragonhusbandry.com) might start with biogas production, but that is just the tip of its potential for kickstarting regenerative spirals.

There are currently several 100 million households around the world using biogas systems and working on improvements. I would have thought that permaculturists would be at the forefront. (And yes, I saw Geoff's bits on one digester, and Andrew Faust has installed one type of digester at his NY site, and I'm sure there are many examples I'm ignorant of….) I figured the permaculture community would be so receptive to development of such a symbiotic, regenerative tool. But that doesn't appear to be the case, and I can't understand why.

Please help me understand. Δ

Biogas Bob is the director of Omega-Alpha Recycling Systems (omega-alpharecycling.com) and Dragon Husbandry (dragonhusbandry.com). He promotes regenerative systems like biogas: natural gas without fracking. "Biological Repair NOT a Technological Fix!"

Mollison Memorials

Bill Mollison

May 4, 1928 - Sept. 24, 2016

Penny Livingston-Stark

A great man, known as The Father of Permaculture, became an ancestor on September 24, 2016. Bill Mollison truly changed the world. He inspired and shifted the perceptions of hundreds of thousands if not millions of people who have, as a consequence, been doing earth repair projects all over the world.

Between meeting the man for the first time in 1994, and 2003, when he decided that he no longer wanted to return to the US, I was blessed to get to hang out with Bill on many occasions, and to learn from him whenever he stayed with me and my husband James Stark in our home at Pt. Reyes Station, California.

Referred to by some as the Tasmanian Devil, Bill was an iconoclast who publicly challenged people to step away from their familiar ideas, learn to see a bigger picture, and dream a bigger dream. He wasn't afraid to speak his mind or to call things as he saw them. Often his message was blunt, and at times those who were thin-skinned got offended. His intention was never to be cruel, however, but to shock, trigger, and anger as well as to inspire and educate people to step up and take action. He wanted people to turn the tides of destructive human activity into positive and productive solutions.

He was generous with his knowledge and...he really did love his people.

Bill was much loved for his courage to speak out against the powers-that-be and to condemn unsustainable practices. Ironically, the very thing that most people loved about him, many also found challenging, especially if it were aimed at them. On the one hand, Bill had a disdain for humanity, especially those who talked a lot but took no action, and on the other hand, Bill had a deep love and respect for his family, friends, students, and those doing effective permaculture work in the world.

Known by some as "Uncle Bill," the man had the public persona of a curmudgeon, and yet among those who knew him well he was kind, accessible, witty, and really fun to hang out with. He loved to learn new things and was open to considering any idea. He was a devout researcher who loved good books.

Bill Mollison in 2008. Photo by Nicolas Boullosa [CC BY 2.0 (http://creativecommons.org/licenses/by/2.0)], via Wikimedia Commons.

His idea of a good time was to peruse bookstores or prepare delicious seafood dishes for his friends and share stories. We spent a lot of time in the car driving across California, and he would read the landscape aloud as we drove. I learned so much from him. He was generous with his knowledge and despite a crusty exterior, he really did love his people. He often spoke about the miracle of the natural world and how it is immeasurable by conventional scientific protocols. For someone "who doesn't have any chakras," he said some very meaningful and sometimes deeply metaphysical things.

Here are a few quotes.

"I saw God last month, in the form of a jellyfish."

"Wealth is a deep understanding of the natural world."

"It is through art, music, dance, and poetry that ecological knowledge is passed on from one generation to the next."

"There is one, and only one solution, and we have almost no time to try it. We must turn all our resources to repairing the natural world, and train all our young people to help. They want to; we need to give them this last chance to create forests, soils, clean waters, clean energies, secure communities, stable regions, and to know how to do it from hands-on experience."

"Though the problems of the world are increasingly complex, the solutions remain embarrassingly simple."

"The fastest way to impoverish a community is to ship all of its resources out."

"We only have to look to history to see that every civilization that has tried to irrigate drylands has failed."

"We know what we don't want; let's put in place what we do."

"Without trees, we cannot inhabit the Earth."

Bill was way ahead of his time. He was a visionary genius who thought in patterns and saw not only the big picture, but the processes that created it. He could tell the story in ways that were direct, inarguable in many cases, and easy for people of diverse cultural backgrounds to digest and understand. He foresaw the coming ecological crisis, and pointed to a pathway for humanity to navigate away from it via permaculture design, and he was well down that path before most people even awakened.

He devoted his life to spreading the word about permaculture across the globe. If he had just stayed home and gardened—as he sometimes encouraged others to do—our world and the permaculture movement would not be as rich, inspired, informed, skilled, or visionary as we are today. He has changed many lives including mine, forever. He transformed landscapes, harvested millions of gallons of water, healed countless erosion gullies, built soil, grew food, and restored forests and prairies. And through his students and his student's students and their student's student's students… the life we know and that he loved goes on….

Rest in Peace, Uncle Bill! The world is a better place because of you, and the future of this beautiful garden planet lives on through your teachings and your students. Δ

"My students who become teachers, they're the only thing that gives me hope." Bill Mollison

Tribute to Bill Mollison

Peter Light

I DIDN'T TAKE A DESIGN COURSE from Bill Mollison or ever meet him, but from the beginning I recognized him as a comrade, a fellow traveler, a simpatico; after reading *Travels in Dreams,* I loved him like a dear friend.

Imagine my reaction when I first encountered his writings in the mid-80s.

In the mid-70s, ten years before I encountered the word permaculture, and at the same time Bill and David Holmgren were developing their ideas in Tasmania and Australia, our family of four was developing a very simple but far from rude lifestyle in the woods of southwest British Columbia, in a very small space—a third of an acre—starting at our doorstep. All human "waste" wasn't wasted, but was recycled and used, including our urine and feces—by means of our composting toilet, an outhouse, a bucket, and an old-fashioned compost pile. Intensive vegetable gardens started at the doorstep of our small 12'x12' dwelling. Squash vines sprawled up and over the roof. The main path through the garden led to chickens a short distance away that ranged in one permanent "straw yard" and were rotated through three other netted runs. Vine crops grew on the fence. Beehives sat on the hen house roof. We planted an orchard of nuts and dwarf fruit trees in the small pastures, as well as an understory and groundcover of clover, comfrey, and other herbs and multifunctional plant species for hen and human. The bees pollinated the fruit trees and visited the clover flowers for honey. The chickens did not eat the bees or the flowers, but fed on the leaves of the clover, which was also adding nitrogen to the soil. The leaf-drop from the trees provided mulch and more richness. Food scraps went to the chickens that were fertilizing both the orchard and garden with their droppings, and helping with earthmoving, leaf shredding, and pest control. Oh yes, they also provided eggs.

Everything was within a few meters of everything else. It was small, and it was beautiful. Moreover, it cost hardly anything.

I thought that I was inventing a radical, new kind of agriculture.

Sometime in the very early 80s, I encountered the book, *Trees Crops,* by J. Russell Smith, describing a shift away from monocropping and annuals to a productive three-dimensional agriculture consisting of trees, fields, and livestock. Soon after that, I burst into the brilliance of Bill's brainchild and I was home. I had a new way to define my life, my protest, my drop-out, and my evolving lifestyle. I became, and am, a permaculture designer and practitioner.

When I started reading *Permaculture: A Designer's Manuel,* I found myself hanging on every word, on the one hand seeing what I had been doing reflected and articulated in his words, and on the other being electrified by how his thinking extended what I had been manifesting. His genius, his new and unexpected ideas, his communication skills, all made it difficult for me to read the *Designer's Manual* because every other sentence would set off a storm of thoughts, so that I would have to stop as my mind raced.

Something else which created a huge affinity for me with him was his political and social radical analysis, and his forthright, uncompromising horror and fury at mainstream industrial capitalism, and the ignorance, stupidity, and immorality it spawns. I had first dropped out in 1962 after one year of university, forsaking a lifetime goal of Zoology PhD to become a full-time "Ban-the-Bomber" and peace worker evolving into a nonviolent, Gandhian, anti-war anarchist. Three years later, feeling that we were "throwing eggs against boulders," I dropped out further into urban hippy, psychedelic explorations, and thoughts on intentional community, and then, further, out of the city and off the grid in 1967 to raise a family and "live simply so that others may simply live," to quote Gandhi.

So to find Bill also wedding subsistence and self-sufficiency with a profound rejection of the dominant paradigm—well this obviously resonated with tens of thousands of us who were so ready for an intelligent articulation of what we could do once we got back to the land.

Anyone's death always makes me sad. The more time we spent with someone, the closer we felt to another, and the greater the effect someone had on our lives, then the greater the loss and the sadder we are to have to say goodbye forever. I spent a lot of time with Bill, felt so close to him, have been so affected by him, despite never meeting him.

I had wanted, this past year, knowing he was in his late 80s and could go at any time, to write to him of my great appreciation for his life. I didn't—too busy doing permaculture. Bill Mollison would no doubt have approved, but I'm not sure I do. In prioritizing my future things to do, I hope I will place "express appreciation for the lives of the living" higher up on my list. Δ

"I Dreamed I Saw Uncle Bill Last Night"

Rick Valley

I KNEW BILL MOLLISON ONLY AS A STUDENT, or as part of the crowd watching—I doubt he ever knew my name. I first saw Bill at IPC-2 at Evergreen State College; I was intrigued by his energy and his seeming ability to understand both his co-stars at the conference: Masanobu Fukuoka with his Buddhist paradigm, and Wes Jackson with his Christian metaphors. His energy and anger appealed to me, and when he told us that he was going to be delivering a presentation on the chapter he was then working on for *The Permaculture Designer's Manual* on pattern understanding at the same time I was scheduled to give my presentation, I started thinking about taking the Design Course he was offering a couple weeks later. By the time I got home from the conference, I had made my mind up to do the PDC, so I got my ducks in line and drove back up to Washington state and in the following two weeks of the PDC got to see a lot of the man and his teaching approach, and heard many of his stories.

...I always saw him listening more than expounding.

He wore old thong sandals as his primary foot gear, punctuated his lectures with long drags on the always lit cigarette he kept at hand, often beginning the pause with "Roight!" in his strong rural Australian accent. A grin was never far off, his eyes twinkled especially when he had just delivered an ironic, bloody, or scandalous punchline. He loved dropping tidbits that illustrated the arrogance of bureaucratic authorities or illuminated some human failing or pretension. Many of his stories showed the cultural wisdom of traditional peoples, whether Australian or European. His stories about his time in the University of Tasmania, or at the end of World War II in Australia left me laughing, and his stories from logging and commercial fishing had a rough immediacy that rang true, along with a darkness that underlined the brutality of the work. When a band was playing a nearby venue on one of our evenings off, Bill went along and danced the whole show, with a style that to me evoked a 19th Century sailor on shore leave on some tribal island. His beer intake was appropriate to the image as well, and his smiles never ceased.

I encountered Bill again when I was part of the crowd hanging around during the shooting of some of the Pacific Northwest footage in the "Global Gardener" videos, and again during the convergence prior to IPC-3 in New Zealand. The smaller gathering, at a rather isolated site on the edge of the Canterbury Plain near Christchurch gave me a chance to see Bill raving angry. The cook hired for the convergence was a German vegan who proudly told the assembled multicultural group fresh from DAYS of hard travel around the world, that the vegan food was chosen to "feed our brains." After the stress of travel, it left my brain feeling starved, and I wasn't the only one. It was the first time some of the international group had encountered dogmatic veganism, and Bill took the lead in lambasting the proud cook, the convenor crew, and anyone who wasn't in support of a diverse polycultural menu. A compromise was devised, with a tiny secondary kitchen being used by volunteers to cook non-vegan organic entrees. The promoter must have taken a bit of a loss with the purchase of the additional supplies of organic chickens and such, but many of us were relieved and volunteered to help cook. It may have saved the convergence. Over the following days, I saw Bill dealing with many requests for interviews, but at meals he usually was eating with anyone who wasn't from a European or Anglo country, and I always saw him listening more than expounding. The group he was with always seemed to be in lively discussion and fine humor. Bill didn't stop promoting the work being done in Africa, India, and the rest of the world.

I could not catch him more than "embroidering the truth" on any of his statements—the most I can say is that when he wrote about how he cooked salmon at a gathering of nearly all vegetarians, and he barely got any food (from *Travels in Dreams),* I was there. I was watching him plank the salmon (can YOU plank a salmon over a fire?), and he knew what he was doing—the fish was perfectly cooked. The crowd was not primarily vegetarian, and we were HUNGRY. Any cook as good as Bill should have grabbed the cheeks from at least two of the fish and set them aside!

We may not get all the results we hope for in the end with this permaculture movement, but it's been a great ride, and I am profoundly grateful for the immense amount of work Bill put into promoting the ideas and the vision. Δ

Movement Musings

North American Permaculture Convergence
California Connections

Rhonda Baird & Koreen Brennan

EVERY ONCE IN AWHILE it is a good idea to gather together to inspire each other with tales of our accomplishments and encourage each other with shared experience. It is good to engage in conversations in person (rather than over the internet or through far-flung phone call or video meetings). This is what happens at the North American Permaculture Convergence. The convergence brings permaculture people from across the continent—and delegates from other continents—to one place to identify what is emerging with permaculture across the continent and take up valuable ideas that improve everyone's game.

After a successful first convergence at Harmony Park, Minnesota in 2014, many questioned whether a second convergence would come together. Indeed, until March 2016, it seemed that the 2014 event might be a one-hit-wonder.

How it all started (for the second time)

This guy walks up to this woman in a bar and says, "We should do this: the Building Resilient Communities Convergence in northern California should host the second North American Permaculture Convergence." That's how it all started about six months before the event actually took place. From there, the BRCC crew along with a small NAPC team came together to welcome people from all over the continent in mid-September.

Michael "Skeeter" Pilarski telling the story of NAPC at the second North American Permaculture Convergence on September 14, 2016. Photo by Rhonda Baird.

Diana Young ran a beautiful children's program. Here she is reading to youngsters beneath the grape arbor. Photo by Rhonda Baird.

The Solar Living Institute has been a host for the regional convergence several times. The Real Goods store occupies the center of the site, elevated on a slight rise. North of the store is a grassy area with a private residence and a beautiful lake surrounded by trees and cool, shady hangout spots with metal sculpture and whimsical car bodies being reclaimed by nature. The southern side of the building is covered by trellises hanging with grapes. Underneath, water runs in channels and spiral pools from a filtration system. During the entire convergence, I was in love with the beautiful children, mamas, and babies playing in the water. Spread out around this centerpiece, temporary tents and edge spaces were occupied by vendors, workshops, music, and art. Campsites literally lined the edges of the property

Programs, working and bioregional groups

Tuesday evening, people from across the country began arriving and helped pitch tents, place chairs, and get things rolling. Early Wednesday, Clinton Davis of the Pomo ceremonially

opened the event, sharing the story of his people on the land holding the event. Michael "Skeeter" Pilarski jump-started the day greeting people with a bell and clipboard for announcements at the opening. His songs opened and closed the NAPC portion of the event. Jan Spencer helped launch the working groups Wednesday afternoon with several key groups already primed before the event for creating a plan of action. Working groups were then invited to announce their own gathering times and reported back on Friday afternoon about their accomplishments and commitments.

The programming during the first few days centered on the working groups, specialized permaculture programs, panels, and keynotes. The keynote speakers, Toby Hemenway and Warren Brush, were well received by those gathered. Panels on water management and projects drew most people as well.

Padma and Narsanna Koppula from the Aranya project and hosts of the International Permaculture Convergence in Hyderabad, India were present for workshops and connections. They will host IPCC in November 2017. The patterns of people gathering regionally, continentally, and internationally is settling into a recognizable and valuable form.

Throughout the event, indigenous peoples spoke up about their experience and more importantly about their work with their land and their people. The emergent thread continued the conversation begun at the first convergence about the experience of people of color with permaculture: its promise and challenge in communities of color. Our theme for the event was "Building Bridges" and this was accomplished in many ways.

Building Bridges theme

Organizers were pretty passionate about the theme of this year's convergence of Building Bridges. People were encouraged throughout the event to create collaborations and beneficial connections. And you really stepped up, beyond expectations. Many beneficial collaborations were discussed and they continue to be explored. We aren't able to keep up with them all, there has been so much work done in that area.

We saw it during the convergence too in the community kitchen, helping each other to build a cob oven, and in many other ways. One aspect we're excited about is our partnership with NorCal Community Resilience Network which has offered the use of a web platform developed for them, to allow working group and other conversations to continue on line in a dedicated space. It is user friendly and the creators are responsive to the needs of our community. If you have a working group that isn't up yet, let us know through the site. http://norcalresilience.org/

People!

While the programs were well attended, the music and dancing in the evening, and the creativity and presence of children, the tea house, the many creative vendors, and others contributed to the festival feeling of this convergence, perhaps the very best part of the convergence was the deep, heart connection between people which emerged. If we know, as designers, that physical designs succeed or fail on the strength of agreements and invisible structures, then those agreements succeed or fail on the depth of understanding and connection between the people involved. Those of us that participated at that level of work in the convergence recognize how much time and skill it takes to do that work: something that is only done in person. The value of the convergence to the movement for creating these opportunities alone, is critical.

Feedback

Because of the short timeline, the core organizers were focused on ensuring we did what was needed leading up to the event. The BRCC crew worked very, very hard to pull the event together and make sure things rolled along smoothly. The feedback from the Solar Living Institute and many participants, however, indicated the success of this event. Feedback will be continuously gathered—and you are welcome to send a thoughtful letter to the core organizing team via the website or contribute via this survey.

Next time

While NAPC might not have happened a second time, there are already plans afoot to bring NAPC back in 2018—perhaps in the Northeast. It takes many, many people knowing their skills and strengths to step in and make a successful event. If you might be one of those people willing to contribute, please let us know. Δ

Rhonda Baird and Koreen Brennan were part of the core team organizing NAPC. Koreen Brennan's leadership and vision of the convergence has held continuity between the first and second convergences. Both organizers are tending courses and designs and preparing to gather with others to begin work on the third convergence. Contact us through the website: www.northamericanpermaculture.org.

Padma and Narsanna Koppula presenting a workshop at NAPC II. They are hosting the 2017 IPCC in Hyderabad, India. Photo by Rhonda Baird.

In Transition Permaculture
The Tavaputs Plateau

Jeremy Elliot Lynch

THE MOVEMENT TOWARD CLIMATE JUSTICE is an emergent property of conscious and engaged communities. We are aware that a particular trauma of our modern mode of living is the prevalence of inactivity, unquestioning obeisance, and disconnection designed into our communities. Though we live in proximal settlements based on exchange, we regularly neglect the realities of true interdependence: an interconnectedness rooted in our neighbors, our watersheds, our ethics. Consider how we design our homes within a community landscape, orienting the entryways of our buildings indirectly, toward the street, such that the path of least resistance is not toward one another but away from one another. We sacrifice energy and resource efficiency—and community—when we direct the flows of access and circulation toward the roads that drive us into solitude.

What does this do to the concepts of *home* and *community*? We come to rely on anxiety and the fear of scarcity in lieu of moral directive. We turn to solipsism—to *island living*—in escape from the stultifying aspects of contemporary life. This is the consequence of the design that preceded us, whose feedback now rings in our ears. We too often deny ourselves the great contributions we might otherwise provide our communities, of which each of us is uniquely capable. The society I wish to see is not reliant on cults of personality or demagoguery, its people so easily distracted by gilded idolatries. The society I wish to see is that which we create in perpetuity. That which enables the many, not merely enabling or ennobling the few. We, as a species within our formed ecologies—urban, rural, global—serve the equivalent function of the mature trees, of the lightning and of the fire. In our destructive acts, we prepare the ground for regeneration. As conscious, reflective beings, it is a matter of rising up together—not merely against, but toward. And there is no one way to rise. Rising is polycultural.

A conversation

How do we propagate ethical incentive for more active communities? It is an open question. This essay at that question is intended to be a conversation beyond myself and these pages. I encourage response, reaction, contribution, critique, or otherwise in future issues of *Permaculture Design* magazine or by direct contact. I so much value continuity, dialogue, and dialectic. Let us use this publication to that end, directly or indirectly. For it is through continuity that history arises, that culture forms and reforms. Consider the landscapes we design. No matter how adapted our plant palette, how finely set the elevations of our earthworks, how deeply mulched our paths, how stable our slopes, our work is for naught if we have not designed for management, care, and adaptation through time. I cannot provide the perspective that succeeds me. I need you for that. I value you for that.

A photograph of the Tavaputs Plateau from 2013 showing a hillside within the present-day Mine Site. Photo Credit Melanie Martin.

I am writing today not to purport some new wisdom, nor the latest strategy toward total global regeneration. I write to share a story. As last issue's contributor Rishi Kumar expressed, we should remain ever conscious of the misdirection inherent in seeking sages for the sake of looking up. Looking up is for necks; while you and I are here, let us speak as equals.

This is a conversation we have already begun. I suspect many of you through your work address the need for increased interconnectedness where you live—whether as builders, gardeners, community planners, small business owners, public officials, and so on. I am many of these things myself. And what I have observed across the intermountain west, from Wilsall, Montana to El Paso, Texas, are (to borrow from anatomy) neuronal networks of small, dispersed rural communities taking action. Like synaptic firings, the youth and energy of these communities migrates between nodal towns and cities, exchanging with people and landscapes and history en route. It is a particular coordinated firing of this neuronal network that I wish to share.

A story

We pick up the narrative where we live in southeastern Utah—the city of Moab—one of a number of dispersed, yet cohesive, rural intermountain communities across the Colorado Plateau. Ours is a historied valley, lain with the tracks of pre- and post-industrial boom and bust—from seasonal Ute crossings to Mormon cattle ranching to military-fed uranium mining to trans-industrial tourism. The life that moves through this valley

is immense, international, and intermittent. It is a community reckoning with its own growth, as that growth continues to outpace the reckoning. It is a familiar story in the new west. With ourselves—the land's citizens—as harbingers of a history of human impact on ecological and watershed health, from this community has arisen an ethic of regenerative land management, or earth care. To understand how this active community expresses itself, we must head north out of the valley.

The Tavaputs Plateau

Fifty miles north of Moab rises the Tavaputs Plateau, a two-mile thick geologic formation uplifted from the surrounding desert and shorn in two by a curving stretch of the great Green River. Reaching elevations up to 10,000' (3000 m), the plateau's alpine forests and meadows are covered in spruce, fir, and aspen forest and support diverse wildlife: coyote, cougar, bobcat, bighorn sheep, mule deer, pronghorn antelope, and vast herds of elk and American bison. Home to the traditional hunting grounds of the Ute people, an extent of the plateau lies within the present-day Uintah and Ouray Indian Reservation where petroglyphs color the dark stone of the sheer rock through long, narrow canyons. The perennial streams that flow through the heart of these canyons are the steady descendants of the vast waterways that have historically and intermittently carved the plateau from its first form.

This contemporary biological diversity is not unique to the plateau's history. The plateau has for eons been inhabited by diverse species whose remains now constitute the vast reserves of mineral stores beneath the soil's surface. As the archive of our local newspaper informs us, the plateau has long been an object of capital ventures in mining and other forms of mineral exploitation. Industrial mining has in fact been a feature of the landscape for well over a century, as prominent as the exposed stratified layer of Cretaceous-era sandstone that give the nearby Book Cliffs its name. While we might spend the rest of this issue discussing the ethics of industrial mining as it is practiced today, suffice it to say here that the methodologies employed in recent years on the Tavaputs Plateau have been of the sort least concerned with care for the earth, from natural gas drilling to tar sands mining. The latter is this discussion's point of concern. As we proceed, and as a reassuring mantra, let us keep in mind the words of Wendell Berry (1):

> *"...land and people have suffered together, as invariably they must. Under the rule of industrial economics, the land, our country, has been pillaged for the enrichment, supposedly, of those humans who have claimed the right to own or exploit it without limit. Of the land-community much has been consumed, much has been wasted, almost nothing has flourished. But this has not been inevitable. We do not have to live as if we are alone."*

The Tavaputs Action Council

The Tavaputs Action Council is a collective of organizations and individuals across the Colorado Plateau and Four Corners Region who believe it is our responsibility to protect from further exploitation a wilderness too long deemed the medium of development by those who choose to live as if they are alone. The TAC defines itself as "a spokescouncil of grassroots groups from the Colorado Plateau seeking a fundamental transformation of power in our society… advocate[ing] for climate justice, clean water, protection of sacred sites, healthy land and clean air [with a] belie[f] in the power of storytelling, music, and art to cultivate the imagination needed to create a different world." The group's recent organizing efforts in southern Utah involve an approach to organizing, activism, and the exercise of civil disobedience that is founded on care for the earth, the struggle against oppression, artistic expression and love: a nonviolent creative resistance in which we all have a role.

The Council asks: when so much of our social and political culture is guided by an ethic of hate, of violence, of oppression, of capitulation, how do we resist through active creativity? How do we bring our art and our work—our care for one another and for the earth—into direct action? And how do we do this without creating further cycles of oppression, antagonism, and hatred? We begin with observation and interaction. We do not close ourselves off to the realities of life as it is lived around us. And we do not rely solely on our preconceptions or the way things happen to be today. We do not begin by countering or reacting. We observe and interact so to embrace the struggle to understand what we do not know we do not know. Care for the earth is love of the earth; love is creation; art is creative process. All is process. When we seek to care for the earth, we are first of all expressing our innate creativity. Every single human being on earth is capable of such expression, and therefore capable of artistic creation. This understanding is an affront to oppressive societies everywhere, and must be.

Artistic expression is universal and change is a function of expression. It comes from within and without. Every system has the potential to become actively oppressive through the stagnancy of its principles, and every system also harbors the elements of its own revitalization. Love in the act of creation is anti-oppressive action. As Paulo Freire wrote in *Pedagogy of the Oppressed,* "Paradoxical though it may seem—[it is] precisely in the response of the oppressed to the violence of their oppressors that a gesture of love may be found. Consciously or unconsciously, the act of rebellion by the oppressed… can initiate love." And while I do not presume to speak to any social op-

Seed sowers collect on-site woody debris to line and bolster the on-contour berm on a hillside at the mining site. The branches and trunks are the remains of the forested slope bulldozed to make way for the mine site.

pression of which I am not the direct object (but which I should bear witness when spoken to me), there are land-based forms of oppression (recall Wendell Berry) for which active resistance thereagainst is our work. For when we serve the earth, we serve one another. The connections we make today will become the pathways to justice tomorrow.

Action

In July of this year, over 100 people—Utahns, Diné, native-born and immigrant alike—gathered on the Tavaputs Plateau to form community and carry forward a multi-year conversation. The gathering called itself A Mine Reclamation Action. It was a weekend for creativity. As the 100' long hand-painted banner read: Resistance is Fertile. Participants came to learn and to share. Workshops were given, panel discussions were held, and a morning field trip through a whispering aspen grove to a sacred spring provided a setting for prayer, reflection and engaged conversation on permaculture practice as taught by youth leaders of the Diné tribe and our Moab-based contingent. It was an opportunity to "celebrate life, water, and resistance on the Colorado Plateau through music, art, and storytelling." The intention, at heart, was to draw out a new narrative—a shared narrative derivative of diverse experience—one to supplant that which was culminating in the wholesale destruction of a landscape now within view, the denuded hillside rising up across a deep, dense draw. While intentionally symbolic, the actions taken were intended to be tangible, literal and guiding. In preparation, a workshop was taught on water-harvesting earthworks as a strategy toward watershed reclamation. The focus remained on earthworks as an art and an actualized process of healing—a means by which the work of our hands can translate to healing beyond ourselves and into our communities.

In the act of literal and celebratory reclamation, 20 seed sowers were arrested for civil disobedience. They had employed permaculture-based land reclamation techniques to hand-carve a 200' on-contour swale and berm along the slope of a bulldozed and deforested hillside, the latest extension of the mine site. With thousands of native seedballs in hand, participants seeded the earthworks before being detained. Their act of civil disobedience represents one of the highest expressions of community as defined within social permaculture—not solely for their act of resistance against a world developing indiscriminately, but for the place they secured for creative expression as anti-oppressive action. When the world you wish to see does not reveal itself before you, you create it. When you do this with love—for the earth, for your neighbor, for the future—there is no shame, no insult, no loss within the system. It is the rise of a current of change sweeping steadily across the landscape, and it is a form of home we may all share. [Update: In early September, the local County Attorney moved to dismiss all charges brought against the activists, citing the peaceful nature of the protest as a justifiable act of civil disobedience.]

Reaction

When we hear a story such as this, we often focus on the sensational: arrest, jail, civil disobedience. These emphases are the product of a culture oversaturated with wholesale suspense, and they distract from a central meaning: such actions are tools, implements within a process through which we may expose the health or decay of a system, an institution, or a way of thinking. As flourishing roots will open the surface of caked, hardpan earth, establishing pathways for water, nutrients, and regeneration, so the efforts of the seed sowers stimulates a dialogue about our own relationship to land exploitation. Other lines are subsequently fed—by media, by the judicial process—but this initial action sets the process in motion. We are a culture of consumption with a belief in accumulation, where we ought to be a culture of creation with a faith in upheaval.

Often, it is through the fissures in our expectations that systems begin to process true change. Instances of our unspoken kinship abound. The arrested seed sowers realized this as the system designed to halt their work revealed its cracks. The seed sowers received admissions of understanding, respect, and, in some cases, whole-hearted support on the behalf of arresting officers. On the jostling three hour ride to jail—along the dirt roads of canyons as deep and remote and profound as the wilderness that precedes all modernity—life stories were unveiled as people temporarily on opposite sides of the system of law discussed where they had come from and why they were there that day. (This should not be surprising for it is the system itself which creates the notion of 'sides,' as though nature divides herself among uncertainties. It is simply not the case, and the rule of law is too often overlaid with a blanket weight, bearing no concern for the site-specific, for the inherent diversity in every circumstance.)

...it is up to us to reconcile these systemic contradictions.

Moments such as these remind us that we are in this together, that we occupy the same land, that it is up to us to reconcile these systemic contradictions. We, all together, represent an underlying social movement that recognizes that people are growing in their consciousness of the consequence of the lack of care for the earth. Change is underway: whether we realize it in the personal histories of multigenerational ranchers who have watched the extractive industries poison their water supplies; through the recognition of coal miners that the long term health consequences of the profession they were born into are by no means worth the paycheck; or simply by the loss of a geography of place across the terrain we once knew to be an extension of our bodies.

Social permaculture

Social permaculture design recognizes that the principles active in nature apply as well to the activities of human beings within modern society. As recognized principally, ecological edges are highly productive zones. The edge of a forest and a

field (or the strip of earth abutting a concrete sidewalk, or the boundary between your home garden and encroaching wild space) fosters a high diversity of life by (a) serving as overlapping habitat for two distinctive regions, while defining itself as a third unique ecology or microclimate; and (b) concentrating the flow and passage of resources between differentiated surfaces. Similarly, social permaculture identifies equivalent 'ecological edges' along lines of culture, socioeconomic boundaries, race, gender identity, personal history, experience, etc. *The boundaries that have traditionally separated us create places of unique creativity and expression.* Such was the Tavaputs Action Council's unspoken intention, to value the marginal in its process of creative thinking.

As in a natural ecology, the aim is to integrate rather than segregate, using and valuing diversity, creating zones of exchange, overlap, and redundancy which help identify strengths, vulnerabilities, and potential, leading to new iterations of life better adapted to changing conditions. The Council has fostered opportunities to work along geographic, socioeconomic,

The native seed used during the planting includes: blue gramma (Bouteloua gracilis), *little blue stem* (Schizachyrium scoparium)*, sideoats gramma* (Bouteloua curtipendula)*, sand dropseed* (Sporobolus cryptandrus), *Indian rice grass* (Achnatherum hymenoides), *alkali sacaton* (Sporobulus airoides) *and desert globe mallow* (Sphaeralcea ambigua).

and cultural edges to foster a bioregional community initiative that maintains at its core (as viewed with a permaculture lens) the three-part ethics of care for the earth, love for one's neighbors, and a desire to create the conditions that foster long term equitable societies. Through intention, observance, and interaction, we draw closer to healing community divisions. And in the process, we gain the benefits of knowledge, wisdom, and growth that come from our exposure to others' experience.

The direct action carried out by the seed sowers was one aspect of a much broader program of community building that has evolved over the past half decade and found unique expression during the celebration at the mine reclamation event. More than the immediacy of the direct action and its effects, the event brought together diverse parties—including Diné youth from the Navajo Nation, rural and urban communities across the Colorado Plateau, and indigenous peoples from throughout the Americas—to engage in processes of creativity, cultural exchange, and community self-determination—all while acknowledging their motivating factor: care for the land of the Tavaputs Plateau. When care for the earth is the core of your intention, there are no limits to the unity that is achievable.

Engagement with this diversity—a highly productive social permaculture 'edge'—is an opportunity to discover new and emergent ways of thinking that help us orient ourselves within present society. We experience thought, worldview, and practice foreign to us and, in solidarity, we are encouraged to respect, care, and love even those things that remain unfamiliar. An action such as this is never one thing. But it does begin and propagate with community. When one leaves behind an iteration of community such as this, the questions arise: How do I find this place again? And how do *we* create the social conditions so that this community regenerates itself?

Reflection

Ultimately, whomever and wherever we are, our work is the planting of seeds and the propagation of a culture of direct and regenerative action. When we tell our stories, we are planting. When we are heard, they propagate. Permaculture, as we choose to comprehend it, is not gardening (though gardening may be permaculture). Permaculture is an approach, an intentional mindset, a paradigm of principles, and a practice of perpetual design and reflection—it is a reminder that we are never bound to ways of being that simply do not work. Its approach is far more than the sum of its parts. It is the seeding of conditions toward the emergence of new arrangements. Through its practice, we express a vision of society we intend to succeed the present so that we may foster more meaningful iterations of human community and land stewardship.

Our work is the fostering of fissures in the institutions and patterns of being that simply do not work within the concept of regenerative culture. We must be the pioneer species who thrive on the edge of the parking lot—in ruts and rifts—there to transform the ground. We must support one another and knowledge that how we speak, how we create, and how we act in the world has the potential to become those very cracks in the system revealed by compassionate arresting officers and creative indigenous activists and the community that supports them both. Our work is peaceful in its efforts, and necessarily disruptive in its imagination. Creativity demands action. For interviews and footage from the Reclamation Action: vimeo.com/172613704. Δ

Jeremy Lynch is the owner/operator of In Transition Permaculture based in Moab, Utah. He is currently in El Paso, Texas working with a collaborative team of design professionals and educators on rainwater harvesting projects in the city.

Notes

1. Berry, Wendell E. National Endowment for the Humanities, 2012 Jefferson Lecture. www.neh.gov/about/awards/jefferson-lecture/wendell-e-berry-lecture.

Reviews

Graveyard Shift
Review by Peter Bane

JOHN MICHAEL GREER
Dark Age America: Climate Change, Cultural Collapse, and the Hard Future Ahead
New Society. Gabriola Isl. BC. 2016. 245 pp. paper. diagrams. $18.95

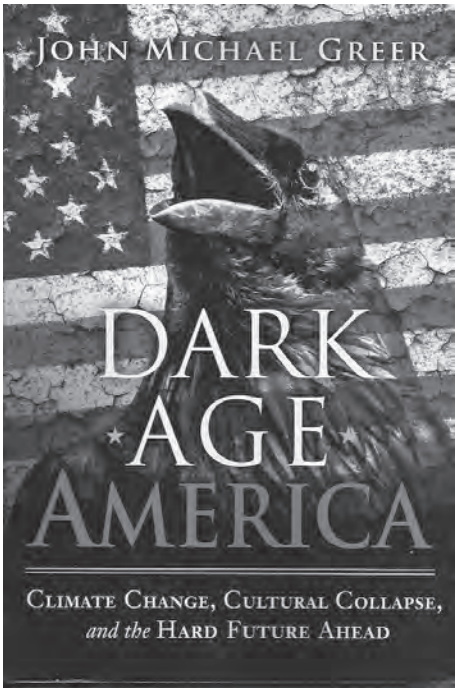
FANS OF THE ARCHDRUID, as the author is sometimes called, will thrill to this latest round of his familiar rhetorical flourishes, dark humor, and scathing excoriation of historical short-sightedness among the powerful. More critical readers will find a few gems in this book, enough to merit reading it. Arguably the best of his string of recent broadsides, in Dark Age America, Greer gathers up the threads of a short but revealing post-Recession history of the country, finds them wanting, and tosses them over his shoulder with a finality that can almost seem comforting: No, this venal, self-deluded, and technically obsessed culture with its arrogant and at the same time incompetent cadre of elite exploiters does not have the wit or the will to save itself. The die is cast, the twilight is descending on a bizarre experiment that wrecked the planet's biosystems, promised the moon, and will deliver a toxic and impoverished legacy to future generations for centuries to come.

The tropes will be familiar to Greer's followers and others of us susceptible to apocalypsia. In the wake of The Limits to Growth, a seminal book that hit the boomer generation square between the eyes during its formative years, there can be little remaining doubt that resource depletion, pollution, overpopulation, and climate change are the new faces of the Four Horsemen. Oh, and war, plague, pestilence, and hunger are still their steeds. With a more compelling touch than can be conveyed by the dry graphs of economic simulation, Greer forecasts and names the heretofore mostly unmentionable as if it were an ineradicable fact. Population in the American mid-section will plummet, leaving a few oases in the deserts that will spread from the Southwest to the Mississippi River, while the remaining habitable and arable zones will shrink and center on the slopes of the eastern mountains, river valleys east of the Big Muddy, and the Atlantic, Pacific, and Great Lakes littorals. How and how soon this will all come about, the author leaves largely for his readers to puzzle out.

Drawing on paleo-climatic studies, Greer projects a hot, dry interior for the continent, rising seas leading to receding coastlines, and a collapse of most industrial-scale technology including agriculture as we know it today. The chapters on science, technology, and economy are among the book's most intriguing, as we learn that all the US economic growth since 2009 can be attributed to the fracked oil boom, a bubble that never had much staying power and is now on the ropes. But in a larger sense, the challenge of reading the future through the eyes of an historian whose timescale is measured in centuries, is that what seems certain in the long run is by no means clear in the immediate years ahead, a period over which most of us imagine having some influence.

Greer entertains and sometimes astounds with his scholarship, dropping bizarre stories from the classical world into his narrative of a degenerative post-industrial wasteland, using the tragic tale of Alexandrian Christian mobs dismembering the noble woman philosopher Hypatia, on her way home from work at the Academy one lazy afternoon in the perilous world of 415 CE, as a cautionary message for scientists of the present day. Dithering, obvious corruption, arrogant disregard for real human needs, and a too close association with the religion of the elites (techno-salvation) will come around to bite institutional science in the butt. When the economy tanks, and great masses of people are disenfranchised and hungry, the wonders of science and technology, adoringly promoted in the middle of the last century, will come to look like so much black magic in the eyes of the public. Signs of the tectonic shifts ahead are already rising.

He argues credibly that the cultural architecture of a rational and scientific civilization is already being eroded of meaning....



Expanding on this story of the suicide of science and the twilight of technology, Greer offers his most penetrating prose in a discursive venture into the mysterious and potent realm of cultural mimesis, the process by which stories become manifest. He argues credibly that the cultural architecture of a rational and scientific civilization is already being eroded of meaning by the whisperings

of the dispossessed, who no longer see a future in, or any purpose to mimic the beliefs and behaviors of the rich and powerful. As this tide swells before the inevitable pressures of energy descent and economic contraction, the forces that will give rise to a series of warlords and charismatic demons, who will tear apart the decaying carcasses of failing industrial states, are being let loose in the night.

The book's final chapter points to what Greer imagines, based on historical precedents, will be an eventual renaissance as survivors of the coming dark age regain purchase on their environment and build a new civilization. In past writings, he has pointed to the possibility of a kind of green wizardry or ecotechnic culture arising from the collapse of the industrial world, albeit some centuries in the future. Where and how Greer sees himself transiting the turbulent times ahead are not clear from his closing remarks (he's 53 and lives in an old Appalachian mill town not far from the eastern seaboard but easily above the reach of rising ocean waters). He encourages individual action, speaks of studying printing technology, and avers that not all will be lost, though the time for retrenchment from the highest levels of modern hubris are long past. Underground cities, private islands, and floating ocean liners of wealthy tourists have little chance of surviving as autonomous fragments of a doomed world.

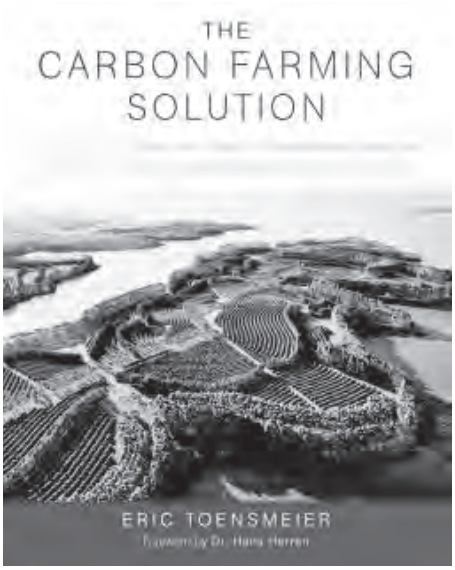
If you want hope, the author offers none. If you've already begun preparing for an impoverished world ahead—"collapse now, and avoid the rush" as he calls it—you probably know what needs to be done. If you can pick up your sorry ass and get out of Dodge today, hie thee to a well-watered section of the nation's eastern interior, preferably not far below the Mason-Dixon line, and start being actually useful to your neighbors: grow food without oil, build needed things, repair and repurpose local equipment and machinery, study and reclaim intermediate technology. The seeds you sow thusly may bear fruit for the humans who survive the crushing times to come.

Δ

Can We Do It?
Review by Rhonda Baird

ERIC TOENSMEIER
The Carbon Farming Solution:
A Global Toolkit of Perennial Crops and Regenerative Agriculture Practices for Climate Change Mitigation and Food Security
Chelsea Green Publishing, White River Junction, VT, 2016
480 pp., Color, $75.00

THE STORIES WE TELL ourselves, right or wrong, shape our choices. A common story told is that the civilizational project to move from horticulture and hunting societies to agricultural societies with the invention of the plow roughly 10,000 years ago is the basis for deforestation and our current ecological devastation. Certainly, the extraction mindset which agriculture engenders in our civilization is damning. Consider also, permaculture arises in the milieu which critiqued industrial agriculture and the exportation of its techniques around the globe during the Green Revolution. For Eric Toensmeier to argue that the very techniques which have been judged in this way are a significant part of the solution to the problems humanity faces today will grab your attention.



Toensmeier argues that we can use farming practices to sequester carbon—mitigating climate change—while meeting human needs including food and fiber. He argues, however, that "carbon farming is not a silver bullet." His plan proceeds to lay out the possibilities of using agroecology and permaculture systems to work directly against climate change.

The big ideas and arguments supporting them are detailed first—then the book breaks down into a toolkit for design, details on staple crops to meet population caloric needs, and industrial crops that hold promise for carbon sequestration. The final portion of the text delineates a path toward implementation.

The book, handsomely bound in hardback, is set up as a text book to learn from; and a toolkit with which to take action. It will fit very well on many university library shelves—make sure it gets there! In this way, it is what fans of Toensmeier's work expect. The book is well organized with beautiful images, tables, and diagrams illustrating the points made. Further, it is a reference book for students, designers, farmers, policy-makers, and others to begin to stretch their current understanding—whether they are working from permaculture design or agro-ecology or forestry or any discipline.

Initially, I was concerned along two fronts. First, Toensmeier seems to be propping up industrial methods (remember, we are well-trained to consider industrial agriculture and extractive industries the root of all evil). For example, he argues that we could not have supported the population we have on our current agricultural land-base without industrial

...we could not have supported the population we have on our current agricultural land-base without industrial methods.

methods. ["We would have had to clear and convert 1.7 billion more hectares to reach the same yield using the 'baseline' (previously widespread) agricultural practices." p. 20]

It might be pointed out that had we opted not to use industrial methods, we would have worked more assiduously to address population growth and the overall health of that very population. Rather than justifying the system we have, we should consider how to transition into a better system. However, it is well argued that we have the means to address very large problems (climate change and food insecurity) with fossil fuels and industrial applications. By adopting a carbon farming approach, there is a slim but hopeful chance of moving into a decent future.

The second concern is that Toensmeier's task is so broad that he chose to narrow it by focusing on industrial production crops: food and renewable agroforestry products used for industry itself. By using this lens, but taking us around the world, the book becomes inspiring but of limited use for farmers in any one bioregion. What emerges is the root pattern—but many more texts are needed which develop the ideas for specific regions. This becomes not so much a concern about this book as a call to action for other writers and researchers to put forward regional studies which flesh out the structure.

The author's basic framework pattern within the reference section introduces a crop according to its common name and Latin name, such as nara *(Acanthosicyos horridus)* along with a paragraph describing its ecological niche (in this case the Namib desert). Following that are sections on uses, yields, harvesting and processing, carbon farming applications, and crop development. The pattern makes this a practical and inspiring reference.

Moving more deeply into the book, we see that Toensmeier has opened many doors for people to walk through. The summaries of crop development, niche placement, and harvest and processing possibilities inspire us to expand our local plant palettes and get really serious about diversifying our broad-scale strategies on the ground now.

Just considering carbon sequestration, the data the author summarizes (using data visualization from Rafter Ferguson) that "woody plant-based systems generally have far higher sequestration rates than improved annual cropping or grazing strategies." (p. 31) This isn't news, but the data table gives us specific information with which to make comparisons. Land managers can consider whether to work in a "maize with fruit and timber" system or a parkland or a banana plantation. Just using this table, we can see that cacao agroforests store more than 40 tons of carbon/hectare/year and are followed by intensive silvopasture plus timber at nearly 35 tons of carbon/hectare/year. Just this table alone is worth the cost of the book for educators, designers, farmers, and policy-makers.

Academic, land-grant universities are beginning to experiment with the agroforestry and carbon farming techniques outlined. The University of Missouri's agroforestry program is taking leadership among land-grant universities. To their credit, they've opened up their webinars and workshops to everyone. This book is a solid contribution in that setting. However, as wonderful as the intentions of those university programs are in researching and documenting the techniques, the world can't afford the decades and millions of dollars these research programs require. Yes, academics out there, please keep your research programs going, but don't let that stop the farmers and designers from picking up the text and putting it into action. As the author points out, "Perhaps the most serious risk is that carbon farming may be a strategy with an expiration date. Climate change itself is an enemy of carbon farming."

Can we take up the task and mount a response to climate change? *The Carbon Farming Solution* tells us, "Yes, we can." The question now is: "Will we?" Δ

Perhaps the most serious risk is that carbon farming may be a strategy with an expiration date. Climate change itself is an enemy of carbon farming.

A Response to Dan Palmer

No Challenge

Peter Light

Dan Palmer, in the August 2016 issue's Movement Musings entitled "Christopher Alexander—His Neglected Challenge to Permaculture," attempts to demonstrate a fundamental conflict between these two schools of thought, both of which have design at their heart. Dan believes that permaculture starts with putting components together to create a whole, while Alexander starts with the whole, out of which emerges the components. The challenge, which, it should be noted, is Dan's perception of a challenge—I am not aware of Alexander himself directly confronting permaculture's design approach—is given import due to permaculture's huge respect for the work of Christopher Alexander and his colleagues.

I don't think there is in fact any fundamental difference between permaculture's and Christopher Alexander's design approaches. It is even possible to flip Dan's contention on its head and say, "Permaculture design does not start with elements, but with the whole; Alexander does not start with the whole, but with elements."

In order to understand these two statements in light of Dan's thesis, and in order to resolve the false appearance of conflict, one must realize that there was no acknowledgement made in the article that two different "wholes" were being discussed; that no distinction was made between the creative conceptualization stage of designing, and the execution of a design; that the author continually referred to components or elements with no further information as to their nature, scale, or temporal appearance in the sequence of design; and that he fell into the trap of cherry-picking bits of permaculture and Alexander's thoughts to bolster his argument.

Let me start untangling the confusion these imprecisions have created by first looking briefly at the statements Dan makes early in his article about "the core idea" of permaculture, and then at each of the quotes from *The Designer's Manual* referenced to support them.

Dan writes, "…the permaculture literature defines design as a process of combining elements into systems," but does not specify which stage of the design process is being considered, nor the nature, size, and specificity of the components.

Next he writes: 1) "the elements exist prior to their connection." Some elements considered in permaculture design do not exist prior to their connection because they are already intrinsically connected, e.g. sun, wind, etc. Aside from these, however, it is difficult for me to image how an element could fail to exist, or more properly, perhaps, be selected, before one decides to connect them. Once again, however, the nature of the component is not made clear, nor what stage of the design process he is talking about.

And, 2) "the crux of design is joining, assembling, or integrating these elements…." Again, there is no indication of the order of joining; the nature and scale of the elements; whether they are intrinsic, pre-existing elements or introduced elements; or what part of the design process he is talking about.

Dan then backs up his statements by choosing five short quotes from the *Designer's Manual,* and even further narrows the discussion by "underlining to emphasize particularly relevant words and phrases:"

"Permaculture, as a design system, attempts to integrate fabricated, natural, spatial, temporal, social, and ethical parts (components) to achieve a whole." Here, I think the most important parts of this sentence are the words not underlined. "[N]atural, spatial, temporal, social and ethical parts" are much more like the "clouds" that Alexander starts with than they are like swales, ponds, or mushrooms.

"It is in the arrangement of parts that design has its being and function" again says nothing about the nature of the parts, the process and order of assembling them, or whether we are talking about the creative conceptualization of the design or the on-ground implementation of the design.

"Permaculture design is a system of assembling conceptual, material, and strategic components in a pattern which seeks to benefit life in all its forms." " [C]onceptual… and strategic components" are far from the grossly over-simplified "Permaculture's Default Design Approach" illustrated in the article and are instead comparable to Alexander's larger primary patterns. At the same time, there is no acknowledgement as to whether this "assembling" is understood to be happening on paper or on the ground.

"The design [is] a beneficial assembly of components." This statement describes an end result, and not an approach to the process of design. Clearly, this describes the end result of any of Alexander's projects as well.

"For the final act of the designer, once components have been assembled, is to make a sensible pattern assembly of the whole." This quote is interesting for two reasons. First, it's not from the chapter on design, but from the chapter on patterns. If it is important to understand and design with patterns, then no component can be added on the ground until patterns are understood. This certainly seems once again to be in accord with Alexander's thinking, not in opposition to it. Second, if the final act of the designer is to make a sensible assembly of the whole, then "once the components have been assembled" must mean either "once the components have been gathered in one place," or "once the components have been assembled on paper" because one cannot first assemble components to build the finished design and then make "a sensible pattern assembly of the whole." I am not quite sure what this means for Dan's argument, but it is a confusing statement, regardless.

Dan's take on the essence of the permaculture design approach throughout his discussion is that it starts with all the individual components that make up a final design, as evidenced by his schematic showing a house, tree, mushroom, herb spiral, swale, and pond being assembled into a whole. His fix on Alexander's design approach, as evidenced by the bits he chooses to select, is that it starts with components that are like "clouds, whose size is imprecise, and with imprecise edges," proceeds to smaller clouds that are "about the right size, clear enough so that you can pinpoint their location with respect to other larger clouds, and to show [their] relations to the things next to [them], but no more exact than that," and ends with "all kinds of details which are smaller in scale" Unfortunately, Dan is unfairly or inaccurately juxtaposing two separate stages of

design work: the on-ground implementation of a design, in the first case; and the formulation of a design in head and on paper, in the second case. This faulty comparison mars the argument throughout.

But there are other things wrong with this comparison. Permaculture design never starts with the precise individual components that Dan suggests over and over again that it does. Far from it—these are the last types of elements added to a design, whether on paper or on the ground, and whether we are considering permaculture design or the "timeless way of building."

In fact, both approaches start with client consultation and then proceed to site analysis, design formulation, and finally, design implementation. All four of these stages start with the whole, and proceed through Alexander's fuzzy clouds to clearer and clearer components; all four together lead to and result in the ultimate creation of a whole: an ecosystem, building, or complex of buildings. None of the four stages of a design starts with fine details.

Thus, all four stages, and both Mollison and Alexander, start with a whole and end with a whole. Both Mollison and Alexander make sense of the whole they are starting with by evolving a picture from large elements to gradually finer and finer elements. Alexander's big vaguely defined clouds become more defined as smaller components are added. Whether he is talking about folds, crinkles, patterns, or details being created during the formulation of a design, he is talking about components. Putting them together in thought and on paper is a prerequisite to the on-ground execution of the design, which starts and proceeds by putting together these very specific components arrived at by the gradual "differentiation" which took place during the formulation stage of the design process.

Interestingly, both Mollison and Alexander start with the biggest whole possible, the whole planet—Alexander in Pattern 1 of his book *A Pattern Language,* wherein he advocates for 1,000 independent regions instead of 200 countries; and Mollison in his first ethical principle: Care of the Earth.

Alexander proceeds from his whole through gradually increasing clarity to Pattern 213, "the last thing you do on paper," before, in Pattern 214, we "put stakes in the ground" and start constructing our building. From there on, every pattern describes the addition of another component!

Mollison proceeds from his whole to "big picture components"—further discussion on ethics, sections on Permaculture in Landscape and Society, and Concepts and Themes in Design, and whole chapters on Methods of Design, Pattern Understanding, Climatic Factors and Trees and their Energy Transactions—before we reach actually working on the ground in chapters on Water, Soils, and Earthworking and Earth Resources. It is only when he comes to Chapter 10, The Humid Tropics, and continues with Dryland Strategies, Humid Cool to Cold Climates, and Aquaculture that we are being taught to put components together to create self-sustaining systems.

During the first stage of design, when either Alexander or a permaculture designer is consulted, a great deal of time must be spent listening to and asking questions of a client to find out as many details as possible about what the client needs and wants, the functions the building or landscape are meant to fulfill, who will be living, working, or being served by the creation, and so on. And both are as likely to start with big broad questions to do with the whole, such as: "What do you want?" or "What are your dreams?" In response, the client is likely to respond with two or three big indistinct clouds!

In either case, what the designer ends up with is decidedly not a blank slate, but a great number of details which will later be used to shape the whole to make a whole. It is important and useful to note these two uses of the word "whole" that are at play in this discussion.

The next step for permaculture is a site analysis, which also happens before the design process begins, of course, but is also an example of Alexander's gradual differentiation. One does not start by looking at small, individual and specific components but rather at large aspects of the landscape: slope, aspect, sun/shade, wet/dry, broadscale sector analysis including wind and fire direction—once again, in Alexander's language, big somewhat imprecise clouds (which, nevertheless, it must be stated emphatically, are components!). From these, we might proceed to take note of areas of tree cover, open pasture land, rocky outcroppings, boulders, and windfalls. Only gradually and finally do we note and record individual species of trees, shrubs, herbs, and groundcover plants.

Once a site analysis is completed and we know all the components that are present—big and little, generic and specific—on the piece of land we want to convert into a permaculture homestead/farm/community, we can begin to start stage three, formulating a design, in head and on paper. We can take the existing elements into consideration and often use them, but, strikingly, just as often, particularly in the development of zones one and two, we might alter, transform, or totally remove many of them. In doing this to create a "whole" starting place, permaculture is mimicking nature, which usually (or always) starts a new design following some catastrophic event which has radically altered a previous landscape—a forest fire, volcanic eruption, hurricane, flood, road-building, logging, or old growth fir crashing to the ground. All of these often involve a radical scouring, creating a new natural whole from which to start—from a whole burnt forest, a whole clearcut, or a recent floodplain, to a deserted pasture, or an abandoned field created by industrial forestry, bulldozers, and plows.

Coming to stage four—the on-ground implementation of the design—nature's approach as well as permaculture's now starts with broad determinants and constraints: sun, shade, wind, water, rich soil, dry soil, stony outcroppings, etc. Nature then saturates the site with very specific components: seeds and critters of all kinds everywhere, building a complex plant and animal community by allowing everything to fight it out. Permaculture starts with such a blank or whole canvas the same way, but then more often uses the opportunity of the disturbance, whether created by nature, past humans, or the designer, to begin to consciously select and add components, starting with big broad ones and finally proceeding all the way to "things from your life," the last pattern in *A Pattern Language.*

To illustrate how the permaculture designer proceeds

(continued on page 19)

EVENTS

Permaculture Design Course
Costa Rica

Dates: April 25-May 8, 2017
Location: Mastatal, Puriscal, COSTA RICA
Description: Join our diverse team of permaculture instructors Scott Gallant, Mitch Haddad, Santiago Miranda, Rachel Jackson, Sam Kenworthy, and Laura Killingbeck for this annual life-changing 2-week experience. The course covers the core Permaculture Design curriculum and emphasizes creating diverse multi-functional human landscapes based on ecological patterns.

Utilizing Rancho Mastatal as a living classroom, the class will mix lectures and hands-on work, exploring design solutions for both temperate and tropical regions. Putting permaculture into practice, the course concludes with students working in teams to create their own permaculture site designs. This course is applicable to anyone with an interest in designing resilient and regenerative futures as well as professionals in the fields of architecture, planning, ecology, education, farming, and community development.

The whole-systems design thinking outlined in the course will give participants the tools to re-design and improve their surroundings; from gardens, farms and homes, to livelihoods, relationships and communities.

The course is offered in English and Spanish.

Instructors: Scott Gallant, Mitch Haddad, Santiago Miranda, Rachel Jackson, Sam Kenworthy, and Laura Killingbeck
Cost: Central Americans, US$850
Residents and Ex-Pats, US$1350
Foreigners (non-Central American) US$1,500
Contact: Tim O'Hara
info@ranchomastatal.com

Social Forestry Course
Oregon

Dates: February 4-9, 2017
Location: Wolf Gulch Farm, Little Applegate, Southern Oregon
Description: Social Forestry connects villages and communities to their forested water catchment basin. Here in a developed industrial empire, the forests are lonely. We have lost our sense of living with forests as friends.

This Social Forestry course explores reconnecting with forests through ecological knowledge, the use of hand tools and woodcrafts, seasonal festivals and work cycles, childrens' stories, pilgrimages, and stewardship covenants. We will learn ecological assessment, carbon sequestration methods, restoration forestry, and the crafts and products that can be enjoyed while we are re-establishing our heart-space and wonder in the woods. Crafts may include tree felling, log carrying, pole peeling, charcoal making, broad-scale burning, safe pile burning, coppicing, pollarding, maple tapping, basketry, medicinals, furniture craft, charcoal can stove, ear cuffs, knot tying, hurdle loom, rod mat, use of tools such as broad knife, two person saw, tool sharpening. This is a 6 day residential course offering an advanced permaculture certificate through Siskiyou Permaculture and Cascadia Permaculture Institute.

Instructors: Tom Ward aka Hazel, Heron Brae and the Siskiyou Permaculture team
Cost: $600 includes camping; bring your own food early registration by Jan. 4 is $500
Contact: siskiyoupermaculture@gmail.com; http://siskiyoupermaculture.com

Permaculture Design Course
Costa Rica

Dates: January 8-22, 2017
Location: Finca Tierra, Cocles Beach, Puerto Viejo COSTA RICA
Description: Our course offers the standard 72-hour permaculture curriculum for certification, recognized internationally by the permaculture movement, with a special emphasis on forest gardening in the tropics. Although we're in a tropical setting, many of the methods and techniques will transfer directly to any climate. The course thoroughly covers all the fundamentals of ecological design. With completion of the course, a Permaculture Design Certificate (PDC) will be issues by Finca Tierra.

Finca Tierra is a 9-acre permaculture facility that's become an important center for education and community development. .

Cost: $1,450 US
Contact: Tim O'Hara
info@ranchomastatal.com

Permaculture Design Course
Oregon

Dates: Weekends beginning February 18, 2017
Location: Ashland, Oregon
Description: The world famous PDC introduces an array of solutions, tools & strategies for moving into a home-centered, resilient way of living sustainably on the only planet we have. Participants will learn to apply regenerative permaculture principles and patterns to design an integrated homestead, energy and water systems, animals, gardens, appropriate technology, forestry, and healthy communities. You will gather practical skills and learn about whole systems design principles for living in ecological balance with the earth. We consider methods for creating persistence, resilience, and re-indigenation with a culture of celebration. This is the full certificate course covering the permaculture curriculum set out by Bill Mollison, along with lots of local knowledge and applications.

Instructors: Tom Ward, Karen Taylor, Melanie Mindlin
Cost: $700, early registration by January 15th $600
Contact: Melanie Mindlin
541-482-7909
siskiyoupermaculture@gmail.com
http://siskiyoupermaculture.com

Send Event and Calendar Listings for Issue #103 (February 2017)
Permaculture and the Commons
by the December 1st deadline
events@permaculturedesignmagazine.com

International Focus

Permaculture Design Course
California

Dates: May 21-June 4, 2017
Location: Quail Springs, Maricopa, CA
Description: This course equips people working in international development and grassroots projects with the perspectives and skills needed to engage with communities in partnership to incorporate elements into the design of communities, smallholder farms and land with household agricultural production which are holistic, appropriate, strategic, effective, and diverse, as well as ecologically and economically sound. This course includes the 72-hr Permaculture Design Certification through the Permaculture Research Institute.

This course is designed for people who work with non-government organizations (NGOs) or governments, or who are community organizers. The teaching is directly relevant for international development practitioners, including the technical teams from agency headquarters and field teams engaged in implementation.

Instructors: Warren Brush, Lindsay Allen, Brenton Kelly, Pandora Thomas, Rafter Sass Ferguson
Cost: $1,650, check our site for discounts
Contact: 805-886-7239
quailsprings.org

Permaculture Design Course
Michigan

Dates: April 8-9, May 20-21, Jun. 24-25, Jul. 15-16, Aug. 19-20, Sept. 16-17, 2017
Location: Ann Arbor, MI
Description: Looking for something more than lecture at your PDC? Extensive reading and teacher-supported study before class sessions allows you to engage more with design process and practice—empowering you in using design skills for real-world problem solving.

This course provides the core content from a variety of teaching lineages and perspectives. We explore and knit together the many tools you will need in your designer's toolbox for effective work in the world.

We look forward to sharing the foundations of permaculture design with you over six weekends throughout the seasons. The course is hosted in a beautiful retreat setting. Students are responsible for their own lodging.

Instructors: Rhonda Baird, Milton Dixon, William Faith
Contact: glpdc.info

Permaculture Design Course
Colorado

Dates: January 6-8, 20-22; February 4-6, 24-26; March 10-12, 24-26
Location: Manitou Springs, CO
Description: Join us for earth-centered education; natural building, living greenhouses, integrated food systems, aquaponics, looped system design and more! Power down energy needs. Come to the beautiful SunMountain Shala with preeminent instructors: Becky Elder, Marco Chung Shu Lam, Avery Ellis, Tara Rae Kent, and others.

Instructors: Becky Elder, Marco Chung Shu Lam, Avery Ellis, Tara Rae Kent, and others.
Cost: $1,550 tuition includes lunches, snacks, and course materials.
Contact: Becky Elder
rselder@comcast.net
(719) 685-0290
Naomi Ironwing
PDCclass@mail.com
(303) 875-8382
pikespeakpermaculture.org

31st Annual

Permaculture Design Course
Colorado

Dates: August 2017, TBA
Location: CRMPI
Basalt, CO
Description: Join us for the 31st annual PDC held on site at a 30-year-old food forest and permaculture homestead. Witness firsthand the regenerative and transformative power of a long running permaculture design in action. Study with a diverse, experienced, and committed teaching team who offer insights into consultation, practical application, greenhouses, community, right livelihoods, and more! Camping in the fresh mountain air and three square meals a day featuring local and organic food. Inquire now for details. $100 early bird discount before Feb. 1, 2017.

Instructors: Adam Brock, Stephanie Syson, Avery Ellis, Jerome Osentowski, and guests.
Cost: $1,875, discounts available credit cards accepted
Contact: CRMPI, Jerome Osentowski
jerome@crmpi.org

JOIN US ALSO for an intensive course on how to design, install, and maintain both outdoor forest gardens and indoor greenhouse forest gardens. July 2017 TBA. More details at crmpi.org or contact jerome@crmpi.org.

Permaculture Teacher Training
Colorado

Dates: November 13-20
Location: Denver, CO
Description: In this dynamic and interactive course, you will learn how to share the world of permaculture design with new students, learn best teaching practices, and deepen your understanding of diverse teaching modalities including interactive experiential activities. We will focus on how to communicate permaculture principles and strategies to a wide variety of audiences and educational settings, give you hands-on experience in developing lessons and get you up in front of the class delivering lessons, and leading exercises. Our goal is to encourage and inspire your unique strengths and abilities by modeling effective use of lecture, storytelling, class discussions, visual aids, and hands-on skills. Having taught this course almost thirty times, Jude continues to refine and adapt the content and curriculum. Students will receive the benefit of her keen attention to continual improvement and her decades of teaching experience. Prerequisite: PDC Certificate. Course size is limited to 20 students. Non-residential.

Instructors: Jude Hobbs with Colorado guest instructors Kelly Sim mons, Adam Brock, and Sandy Cruz
Cost: $850 (plus credit card fee) includes lunch. Limited scholarships available. Discount for Denver Permaculture Guild members through Sept. 1.
Contact:
Kelly Simmons,
Sunflower House Permaculture Education,
sunflowerhousepermacultured@gmail.com;
http://coloradoteachertraining.eventbrite.com

Permaculture Teacher Training
Michigan

Dates: March 5-10, 2017
Location: Ann Arbor, MI
Description: Engage the movement in this dynamic, fun, fast-paced course! The Teacher Training is offered as an advanced course to support your presentation of permaculture design. Learn your teaching style, practice delivering material, deepen your facilitation skills, lead exercises, improve your graphic skills, and much more. This course will support you in your permaculture journey in and out of the classroom.

Peter Bane has long been offering successful teacher trainings and supporting the development of teachers throughout the United States. Rhonda Baird apprenticed with Peter Bane for five years following her PDC and brings years of organizing and educational work to the training (including work with children of all ages).

Prerequisite: Permaculture Design Course
Instructors: Peter Bane, Rhonda Baird
Cost: $800 before 2/1; $900 after; includes lodging and meals.
Contact: Peter Bane
PO Box 182
Montague, MI 49437
812-335-0383
pcactivist@mindspring.com

Permaculture Design Course
Ohio

Dates: January 7-March 5, 2017
Location: Akron, OH
Description: You won't want to miss this Permaculture Design Course! Join international award-winning landscape design firm, Salsbury-Schweyer Inc, for this course. Featuring acclaimed instructors: this will be a PINA-recognized PDC running over 5 alternating weekends, including two Fridays. You'll never look at design in the same way again.

The Permaculture Design Courses offers training in holistic problem-solving and practical ecology for homeowners, civic leaders, and healing practitioners and peacemakers of all sorts, from landscape managers to clergy to those whose vocation has yet to ripen into professional work. Life-changing, uplifting, and multi-dimensional, the experience will rock your world.

Instructors: Peter Bane, Sabrena Schweyer, and guests.
Cost: $1,150
Contact: Sabrena Schweyer
330-375-9600
info@salsbury-schweyer.com

Permaculture Design Course
Indiana

Dates: February 3-5, 17-19; March 10-12, 24-26; 31-April 2; 21-23, 2017
Location: Bloomington, IN
Description: Go deeper than learning the techniques discussed in books or shown on a You-tube video. Join one of the longest running weekend courses to immerse yourself in permaculture design. The course is structured to introduce you to problem-solving through permaculture design and systems thinking. We cover core ethics, principles, the use of pattern in design, as well as design practices and processes.

A mix of lecture, pre-session reading, in-class exercises, hands-on demonstrations, and practical design challenges, as well as optional mentoring post-course, will give you opportunity to find your part in regenerating our world.

This course is ideally suited for land managers, city planners, farmers, and community-minded urban residents in the region. Optional field trips to farms and demonstration sites will be scheduled on off weekends.

Instructors: Rhonda Baird, William Faith, and guests
Contact: Rhonda Baird
812-323-1058
shelteringhills@gmail.com

Permaculture Design Course
Massachusetts

Dates: May 20-24 and July 15-21; with home study between sessions
Location: Various sites, western MA
Description: Spring/Summer 2017 Sowing Solutions Permaculture Design Certificate Course in Western Massachusetts! May 20-24 and July 15-21 (this program is offered in two parts, with home design practice assigned). Hosted at Snow Farm New England Craft Program and Nine Mountain Retreat Center. Practice ecological design alongside leading designers and educators in the Northeast; Gain your permaculture design certificate; Visit numerous demonstration sites such as Sirius Ecovillage, Hickory Gardens, Wildside Cottages and Gardens.

Instructors: Kay Cafasso, Keith Zaltzberg, Llani Davidson, Walker Korby, Ryan Harb, and guests
Contact: www.PermacultureSeries.org

Permaculture Design Course
Indiana

Dates: June 4-18, 2017.
Location: Bloomington, IN
Description: Join this soulful dive into permaculture design through one of the longest-running university-sponsored residential courses. Top-notch instructors use various methods to help you effectively engage with permaculture design while also supporting your journey as a practitioner of permaculture. Topics and discussion range from ecological design to political economy to village-building through community engagement. Hands-on activities and system development in our new location are opportunities to gain practical, mentored experience.

This course is excellent for those wanting to immerse themselves in permaculture in a beautiful setting and take up the practical, necessary work to transform their own lives and communties.

Instructors: Rhonda Baird, Peter Bane, Keith Johnson, and guests
Contact: Rhonda Baird
812-323-1058
shelteringhills@gmail.com

Permaculture Design Course
Vermont

Dates: June 23-July 7, 2017
Location: Mad River Valley, VT
Description: This course offers an unparalleled opportunity to gain hands-on applied permaculture skills immersed in one of North America's most diverse and intensive permaculture research sites now in its 2nd decade, along with our 2nd site where we are establishing our proven approaches at the commercial permaculture farm scale.

Participants engage with high-performance home and community resource systems that are more resilient in the face of problems posed by peak oil, climate change, environmental toxicity, and the inability of existing economic and social systems to deal with such challenges.

Instructors: Ben Falk, Cornelius Murphy, Erica Koch, Mark Krawczyk, Eric Schellenberg, Dr. Lee Reich, and others.
Cost: $1,850 early bird; $1,950
Contact: 802-343-9490
wholesystemsdesign.com

Permaculture School
North Carolina

Dates: May 22, 2017-August 18, 2017 (residency), August 2017-May 2018 (9-month post-residency)
Location: Earthaven Ecovillage Black Mountain, NC
Description: Permaculture School is a year-long learning journey with a 3-month residency near Asheville, NC at Earthaven Ecovillage. Dive deep into gaining skills and knowledge in Design Systems & Projects + Organic Cultivation + Generative Foodsheds + Food As Medicine + Herbal Medicine & Botany + Natural Building + Renewable Energy + Wise Water Practices + Personal Growth & Communication + Vision & Career Development.
Instructors: NikiAnne Feinberg and Zev Friedman
Cost: $9,600 for the 12 month program
Contact: bekah@ashevillage.org

LETTERBOX

Hello *Permaculture Design*,

Thanks so much! I hope you will strengthen the bookstore/book review sections—my favorite part.

Sandy Cruz
Salida, CO

Hello *Permaculture Design*,

I just had a chance to make a dash through your latest issue; it's AWESOME. You've gotten some terrific contributions, and it's full of real original and real work. If the move has you feeling you'll be improving the magazine, well, your initial work has already got the ball rolling.

Rick Valley
Lost Valley, OR

Hello *Permaculture Design,*

I received the back issues and the first issue of my renewed subscription. Thanks.

I would like to suggest that you devote an upcoming issue to "The Doorstep." I could contribute two articles.

I also wonder if, by always having a theme for each issue, a wide range of possible submissions are perhaps shut out. I sometimes have ideas for articles, but they either don't fit a planned theme, or I have missed the opportunity. What do you think?

Peter Light
Roberts Creek, British Columbia

Hi Peter,

Thanks for your thoughts. I think you're right about the theme, but rather than dispense with the theme altogether, we decided to aim for only a few articles really on-theme in each issue, and the rest of more general interest. That would give us more "balance" and perhaps make us more appealing and useful to the general readership. In actual practice, we tend to do that anyway, just because of the diversity of submissions. Please don't hesitate to contact us with your ideas for articles, even if they don't directly relate to the issue's theme. Publisher

Calendar

November 2016

November 13-20. Denver, CO.Colorado Teacher Training. Kelly Simmons sunflowerhousepermacultured@gmail.com.

January 2017

January 6-8, 20-22; February 4-6, 24-26; March 10-12, 24-26. Manitou Springs, CO. Permaculture Design Course. Becky Elder, rselder@comcast.net, 719-685-0290; pikespeakpermaculture.org.
January 8-22, 2017. COSTA RICA. Permaculture Design Course. Tim O'Hara, info@ranchomastatal.com.
Weekends beginning January 7-8. Akron, OH. Permaculture Design Course. Sabrena Schweyer, 330-375-9600, info@salsburyschweyer.com.
January 27. Cincinnati, OH. Cincinnati-area Permaculture Convergence. Braden Trauth, bradentrauth@yahoo.com.
January 28-29, February 11-12, June 17-18, 2017. Various venues in Colorado. Permaculture Teaching Training Course and Mentorship Program. Sandy Cruz (719) 539-7685, hialtpc.org.

February 2017

February 3-5, 17-19; March 10-12, 24-26; 31-April 2; 21-23, 2017. Bloomington, IN. Permaculture Design Course. Rhonda Baird, 812-323-1058. shelteringhills@gmail.com.
February 4-9, 2017. Wolf Gulch Farm, OR. Social Forestry Course. siskiyoupermaculture@gmail.com; siskiyoupermaculture.com.
February 11. Chicago, IL. Great Rivers and Lakes Permaculture Institute Kick-off and Regional Gathering. William Faith, william@geniuslocipermaculture.com.
Weekends beginning Feb. 18. Ashland, OR. Permaculture Design Course. Melanie Mindlin, 541-482-7909, siskiyoupermaculture@gmail.com, siskiyoupermaculture.com.

April 2017

April 8-9, May 20-21, Jun. 24-25, Jul. 15-16, Aug. 19-20, Sept. 16-17, 2017. Ann Arbor, MI. Permaculture Design Course. glpdc.info.
April 25-May 8. COSTA RICA. Permaculture Design Course. Tim O'Hara, info@ranchomastatal.com.

May 2017

May 20-24 and July 15-21, Permaculture Design Certificate Course, Western Massachusetts! Hosted by Snow Farm New England Craft Program and Nine Mountain Retreat Center. www.PermacultureSeries.org.
May 21-June 4. Maricopa, CA. Permaculture Design Course-International Focus. Quail Springs. 805-886-7239, quailsprings.org.
May 22-August 18. Black Mountain, NC. Permaculture School. bekah@ashevillage.org.

June 2017

June 4-18. Bloomington, IN. Permaculture Design Course. Rhonda Baird, 812-323-1058. shelteringhills@gmail.com.
June 23-July 7. Mad River Valley, VT. Permaculture Design Course. 802-343-9490. wholesystemsdesign.com.

July 2017

July, TBA, CRMPI, Basalt, CO. Permaculture Academy: greenhouse, forest garden, greywater intensive. crmpi.org

August 2017

August, TBA. CRMPI, Basalt, CO. Permaculture Design Course. crmpi.org.

November 2017

November 25-26. International Conference, Hyderabad, INDIA; Nov. 27-Dec. 2. International Convergence, on the Farm, ipcindia2017.org.

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Convergence : 27th Nov' - 2nd Dec' 2017

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