Building a Bamboo Farm

Using Permaculture Principles in Bamboo Agroforestry

by Simon Henderson

"The form, foliage and bloom of the bamboo give the most beautiful effects in the landscape, especially when grouped with tree forms. They are usually cultivated in small clumps about dwellings in places not otherwise readily utilized...Tall slender graceful bamboos clustered along the way and everywhere threw wonderful beauty into the landscape...It would seem that the time must come when some of the many forms of bamboo will be introduced and largely grown in many parts of this (the U.S.) country."

--F.H. King, Farmers of Forty Centuries: Permanent Agriculture in China, Korea, and Japan, 1911

When I speak of "building" a bamboo farm, I imply a process of design. Things that are built are interconnected. Bamboo lends itself to human built landscapes for a variety of reasons on which I will further elaborate. Planting bamboo as if it were a row crop--like corn--ignores the true fractile nature of bamboo grove patterning. Bamboo thrives through socialization with humans as well as it's indigenous association with a myriad of neighborly tree species in an agroforestry complex. Thus I introduce conceptual themes of design by first smashing the paradigm of conventional agricultural practices. We will then build a bamboo farm, as if we were architects of the sacred. I speak of a new ecology for the American farmscape. In the temperate regions of the U.S., where it may be appropriate, bamboo will be a key component in this agricultural restoration.

In the fall of 1995, Bamboo People decided to design and install a Bamboo Research Station, which would model permaculture concepts in design, further research on varietal trials and yields specific to the Pacific Northwest, to grow bamboo as an agricultural crop and create a body of first-hand knowledge which we could offer to those farmers and landholders who may be interested in planting bamboo on their properties. A careful accounting of the costs for installing and maintaining bamboo as an agricultural crop would be of great value, as data for bamboo in North American agriculture is virtually non existent. I chose the world "station" to honor those geographical locations in the U.S. where many of our important bamboo species were first introduced in the early part of the 20th Century. We would strive to carry on the work of bamboo pioneers like F.A. McClure, David Fairchild, David Bisset, and Robert Young, etc. in places like Savannah, GA, Avery Island, Louisana, and Mayaguez, Puerto Rico.

A Place To Start

"As soon as we start doing, we learn how to proceed." - Bill Mollison

After gathering data on the site, such as aerial photos, topo maps, county soil surveys, listing a plant and animal species index as well as information gleaned from intimate observation, we created a base map. This included basic site information denoting existing structures, riparian areas, water courses, springs, septic systems, drain fields and wetlands. We roughly sketched in forested areas, pastures, paddocks, fence lines, roads and access.

Design Strategies:

1). **Virtual Design**

To create our conceptual design we hired a computer technician, familiar with the CAD program for "Computer Assisted Design". By taking very accurate measurements of distances between buildings, fence lines, forest edges, wetland areas, and cross checking them with measurements from other components in the landscape, our CAD technician could then enter this data into his computer to create precise spatial line drawings of the components on the site. By utilizing the CAD drawing we were then able to use overlays to create our Conceptual Master Plan with accurate spatial dimensions. This would prove to be invaluable when calculating the square footage of an area, so as to determine the quantity and appropriate placement of bamboo groves, spacings for trees and particularly valuable in irrigation system design.

2). Designing With Nature: The McHarg Overlay Method (Or, Design By Exclusion)

In Ian McHarg's brilliant work, *Design With Nature*, he details how the various components of any given site can be identified and designated on mylar (or tracing paper) overlays and assigned a color code (or a numerical rating system)(1). After identifying, for example, wetlands, riparian zones, forested areas, refugia and wildlife habitats, sacred sites, nature preserves, farmland and settlement areas, the site itself then dictates the direction of design or development. This methodology is also referred to as "design by exclusion".

Once you have excluded those areas of any given site from human manipulation, you will find self-designated zones for home sites, agricultural zones and the like. From my own experiences, I would say that the most likely scenario for rural design is the chronic retrofit of poorly designed sites, with thoughtless or impossible access (*pattern* application), and most of which have been randomly plopped down in the wrong place for the most arrogant of reasons. Homes on ridgetops (lovely view, but all resources, nutrients and firetrucks need to go uphill), homes on floodplains (good soil and owners like to be near the water, but sometimes under it), and homes hacked out of the bush (because people want to "live in harmony with nature"... but spend the rest of their lives trying to exclude Her).

At our Coyote Ranch site, a former dairy farm, we were easily guided in our design process--once again by excluding non-developed areas of forest, grazing pastures, riparian and wetland areas--which easily narrowed it down to a couple of acres of meadowlands adjacent to a native forest system.

3. Using Permaculture Principles

In permaculture systems design, we mimic natural ecosystem dynamics. If we are very clever in our ability to observe and translate this information to human built ecosystems, we can enhance diversity and yield, while providing for our own right livelihood, provide food, habitat and structural forests for ourselves and wildlife.

With a third of our site consisting of native forest, we chose to use the principle of **edge effect** in planting our bamboo groves. An edge "is an interface between two mediums".(2) In our case this would be the edge between the forest and meadow. Diversity, productivity and nutrients are enhanced at these edges. We would utilize the edge for microclimate; the rich soils at the forest edge which had formerly grown blackberries, nettles, and Reed Canary Grass, with a backdrop of alders and conifers, were chosen for our grove sites. The soils at these edges were dark loam with 80 years of accumulated organic matter.

By elaborating the forest edge we place bamboo in it's ideal--and natural niche--in the farm ecoysytem. The trees reflect light and heat, creating "**sunbuckets**" which maximize bamboo yield and vigor. The trees lift or modify damaging winds and pole production is observably straighter, thus more desirable.

True agroforestry grows multiple, high yield crops of fruits, nuts, berries, timber, nitrogen fixing trees and pulses, root crops, vining plants, herbs, fungi and shoots which often have beneficial associations known as **guilds** in permaculture. Bill Mollison describes guilds as, "made up of a close association of species clustered around a central element (plant or animal). This assembly acts in relation to the element to assist its health, aid in management, or buffer adverse environmental effects." (3) In organic gardening we refer to many of these traditional plant usages as *companion plants* . Many of these plant associations (and polycultures) have been previously listed, such as comfrey, daylillies, Equisetum, and nettles. (See Rick Valley's excellent article, *Bamboo In Permaculture Design*, TBQ, Vol. II, numbers One & two, Spring-Summer 1995).

In China trees such as Paulowina and Persimmons are grown commercially in association with bamboo.(4) In Thailand, tropical hardwoods such a mahogany are grown with bamboos, as the bamboo acts as a nursery plant which encourages the mahogany to grow straight and tall, upwards, toward the light, thus a superior timber product. We will test some observed assumptions from other sites in our bamboo/ plant assemblies at Coyote Ranch.

From the biodynamic discliplines, there are plants and trees utalized as **dynamic accumulators**,

which "amass a greater than usual amount of a particular nutrient in their foliage". (Robert Kourik, Designing and Maintaining Your Edible Landscape Naturally, pg. 266). Though similiar to the principle of **guilds** in plant communities, dynamic accumulaors may not have specific associations with other plants particular to our species template. However, we will use these accumulator species on site from which we can harvest particular mineral elements useful to bamboo or other agroforestry crops. Thus we will grow our own plant fertilizers and recycle their elements for the growth of other plants. Though oaks are regarded in Asia, as bamboo antagonists (5) their volumes of calcium rich leaf litter can be easily gathered in the fall and used as mulch for bamboo. Indigenious to our site, large quanites of braken fern provide concentrations of potash, and when burned release potassium. Buckwheat and mustards accumulate phosphate and improve the soils.

Many species of pulses (or legumes) are highly recommened for nitrogen accumulation, with subsequent tillage as green manure, back into the soil. Utilizing the myriad of plant resources from the above strategies becomes a facinating game of chess with nature, known in permaculture as the principle of **stacking functions.**

In our research groves we have begun work with local mycologists in the Pacific Northwest to determine which species of mushrooms can be innoculated successfully in the understory to grow select species of edible fungi starting with innoculations last fall of Shaggy Mane (Coprimus comatus). Many species are grown in association with the silica rich leaf litter of bamboo in China. Our work in this arena in North America has just begun.

Adam Turtle, Editor of Temperate Bamboo Quarterly, has found black morels (Morchella elata) in a grove of Phyllostachys aureosulcata in Oak Ridge, Tenn. and white morels (Morchella aff. deliciosa) in his Moso grove in Summertown, Tenn.

Beneath the soil surface--at the root level, or *rhizosphere*--we encourage the micro-ecologies and associations of beneficial mycrorrhizal fungi. Recent research by the United States Department of Agriculture (6) has indicated that bamboo benefits from innoculation by these organisms at the root level.

Mycorrhizal " *fungi*... penetrate the living cells of plants without harming them , and whose hyphae at the same time range far into the bulk soil, establishing equally intimate contact with the microbiota of soil aggregates and microsites. By doing so, these fungi link plant and soil, transporting mineral nutrients to the plant and C componds to the soil and its biota (Reid, 1990). They are therefore both agents of plant nutrition and what we will call *soil nutrition*--the vesicular-arbuscular mycorrhizal (VAM) fungi."(7)

Much of the landscape profile of Coyote Ranch is rolling farmland, assembled in small rises and depressions. My decision to plant most of the bamboo on contour arose from observations in the resource efficiency of traditional agricultural systems in Guatemala, Mexico, Bali, Vietnam and China. We used a traditional A-frame device (with a contractors' line level taped onto the horizontal cross piece) to place serpentine contours around the elevated mounds in the front meadow. This appropriate, low-tech tool allowed us to extend the natural pattern of forest edge, and create a sensous series of bamboo plantings which meld into the native forest.

This is called **pattern application** in permacuture. More than an aesthetic caprice, these countours will now direct water flow and nutrient dispersal with maximum efficiency via gravity. Our drip irrigation system will be laid on these level horizons where flow will not be interrupted by elevations, which would otherwise cause pooling and emitter clogging. **Swales** could (and may) be directed on the existing contours, just above the bamboo plantings to harvest seasonal sheet flow of rainfall which would slowly inflitrate and recharge groundwater downslope, thus retaining moisture in the landscape much longer. Green manures and fertilizers can also be laid in swales where gravity will disperse the nutrients in time release.

Bring In The Eyes

Then we brought in the "experts", to bring more eyes to the site. People trained in other disciplines often prioritize (and see) things differently. The property at Coyote Ranch is surrounded on two sides by the well-managed Philchuck Tree Farm. We consulted with the Head Forester, and he gave us valuable information on jump starting the 200 hardwood trees which we had selected for our agroforestry nursery.

In a one acre area of the property where alders were climaxing and lodging, we chose to harvest the trees for timber and firewood, and to replant with high value hardwoods mixed with native conifers and bamboo on the margins. A local logging company gave us valuable information on "cruising the timber"; formulas for estimating the board feet of harvest and how to create the lowest impact on the site for skidding the trees out (extraction).

With this information I applied for a "Forest Practices Application Permit" with the local Department of Natural Resources. These people carefully deciphered the coding laws on permitted logging distances from streams/riparian areas and wetlands, etc. They walked me through the process of creating a "Forest Practice Base Map". With high marks for mapping, I was given a permit to log. We have created an ongoing dialogue with this state agency which is very much interested in monitoring the evolution of our agroforestry installation.

Next we called in local county extension agents, who could see first hand, the installation in progress, and--we hoped--would recommend bamboo to farmers and landholders who may contact them for information on new crops. The bamboo interested them to some degree, but of greater interest was the approximately two acres of "**sheet mulch**" which we had laid out over an eight month period.

After each grove had been planted (with spacings of at least 50' between varieties), we laid down a cover of cardboard, overlapping, to supress the grasses, especially Reed Canary Grass). On top of this, straw (NOT hay) was spread, to add mulch, and to cosmetically cover the cardboad.

This creates a variety of beneficial effects. The cardboad supresses the grasses, retains moisture in the soil and creates the ideal microhabitat for earthworms. The earthworms slowly consume the celluose in the cardboard (which is like cake to them) and they then turn the former sod into humus, leaving behind their mineral rich casting very near the soil surface, and thus available to the bamboo. Nothing like having several million earthworms per acre to digest, aerate and fertilizer your bamboo groves for the mere price of a few tons of cardboard. (Cardboard can be purchased in 300 lb. bales from most local recycling facilities for approximately $100/ton. Or they will deliver for a bit more).

Then in three years time the bamboo canopy will close and the memory of Reed Canary Grass, blackberries, etc. will be only humus. This technique demonstrates yet another valuable permaculture principle of "**using biological resources**". We could have used roundup for annual weed and grass control. we could have deleriously plowed and tilled the soil only to propagate the grasses. We could maintain an annual seige state against nature. Or we can let nature be our ally and do it for us.

Another methodology in permaculture design is a combined space-time factor which is called a **schedule.** Or "a time to be in that place". I was intruged with this concept for use of a **niche in time and space** while consulting for Bob Gow at Hacienda Xixim, a large bamboo/agroforestry installation in the Mexican state of Yucatan. His mayan workers had cleverly interplanted corn and squash in the open spaces between the bamboo. For the next couple of years this will be an area of high food production (of traditional meso-american crops) until the conopy closes. And by planting a useful food crop, they eliminated the need to weed large open areas which where covered by acreas of trailing squash vines. We will try this stradegy at Coyote Ranch in the summer of '97

In March of 1996, we began to prep the site for the initial bamboo plantings. A site was chosen adjacent to our driveway parking lot as a staging area where we could most easily off-load field divisions of bamboo, boot them into sawdust for a few days, and then be able to truck them out to the various grove sites as planting crews and time allotted.

The staging area was canopied by a large purple plum tree, which shaded the stressed bamboo from the hot afternoon sun. (Murphy's Law dictates that it will always be hot and torrid and windy the day you have to pick up bamboo from as far away as Portland (Rick Valley's Northern Groves), and it will definitely rain the entire time you are planting it). Nature demands participation.

Bamboo People (and friends) spent several days planting approximately 500 bamboo plants. Several weeks per year will be spent in annual maintence. The final verdict is yet to be revealed. What were the true costs if labor were calculated (as opposed to donated time)? How much would a farmer have to pay per acre for bamboo? Per plant? What are the true infrastructure costs? Investment capital? For irrigation systems? For land (if not cooped, as in our case)? For fertilizers? Tools? Soil tests?

By keeping accurate records and detailed accounting of expenses we can begin to assimilate the broad base of knowledge which is needed to demonstrate bamboo's feasibility as a cash crop. Trials for shoot flavor and quality must be ducumented as well as size and growth ratios for the Pacific Northwest. Bamboo must be shown to create a sustainable yield vs. an energy sink.

Consequently, the same research must be done for bamboos in the Southeastern U.S., the Desert Southwest as well as New England and the U.S. Gulfcoast. Not everywhere is suited, and in some cases it may be an unethical recommendation. (Adam Turtle's cardinal question is: "Where are you getting your water?")

As a research facility, these are questions we hope to begin to answer. We document and share our mistakes as valued information. By modeling bamboo's place on the diversified farm and sustainable economics, we walk the walk. Hopefully, we take the risk of success or failure, before we ask a farmer to follow suit. Thus we would speak of a new ecology for the American farmscape. As architects, we will build that place.

(1). McHarg, Ian L. *Design With Nature*. 1971. Doubleday/Natural History Press, Garden City, New York.

(2). An Introduction to Permaculture by Bill Mollison. Tagari Publications, Tyalgum, Australia. 1991

(3). Ibid

(4) Agroforestry Systems in China. Published Jointly by The Chinese Academy of Forestry, People's Republic of China and International Development Research Centre, Canada (IDRC)

(5). (David Fairchild, Japanese Bamboos and Their Introduction into America, USDA, Bureau of Plant Industry--Bulletin No. 43, 1903)

(6). USDA Library, Bethesda, Maryland. "Bamboo", under the sub-heading "Grasses".

(7). G. J. Bethlenfalvay and R.G. Linderman, coeditors. "Micorrhizae in Sustainable Agriculture", 1992. Horticultural Crops Research Laboratory, USDA--ARS, Corvallis, OR