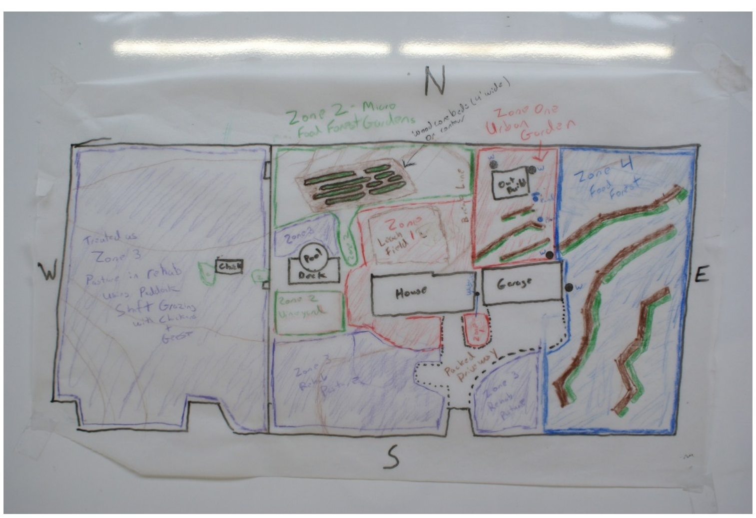
The property in question is mostly flat, with very little grade. This is compounded by fractured limestone (caliche) and little to no real subsoil. The soil itself is excellent loamy clay with almost no layering. We basically have high quality top soil and rock with almost no typical sub soil. Depth of soil on the entire property ranges from as little as 2 inches to as deep to as deep as two feet. In the selected area average soil depth is 12 inches with fractured limestone. Below that depth is mostly slab limestone.

This presents unique challenges. We observed however that the native live oaks have broken into cracks of the limestone. In these areas the limestone changes from pure white and very hard to quite brittle. In these areas the pure white caliche becomes brown to orange. At this stage it becomes so easy to break we can often break very large pieces of it with bare hands. This provides a lot of confidence that earthworks and heavy support plantings can actually convert much of the sub surface rock into sub soil and create many more fractures for the trees to exploit.

The plan is a multi-stage implementation, designed to use earthworks in conjunction with a ratio of support legume trees and shrubs to productive trees of 7 to 1. The intent is to rehydrate the area, further allow the trees to continue to penetrate the limestone and build sub soil via root infiltration. The plan is aggressive and in an area that is generally considered "suitable only as range land" by the USGI, making it perfect for permaculture's unique solutions.



* The Site as currently planned the Food Forest described in this document is the area labeled "Zone 4 Food Forest" on the eastern property boundary. A full sized image of this print can be viewed at http://bit.ly/1dd99Ky

*Aerial view of the entire property, a full sized image can be viewed at http://bit.ly/1cC3wZV

The implementation is broken down into 5 primary components

1. Earthworks and water harvesting
2. Forest establishment planting
3. Soil building in the interswales with livestock and organic matter
4. Attrification out of 80% or more of support trees over 5-7 years along with additional removal of more of the native live oaks as needed.
5. Long term system management as a zone 4 system

Project Goals

The Goals of this system include

1. A massive polyculture food forest, first of its kind in north Texas
2. Serve as an educational system
3. Produce sufficiently to provide food beyond the property inhabitants needs with surpluses donated to the end of encouraging new sites
4. Provides cuttings and seeds for the establishment of new sites
5. Prove out and test varieties and guilds for the north Texas area.

Implementation Stage One - Earthworks and Water Harvesting

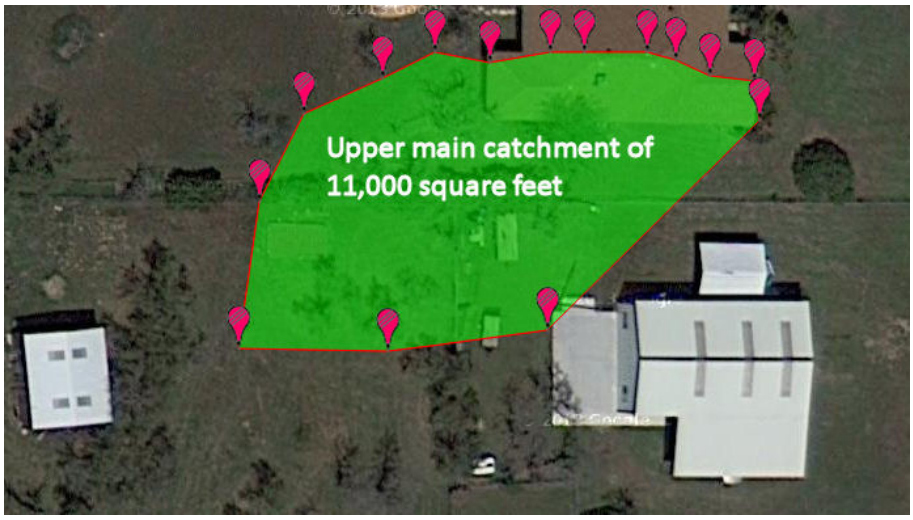
The climate in North Texas is really on the edge of cool temperate and warm temperate. Our property is also on the very edge of USDA zones 7 and 8. It features very hot summers with high temperatures even overnight. Low rain fall

is quite common from mid-May of each year until the end of August. Some years do have significant rainfall in summer; said rains though are not the normal pattern and can't be relied upon.

Annual rain fall of the site averages 34 inches per annum with recent years as high as 42 and as low as 25. The situation is compounded by the very shallow soils, a relatively small catchment area (the area is one edge of saddle in the landscape) and our high evaporation over rainfall ratio for about 4 months of the year.

To deal with limited catchment we have installed three swales, totaling 525 linear feet. Distances between the interswales are roughly 15-30 feet depending on contour. Elevation changes between each swale are only about 4 inches. The water catchment totals break down as follows.

1. **Upper Main Catchment** - There is an upper main catchment of about 11,000 square feet of adjoining land, mostly clear. This also includes a portion on the adjoining properties roof, which in of itself is 1,500 square feet of hard surface runoff. Average rainfall of 34 inches annually means that this area receives about 230,000 gallons of rain annually with a high percentage of run off. We installed the upper swale to harvest as much of this water as possible.



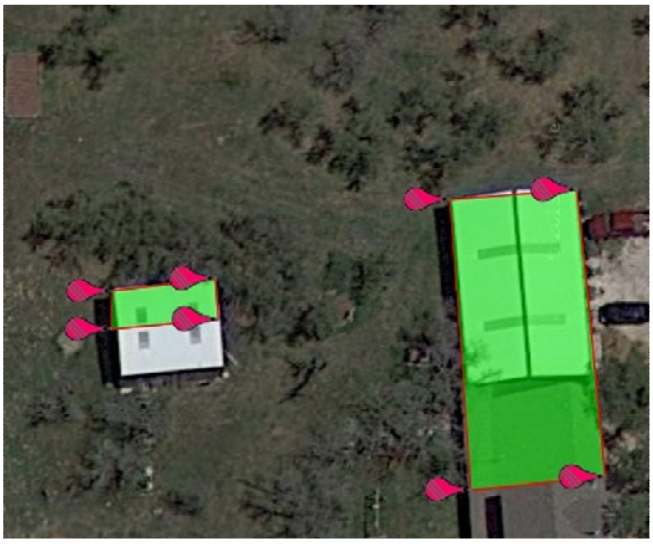
*The areas referred to as "upper main catchment" A full sized version can be viewed at http://tspc.co/1eGq9On

2. **Hard Roof Runoff** - On the subject property at the boundary of the food forest there is a 2000 square foot steel frame building and a 800 square foot out building. Due west of the 2000 square foot out building is the main dwelling, The

main dwelling has 2500 square feet of roof top. Of that about 1500 square feet of the main dwellings roof top feeds into the target area.

The 800 square foot out building sits on a break line, so 400 square feet of this building feeds catchment to the east and 400 to the west. The total hard roof run off into the system from these buildings is just over 100,000 gallons annually based on average rainfall.

The large out building alone sheds a total of 21,000 gallons of water off each side to the north and south. 1550 Gallon Poly tanks are due to be installed on platforms at each eastern corner of this building. All tank overflows from the north tank is fed directly into the top swale in this system. All tank overflows from the south tank is fed directly into the mid swale.



*Roof Catchment Area – Up is east in this image. A full sized image can be seen at http://bit.ly/1kJfQcA

3. **Hard Driveway Run Off** – There is about 5,500 feet of compacted hard gravel driveway and parking area to the west of the target area. 100% of the run off from this area drains into the target area. This represents an additional 100,000 gallons of run off. 90 percent of this run off feeds the mid swale, which overflows into the lower swale.

*The Hard Driveway Run Off described above. A full sized image can be viewed at http://bit.ly/1edz2dG

4. **The Target Area Itself** – The target area for this system totals about .7 acres or roughly 30,000 square feet. This area alone will receive about 600,000 gallons of rain annually. Approximately 85% (or 510,000 gallons) of which is upgrade of the lowest swale in the system.

The areas above total to an average annual catchment of roughly 900,000 gallons annually. It should also be noted that there are three small swales in an urban garden zone one area between the large out building and the smaller outbuilding. The lower swale in this system is designed so that its eastern edge acts as a sill and spills water into the top swale of the target area. In this way we have actually integrated Zone One directly into a Zone 4 style food forest.

Swale Sizes and Initial Observed Results

The small swales in the urban garden area mentioned above are more accurately swale like paths; they are about 3 feet wide and 4 inches deep. In heavy events they overflow quite quickly and again feed all water from the roofs and the eastern property into the target area.

The main swales again total about 525 linear feet and are 6 feet wide by 12 inches deep. This gives them a holding capacity of 23,625 gallons. When this volume is exceeded each swale has a level spillway of 6 feet in length to allow for over flow.

On the day the swales were installed we experienced a major rain event only about one hour after they were completed. We received about one inch of rainfall in a 90 minute period. All three swales filled to capacity, all three had

their sills over flowed and all three functioned perfectly as designed. We had an additional inch of rain over the next 4 days; the swales remained mostly full, overflowed one more time and continued to perform perfectly. This proves that we can quite easily hold over 20,000 gallons per inch of rain in this area after it becomes saturated in only one inch of rain fall. Watching the system function only an hour after its creation also gave us a great deal of confidence in the design and was a real bonus to our students. Many were running up and down the swales in freezing rain with flashlights in the dark excited to see the sills they had just created working perfectly and gently sheeting water over their top levels.

*Videos of the swales at capacity both from rain runoff and snow melt can be seen at http://bit.ly/1aotQRB and http://bit.ly/1dpp76l respectively.

Irrigation During the Dry Period

While the water harvesting numbers above are quite impressive we do still deal with heavy droughts and long periods of very dry weather. This is of course compounded by the shallow soils and rock sub surface. To instill resilience in the system, especially during the establishment phase we have planned for irrigation as necessary. This is accomplished via three primary components.

1. **Rain Water Holding Tanks** – We are installing 4, 1550 gallon black poly tanks. Two on the north east and south east corners of the large out building respectively. And 2 on the 800 square foot out building on the north east and north western corners. These tanks can be used both to irrigate the target food forest area or the zone one urban style garden that adjoins the food forest to the east. Each is installed on a 1 foot high platform, allowing gravity feed if desired. Two of them will have inexpensive exterior pumps which can move large volumes of water if needed.

2. **Well** – There is a well on the property which produces water reliably year round. While the water is high in minerals which is good for plant health it is also very hard, which presents challenges for drip irrigation, due to clogs from hard water deposits.

3. **PVC Pipe Infrastructure** – During the installation of the swales three quarter inch PVC pipe was installed within the swale berms. At present time they are capped off but we will be trenching in connecting lines that

will allow their use with both the well and catchment tanks.

We have never seen this done before and it should be considered on more sites due to the low cost and ease of installation. We simply laid the pipe on the down grade side of the contours and buried it with in the berm with soil excavated from the swales. At desired interval T's were used to create standups. This presented only very minor difficulties for our excavator operator in the beginning and once he got into a rhythm it was no inconvenience at all.

While such an installation may not make sense on very large systems; in our case for a few hundred dollars and about 2 hours of labor we have water for irrigation and for livestock distributed throughout the entire swale system. This is of particular importance to us, because the construction of even small dams is impractical and our plans include cell grazing in the interswales.

Without adding this step we would either have to drag hoses out to portable stock tanks or haul water out to the grazing areas. Due to the very rocky soil trenching is difficult and this single step reduced the entire need to trench down to less than 150 total feet in return for an infrastructure of about 675 feet total.

Cover Cropping After Installation

We used a very small excavator for this installation (6,200 pounds) and it did remarkably little damage to the landscape and was agile enough to work around the existing live oaks. Only 3 had to be removed. The machine also had more than adequate power for the job at hand save for two spots where the sub surface slab will be taken down later with a jack hammer.

Due to educational goals and budget constraints we were forced to install the earthworks in the late fall and do our tree and other main planting in the spring. To compensate for this the entire swale berm system has been straw mulched and cover cropped. It was necessary to take particular care to plant crops that

can germinate in our climate this late in the year. The following is a list of the seeds included in our mix.

- Merced Rye
- Red Winter Wheat
- Cayouse Oat
- Triticale
- Grouse Chicory
- Salva Sail Medic
- White Landino Clover
- Tonic Plantain
- Bell Beans
- Hairy and Common Vetch
- Austrian Winter Pea
- Semi Dormant Alfalfa
- Birds Foot Trefoil
- Daikon Radish
- Mustard
- Turnip

This mix was designed for 4 primary goals during the interim before system planting.

1. Erosion Control
2. Bio Accumulation
3. Dynamic Accumulation
4. Nitrogen Fixation

We weighted the mix more to the brassicas, annual legumes and annual cereal grains. These are all known to germinate and grow rapidly even in our colder winters. They will accumulate large biomass which will be used in the spring for mulch via chop and drop. This will reduce the amount of material we will need to bring in for mulching this spring. It is hoped that some of the perennial cover

crops will germinate but they will be resowed in the spring along with summer legumes, primarily those will be red cow pea and black eyed pea.

While planting immediately after excavation would have been ideal, it was simply not practical. We feel this mix of cover crop will do an excellent job of balancing erosion control and preventing major soil compaction until spring planting.

Additional Notes

During the next few months the surrounding suburbs will experience annual leaf drop of all deciduous trees. During this period we are gathering as many bags of leaves as we can get our hands on. The majority of these leaves are being deposited in our inner swale areas to aid in the building of top soil. Some are also being used for a similar purpose in our western pasture which is severely degraded. Acquiring these inputs saves them from going into a landfill, costs nothing and can easily be combined with weekly errands.

We are also building a fungus inoculation pile during this time. This pile will consist of old wood, anything we can scrounge that isn't treated. We will layer the wood lasagna style with leaves and forest soil, keep it moist and in a shady area. This is a large scale version of IMO (indigenous microorganism) harvest. IMO is a well-known technique in traditional Korean Agriculture. We will be using this inoculation along with compost when we do our spring planting. This use of this local inoculation will accelerate the formation of fungal hyphae networks in our new food forest and take advantages of freely available local resources.

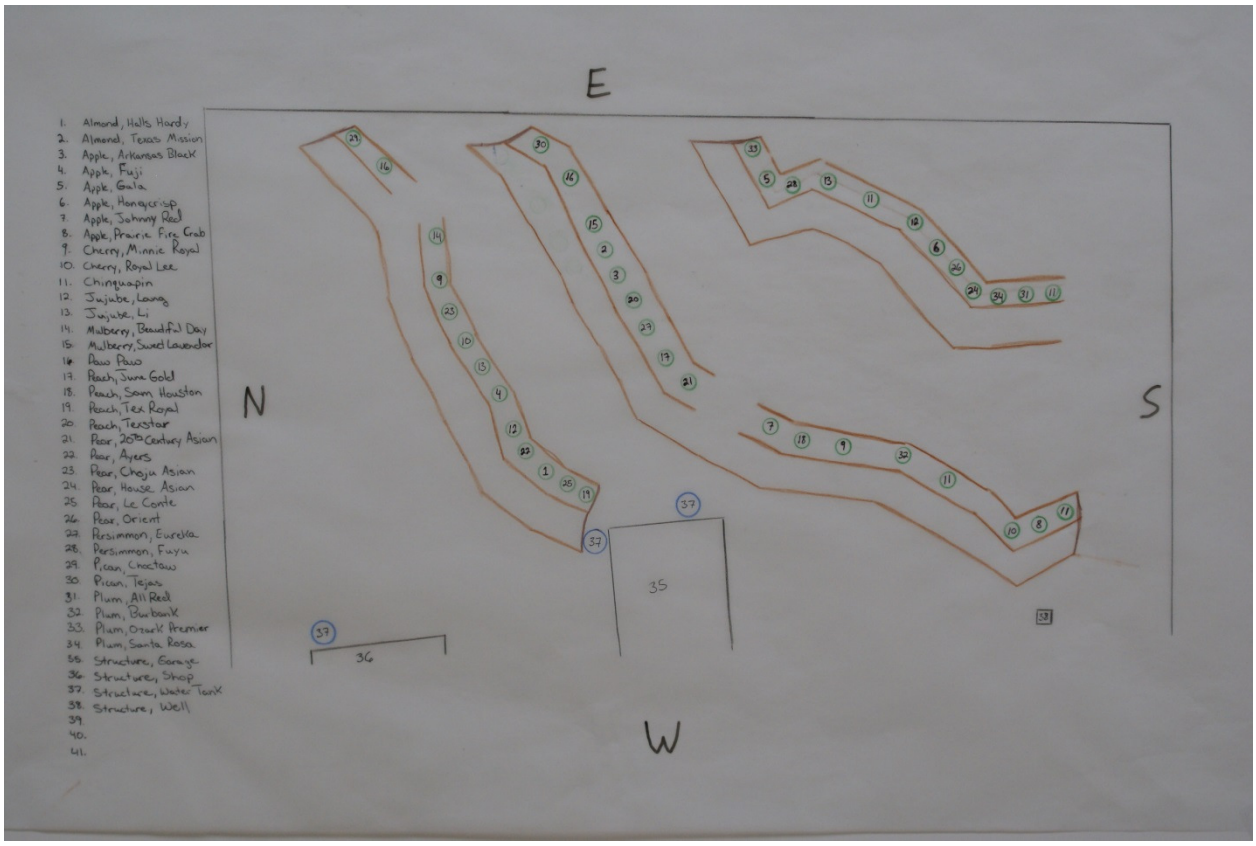
***Note** - Attribution to Nick Ferguson of PermacultureClassroom.com for this technique.

Implementation Stage Two – Forest Establishment Planting

Planting will occur in late March – early April of 2014 and will be conducted as an educational workshop attended by 25-30 students. The primary productive trees will be made up of 45-50 main trees. While not set in stone the species and varieties to be planted include

- All Red Plum
- Santa Rosa Plum

- Ozark Premiere Plum
- Burbank Plum
- Texas Mission Almond
- Halls Hardy Almond
- Chinquapin
- Ayers Pear
- Leconte Pear
- Orient Pear
- Prairie Fire Crabapple
- Gala Apple
- Fuji Apple
- Arkansas Black Apple
- Honey Crisp Apple
- Jona Red Apple
- Texas Star Peach
- Texas Royal Peach
- June Gold Peach
- Sam Houston Peach
- Choctaw Pecan
- Tejas Pecan
- Fuyu Persimmon
- Eureka Persimmon
- Chojuro Asian Pear
- 20th Century Asian Pear
- Housi Asian Pear
- Paw Paw (variety TBD)
- Lang Jujube
- Li Jujube
- Minnie Royal Cherry
- Royal Lee Cherry
- Beautiful Day White Mulberry
- Sweet Lavender Mulberry



*Current planting diagram for the primary fruit and nut trees along swale mounds. A full sized version can be viewed at http://bit.ly/1dFpeZj

The productive, vine, rhizome, ground cover and shrub layers have yet to be fully planned as to species selection but will include varieties of

- Blackberry
- Jueresulum Artichoke
- Globe Artichoke
- Strawberry
- Goumi – also a N fixer
- May Pop – (a temperate climate passion flower species)
- Blueberry
- Bush Plums
- Bush Cherry
- Garlic
- Japanese Sweet Potato
- Wolf Berry
- Jute Mallow

- Melons
- Groundnut (apios Americana)
- Grapes
- Squash
- Amaranth
- More TBD

The Support Trees Will Include the Following

- Pagoda Tree (S. japonica)
- Pearl Acacia (A. podalyriifolia)
- Siberian Pea Shrub (C. arborescens)
- Eastern Redbud (C. canadensis)
- Black Locust (R. pseudoacacia)
- Honey Locust (G. triacanthos)
- Autumn Olive (E. angustifolia)
- Mimosa Tree (A. julibrissin)

A Large Variety of Perennial Herbaceous Will be Planted Including

- Red Valerian (C. ruber)
- Salad Burnet (S. minor)
- Comfrey (S. officinale)
- French Dandelion (T. officinale sativum)
- Mitsuba – Japanes Parsley (C. japonica)
- Chervil (C. crispum)
- Sweet Marjoram (O. majorana)
- Sea Kale (C. maritime)
- Lovage (L. officinale)
- Turkish Rocket (B. orientalis)
- Feverfew (T. (chrysanthemum) parthenium)
- Niebita (Calamintha ssp.)
- French Sorrel (R. scutatus)
- Roman Chamomile (A. nobillis)
- Lemon Balm (M. officinalis)
- Greater Plantain (P. major)
- Betony (S. officinalis)

- Oregano (O. vulgare)
- Sage (S. officinalis)
- Parsley (P. crispum)
- Thyme (T. vulgaris)

Notes on Species Selections

The polycultures established in the species varieties above were selected carefully from many possible varieties. It is our intention to establish an ecosystem with production geared toward both perennials and self-reseeding annuals. We are also looking for extensive dynamic accumulation. We have followed the principle of observation before action at this site for over a year. We have also investigated many species that are already thought to do well in the area. A complete breakdown of why each element was selected would be exhaustive but here are a few concepts that went into some of our selections.

- **Fruit and Nut Trees** – These were first selected as to type based on the dietary habits of the residents of the property and their extended families. From there individual varieties were selected based first on varieties that are known to do well in north Texas.

  From there things get a bit more interesting. For instance cherries were desired so Royal Lee and Minnie Royal were selected because they are both low chill varieties and because they cross pollinate.

  As Pecans were desired and are known to produce juglone which is allelopathic to many species we needed a juglone "buffer area". Two trees known to do well around black walnut which is far more allelopathic than pecan are mulberry and paw paw. Paw paw ("Asimina triloba" not the tropical papaya sometimes called paw paw) is best established in full sun but once established does well as understory. So we chose to place a paw paw adjacent to our pecans followed by a mulberry.

While that works we then entered into a “social design consideration”. While the property is rural we have a neighbor on the eastern property line that is very close to us. Mulberries stain; they also attract birds that then stain with purple droppings. Such is undesirable to most people when deposited on their vehicles, homes or driveways. To combat this we selected varieties “sweet lavender” and “beautiful day” both of which are “white mulberries” that don’t have the staining characteristics of typical mulberry. This type of social design consideration is something we feel more permaculturists need to consider as we continue to establish more systems which are surrounded by more “conventional” housing and agriculture.

Additionally placement of the fruiting trees was set up to insure no two same varieties of fruits were ever adjacent. An apple is flanked with a pear and a peach for instance. Then perhaps a plum and an almond. Cultivars were also selected so that any pest that preferred say a gala apple would first have a hard time finding it, then would have an impossible task of finding a second one.

Of course conventional considerations were taken into account as well. Apples were selected to insure for instance that bloom times allowed for good cross pollination and a prairie fire crab with very long and heavy bloom was added for insurance. Additionally there will be many other fruit trees included on other parts of the 3 acre property. With this we understand a guild is larger than a polyculture. While an apple and a comfrey may guild as a polyculture in close association. Two apples that are not a polyculture in spatial relationship, may still “guild” as cross pollinators across say 100 or more yards.

While more went into our species and variety selection the above should provide a solid understanding of the thought process and application of permaculture principles that went into our design.

- **Shrub, Vine and Rhizome Species –** Many considerations are at play in this area as well. For instance it was observed that both wild amaranths and lambs quarters (Chenopodium album) grow abundantly on the property. Both are dynamic accumulators. Hence we have decided to grow some cultivated amaranth during the establishment phase of the design. This will provide both biomass accumulation and dynamic accumulation and aid in soil building. It will also provide a grain yield that can be provided to our poultry as they are paddocked in the inner swale.

  Here we are stacking both function and time. Amaranth will grow from 8-10 feet in height and stand in in some ways like a small support tree. It can accomplish this growth though in only 90 days. The plant can be chopped and dropped and will leave a massive root system. The grain is a livestock supplement and the plant does self reseed here quite readily. In fact in trials last year both amaranth and sorghum when planted early, in fact coppiced and produced a second smaller grain yield by season's end. This is a unique way in which "chop and drop" can include fast growing large structured annuals. While in later years the area may be two shady for amaranth or sorghum there will be plenty of sun during the early years.

  Another consideration is the inclusion of blackberries. While grapes in the food forest will likely be included we actually have plans for a zone 2 style vineyard. While there will be plenty of polyculture in the vineyard the main area will be mostly conventionally trellised grapes grown for home vinting of wine. Leaf hoppers are a major pest of grapes. Based on a study in California large populations of blackberry attract a similar leaf hopper, which in turn attracts their primary predators.

  Due to the fact that blackberry leafs out earlier it brings in said predators and holds them in the area for the grape leaf out. It is reported that large stands of blackberry have this effect even at up to 4 miles away. So by including blackberry in our shrub layer and in other areas of the property, we again are stacking in both time and function.

We have also included groundnut (A. americana) in our design which fulfills multiple roles. First it is one of the few true perennials in our climate that fills the roles of climbing, ground cover and rhizome yielding. It is easily propagated with division allowing us to meet one of our key goals in providing planting for others attempting to replicate our goals. It also fixes nitrogen and will likely excel in some of the moist and cool microclimate areas in our system. This tuber also essentially stores in the ground and can be harvested at any time after two years of cultivation.

Groundnut also fills an important nutritional role for the inhabitants of our property. We are all primarily on what is called the "paleo diet" which seeks in some ways to minimize carbohydrates. Given apios and additionally sun choke derive their primary carbohydrate load from inulin they are fitting with the desired profile of nutrition by the property owners.

As with the tree selection a complete explanation of every species and its intended uses would be exhaustive, these are just a few of the concepts we followed in our selection of species and variety.

***Note** - Attribution to Dave Jacke of EdibleForestGardens.com for information on the California study on the relationship between leaf hopper predators and grape and blackberry guilds.

Support Legume Trees – A great deal of thought went into creating a list of diverse and useful support species for this project. We feel one of the most promising is the Japanese Pagoda Tree (S. japonica). This tree has a fairly quick growth rate, it fixes nitrogen, accumulates large amounts of biomass, is deciduous and is considered a desirable landscaping tree. This tree also allows a lot of light penetration (about 60%) even when mature due to its leaf structure and propagates easily from seed requiring no stratification period.

There are a huge number of components above but one note must be made before continuation. That is that this species of Pagoda is; Sophora japonica, not Styphnolobium japonica. This is important because

Styphnolobium has not been shown to produce nitrogen in conjunction with rhizobia (nitrogen fixing bacteria) on their roots whereas Sophora have.

As to the selection of this tree again much is at play. First the fact that it is easily propagated from seed will allow us to provide seed and seedlings for other projects for free to others. However, given the tree is marketable as a landscaping tree both seed and seedlings can be a viable source of income.

Additionally the open nature of the canopy which allows reasonable light penetration to the sub canopy makes this an ideal tree for us to leave one or two in the long term canopy. This will be sufficient for massive seed stock. Another aspect of this tree is that is blooms both heavily and late in the season, hence it will be quite beneficial for the bees which will be brought onto out property this spring.

Much of the above can also be said about our other primary support tree, Mimosa Tree (A. julibrissin). This tree is extremely hardy though out much of the nation and certainly in our climate. We were fortunate to find a large wild growing specimen at a nature center less than 5 miles from our property. The genetics of this plant should be optimum as it has grown large on its own with no support. We will also bring in some other seed to diversify genetics of our seed stock.

A. julibrissin provides many great attributes, it is rapidly growing and like S. japonica doesn't require cold stratification for germination. It can be produced in large numbers and provided to others for their projects. Like S. japonica though it is also a desirable species for many in landscaping. Trees sell on other market for an average of 10 dollars for a 2 foot specimen and average as high as 50 dollar for a well-established 5-6 foot tree. Once again there is a large amount of space, function and time stacking in these two species. While many permaculturists struggle with finding good support species in warm and cool temperate climates, these two trees seem to be exceptional options.

Black locust is another example of a tree we have selected for more than

just its nitrogen fixing ability. While wood heating needs are minimal we do have some need of wood for both cooking and heating. Much of this need can be handled by black locust, we have plans for a small stand on another location of the property, the chop and drop from the food forest can augment these needs in the establishment phase of the property.

Black locust isn't really a great chop and drop tree if used for its woody material. As it is one of the slowest to break down woods known. However its green material is high in nitrogen and breaks down readily. So we will be dropping the green and harvesting the woody components for other needs. This tree is also another exceptional bee attractor with a reputation for the production of excellent honey. While much has been made about black locust becoming "invasive" this is due to mismanagement, not the tree itself. Like many locusts it is a pioneer that will fill empty unmanaged spaces and survive where other trees do not.

Permaculturist Ben Falk of "Whole Systems Design" in Vermont is currently growing many species such as black locust, sea berry and others considered to be invasive with no ill results. Simply put most of these species deemed invasive are of little concern on well managed and grazed property. Black locust is also marginal for our USDA zone 8 climate and should pose little risk to the surrounding ecosystems. In fact we asked Ben for his results with black locust and this was his response.

"We have planted about 1200-1400 black locusts here on our 10 acres, 90% of which are located along about 1800' of property boundary, with the remaining planted as hedges within the property itself (on top of swale mounds) and about 150 trees planted in patches to grow pole wood for building materials.

We graze in and among the plantings so any root sprouts are quickly grazed by sheep, though root sprouts only happen when the soil is disturbed by digging near an established tree. So far, the trees are our fastest growing - faster even than willow and alder, and we have fence post - sized trunks ready to harvest in year 5."

Autumn Olive (E. angustifolia) is another species we have chosen that is

noted for being an invasive species. As we considered whether or not to use it we asked ourselves if we would create any real risk by using a plant that is already present and considered invasive because according to the state of Texas it, "it has the capacity to adversely affect the nitrogen cycle of native communities that may depend on infertile soils" (source http://bit.ly/1bbcvhj). So improving infertile soil is a problem?

The reality is Autumn Olive is another great example of time, space and function stacking in a support species. While we want to and will be attempting to grow another Elaeagnus species, goumi (Elaeagnus multiflora) it is very marginal for our area. Autumn Olive doesn't generally disperse rapidly in our climate the way it does in more north eastern climates but it does survive in well managed systems far beyond the ability of goumi. So we plan to use the fruit of Autumn Olive for many uses including juices, vinting, brewing and other needs. If we are able to establish goumi to a higher level we will then atrophy out much of the autumn olive as a more conventional support tree. If not it will serve as insurance for this type of a fruit yield.

Final Note on Invasive Species – While we realize many will disagree with us, we find the term "invasive species" to be inaccurate in most but not all instances. There is no doubt for instance to the damage done by kudzu in much of the south but many other so called invasives are in my view doing more to repair damaged ecosystems, rather than damaging healthy ones. For instance are these species really doing harm when they displace massive mono crop style stands of pine which lack diversity? Stands which are not typical of a "natural ecosystem", but rather the results of heavy timber harvest and land mismanagement.

Most of these species are "pioneers" which naturally occur in edge environments and success out as larger over story takes over and shades them out in time. In this way we feel that many people who claim these plants are "damaging natural systems" are actually saying they are altering unnatural systems and moving them toward forest succession. In the end they may be more of a blessing than a curse.

As an example western juniper is now considered an invasive species in

sage brush steppe ecosystems which is now vilified for "choking out other species". This is in spite of the fact that western juniper is a NATIVE species in sagebrush steppe ecosystems. It is clear that juniper didn't "invade" the sage brush steppe ecosystem and damage it. Rather man has damaged the sagebrush steppe in such a fashion that advantages juniper over many other plants in the ecosystem. Hence to fix the problem this ecosystem requires the restoration of balance, not the eradication of one of its own native species.

In the end in our view species labeled as invasive should be chosen and managed with care but not simply avoided. If you disagree, again please consider the example above where a native species is now labeled as invasive in its own native habitat. The same can be said with species such as mesquites and locusts again in their native habitats. Ironically black walnut often exhibits more of a tendency to take over an area then black locust which it guilds quite well with. Yet black walnut (which is allelopathic) isn't labeled as invasive simply because it represents an economic yield as high quality timber.

I wonder if modern man would have called chestnuts "invasive" prior to the eastern chestnut blight. At that time chestnuts existed in such numbers that they were loaded into carts with coal shovels at in the fall for livestock feed. So were chestnuts invasive? I say no and paraphrase Bill Mollison in saying, "we use 100% native species, all of them are native to planet earth".

***Note** - Attribution to Ben Falk of Whole Systems Design for information on black locust and other species deemed as "invasive" via direct consultation and via his book The Resilient Farm and Homestead.

- **Perennial Herbaceous Species** – The herbaceous selection was less involved then the other plantings. Mostly we selected any desirable herb that was both perennial and was hardy to our climate. We have a desire for four primary roles of herbs in the system functionally speaking.

    - **Insect Habitat and Attraction**
    - **Medicinal Use**
    - **Culinary Use**
    - **Dynamic Accumulation**

In general if you plant a wide variety of perennial herbs all of these goals will be met. There are a few though that are worth mentioning for some unique attributes.

Greater and Tonic Plantain – This herb is hardy to the extreme and offers many benefits. As a dynamic accumulator it accumulates magnesium, calcium, silicon, sulfur, manganese, silica and iron. It is an edible green; seeds are edible and high in protein. It makes excellent wildlife and livestock forage and it is a very good general purpose medicinal. As a medicinal it excels on bug bites and bee and wasp stings along with helping to heal minor cuts and abrasions. This herb is an example of a super plant labeled a weed by modern society. It is also inherently safe as a medicinal plant. We feel it belongs in every system.

Garlic – While garlic is technically an annual according to most it is easily harvested and replanted at the same time. It is far too valuable of both a culinary and medicinal herb to leave out of any design. We also plan to bring other alliums into the system such as walking onion and both onion and garlic chives. What many don't seem to realize though is that garlic is and many alliums are also accumulators of iron, sulfur and phosphorus. Any uppers not desired for consumption can simply be snipped off and dropped during harvest. We are also considering wild leeks (Allium tricoccum) as a perennial allium in this system but are not sure as to how well they can survive our hot and dry climate.

French Dandelion – While the local wild varieties of dandelion will likely show up and be quite welcome we wanted to include this "improved variety" as a choice salad green and highly desirable livestock forage plant. Dandelion as a whole is also a great dynamic accumulator of many important minerals, not the least of which is iron. This herb will also provide for us and educational component as we can show an example of how a "wild weed" can be "improved" to enhance its culinary use.

Comfrey – Needing little introduction to organic gardeners or permaculturists, comfrey is quite simply one of the most amazing plants for natural ecosystem establishment. As a dynamic accumulator it is one of the best accumulating silicon, magnesium, calcium, potassium and iron. It is beyond simple to propagate meaning once established we can donate

large amounts of cutting to establish other systems. In spite of its ease of propagation cuttings are also in high demand to a relatively low supply of those selling them so it can represent an economic yield as well. At minimum we plan to plant one comfrey start for every long term tree. The value as forage, insect habitat, topical medicinal use, mulch production are all through the roof with comfrey.

Mullein – This herb in our view is highly underutilized for many purposes. The large leaves of course are noted as being suitable for toilet paper, and they are but this is a side note at best on a great herb. As a biannual it grows slowly in year one establishing a large taproot and then to 6 feet or taller in its second year. At this time it flowers extensively and is a good insect attractor. It is also a massive dynamic accumulator of iron, magnesium, potassium and sulfur. We actually plan to flank all productive trees in the system with mullein on one flank and comfrey on the other. Mullein is also amazing in its ability to grow on compacted soil and even on almost solid rock and asphalt. Given our challenging soil, mullein will be a huge ally in exploiting any fractures in our limestone sub surface as a pioneer for other species.

***Note** - Attribution to Paul Wheaton of Permies.com for information on the many attributes of mullein. Including this fantastic video he produced on the subject. http://bit.ly/1dSHzak

Final Note on the Herbaceous Species – Perennial and annual herbs will be an ongoing mosaic in our food forest edge as well as in many other parts of our property. In time we will catalog all of those that succeed but the reader should take note that many of these herbs are actually more accurately perennial vegetables. Examples are Good King Henry, Sea Kale and Turkish Rocket. We have the goal of establishing and replicating these on mass as they are all exceptional food crops.

Implementation Stage Three - Soil building in the interswales with livestock and organic matter

As previously noted the area for this food forest is far from ideal. The soils are shallow in the 1 foot range including fractured limestone. So much so that in many areas we have difficultly even pushing electro fence poles into the ground in order to manage livestock. Due to the significant catchment areas tied to this area erosion was quite severe prior to the installation of the swales. Now that

they are installed erosion is practically halted via the earthworks alone. We are already working to build soil in this area. The primary methods of soil building for this area will include…

- Grazing of livestock
- Inputs of large amounts of organic matter
- Chop and drop of support species
- Over seeding of pasture and cover crop mixes after each grazing rotation

As we move into this segment of the project much still has yet to be determined. As decisions are made and refined we will make updates to this document. The most recent version can always be found at

- **Grazing of Livestock** – The property is currently inhabited by a laying flock of 11 hens and one rooster. We also have a small flock of Toulouse geese totaling 5 animals. We are going to be increasing head count in 2014. Additionally we typically tractor about 100 meat chicks per year in 3 cycles of about 30-35 birds a cycle.

  Moving our laying flock to the food forest area is difficult due to where they are housed. Moving the geese is simple as they have imprinted and will simply follow our lead. Our plan is to begin running more meat birds in 2014 to increase their impact on the property and/or to possibly to set up 1 or 2 mobile coop-fence combinations with small flocks of 4-6 laying birds each.

  One method of fencing that has worked free standing for us is the use of 4 16 foot hog panels wired together. The problems though are twofold. One this is a heavy system to move and its size makes it difficult to move between swales and around trees. We plan to experiment by cutting two 16 foot panels in half for an 8x8 area. With 4 birds on an area that size they could be moved once a day with suitable impact from their presence. Coupled with a small moveable coop, said system could be moved in the evening or morning when the birds are in their coop, making the move very simple. We haven't given up on movable fencing yet, this is simply a contingency for areas where the rock prevents its use.

  We feel the property is too small for even miniature cattle but are

considering the addition of a small flock of hair sheep, most likely dorper sheep which do excellent in our area. With three ewes and one ram we can add a great deal of grazing impact to the entire property and produce a meat yield of lamb as well. Dorpers are excellent sheep for our climate as they do well on browse that is more typical of a goat. They are a hair sheep in that they shed naturally and do not require shearing. You can breed a ewe about once every 8 months and unlike some sheep they will breed year round so we can time breeding for a steady crop of lamb.

Lambs of this breed reach an ideal slaughter weight of about 80 pounds typically in only 12-14 weeks. We are not 100% in adding sheep to our property just yet, we definitely will have a husbandry learning curve if we do but the benefits do some worthy of consideration. We have also considered simply purchasing a few female dorpers and running them solely for their grazing value and thus putting off for a time the additional issues that would come with lambing and controlling breeding.

In the end the primary livestock on the property will continue to be chickens and geese. We have been particularly impressed with the "freedom ranger" chickens we have run for a meat yield. They quickly grow into large birds and unlike Cornish cross hybrids seem to suffer almost no ill effects due to their rapid growth. In fact this fall we introduced two pullets into our laying flock as surplus birds from our meat run, they are now about 20 weeks of age and happy and healthy birds.

These birds have huge feet and do a massive amount of work as scratchers. They are somewhat skittish compared to our Rhode Island Reds and Leghorns but were raised 100% on pasture so that could be part of the issue. They are reportedly decent layers and may actually make a fine dual purpose bird, especially given that we are currently already producing eggs far beyond our needs.

The other real asset has been our Toulouse Geese, despite a loss of 3 to a predator the other 5 have done very well. All were in excess of 11 pounds in only 12 weeks from being delivered as day old hatchlings. We have worked with them and have them to where we can move them at will with little effort to any area of the property. Our goal is to increase our flock

size this spring when breeding season arrives. We expect they will be of great value as interswale grazers.

- **Inputs of Large Amounts of Organic Matter** – As noted the property has very shallow soils, lots of rock and is in severe need of improvement. While simply doing grazing and chop and drop would likely work in time it is our intention to accelerate thing. Recently I watched a video by Geoff Lawton on running chickens fully on compost with no grain inputs at all. That video can be seen here. http://www.geofflawton.com/fe/59960-feed-chickens-without-grain Our thought it is to emulate this method in a mobile manner. To pasture the chickens in the paddock and bring in as much waste organic material as we can acquire. As previously mentioned large volumes of leaf fall can be had locally just for picking them up in suburban areas.

  We will also be discussing options to acquire waste vegetable matter from local supermarkets. This should be quite feasible as there are many within a 10-15 mile radius of our home. Additionally we are working to set up relationships with tree pruners to dump large amounts of wood chips at our property. Given many are paying to dump them now at a local materials company this should be quite easy to get done.

  In any event for at least the next two years if it is organic and safe for composting use it is going to be collected, spread and worked by chickens in our target area.

- **Chop and Drop of Support Species** – As stated we have a very heavy ratio planned of 7 support trees and shrubs to every 1 long term productive species in the initial planting. These trees will total almost 300 in number on initial planting. The plan is for only about 10-15 to remain in 5-7 years. This will result in biomass and root mass accumulation at a very high level over the establishment phase.

  As noted we also have a very large number of heavy biomass producing herbs such as comfrey and mullein being planted into the system. Along with large annuals such as amaranth, jute mallow, sorghum and mammoth sunflower. All will be treated as chop and drop for their excess biomass.

- **Over Seeding of Pasture Cells in the Interswale** – After each grazing rotation we will be applying various seed mixtures. Most of the seeds used will be the same as the ones listed in our section on cover cropping. The goal is to grow a mix of annual and perennial species in these cells with a long term plan to move to a perennial dominated system.

  Early on though some areas will be heavily seeded with fast growing annuals to build biomass and nitrogen rapidly. In our climate we can easily seed and area with cow pea and buckwheat and within six weeks graze it with chickens, replant it and graze it again in another 6 weeks. It is quite doable to run 3 rotations in only one season with this type of mix and still have time to plant a heavy perennial cover crop before fall weather gets too cold for establishment.

  In winter seasons we will sow large amounts of daikon radish and purple top turnip. This will be done in both the interswale and in the swale berms themselves. These two plants grow rapidly and provide a tremendous amount of subsurface biomass and have been shown in many instances to reduce irrigation requirements if simply sown in the fall and allowed to summer kill in the following season.

  The key take away from this section is every time an area is grazed it will be at minimum lightly over seeded.

Implementation Stage Three - Attrification of 95% or more of Support Trees Over 5-7 years

There are currently 40 live oaks scattered on the property. They average about 16 feet in height and about 10 inches in circumference. Their stature appears more like that of mesquite rather than live oak, due to the shallow soils they have apparently stunted into this unique growth pattern.

The trees provided some very limited utility. As noted they have in some areas penetrated well into the fractured limestone. However these trees are highly unproductive. They do little to accumulate biomass as they are mostly evergreen in habitat and have a very low leaf drop. The mast they produce is limited. The

acorns are small and attractive only in the most minor way to livestock or wildlife. They would be practically useless as human food. Due to their stunted growth they also represent no potential yield as quality timber.

Hence over time many of them will be removed, we have targeted about 4 right now for removal prior to primary planting. From that point forward they will serve mostly as a shade species for our livestock and to reduce evaporation. We will remove them selectively over the next 5-7 years as the productive species come forward and require more space.

That said they are a native species and have been hit hard locally by “oak mold”. Many of our trees were in fact infected with this disease when we arrived. A trees chance of survival once infected is considered very low and harsh chemical treatments are the recommended course of action. After one year of simply grazing the area all but 5 trees which we removed are in full recovery and show no sign of prior infection. So our intention will be to leave about 10-12 of them as examples as to how a healthy ecosystem can counter problems that we are often told are insurmountable.

Additionally as previously noted we will be planting support legume species at a ratio of about 7-1 in relation to our support species. As we reach final design decisions this will be a number between 280-320 support trees. At minimum 95% of these will be removed via “chop and drop” methods. In the end our intention is to move from a 7-1 ratio in favor of support species, to a ratio of 4-1 in favor of productive species. This would at current planning leave room for only 11-12 long term support legumes.

While that may indeed be the case likely the total productive trees in the system will grow over time. Also note that some of the “support species” are dual purpose. Plants like autumn olive and goumi will be retained more for their productivity rather than the fact that they fix nitrogen.

Very few if any installations have followed this pattern that we are aware of any way in true temperate climates. Generally the high support species ratios are used in tropics and sub tropics where soils are far more fragile and lost at a higher rate. Such climates often times do not experience the heavy natural leaf drop of temperate climate winters. Hence heavy chop and drop is used to accelerate the organic matter and carbon cycles, in an effort to build soil rapidly.

Many of us in temperate climates don't seem to realize the advantages we have over many tropical climates and instead focus on the species we can't grow vs. the soil building ability we have. In our case though we are in a situation we our soils are so shallow that in many ways we are in need of the same type of accelerated growth. We also hope these hardy legumes with do a good job of penetrating the limestone in many areas, which will be key to the establishment of a shallow aquifer in the area. Lastly we hope to prove that this technique is quite valid in temperate climates.

We have heard from many permaculturists things like, "I have planted productive trees with nitrogen fixers and without and notice no real difference in productivity". Inevitably, you find that such individuals are working with very good soils from the start; they also tend to plant very small ratios, such as 1 legume to 5-10 productive trees. Such actually may be quite sufficient in developed soils particularly in more northern climates.

Our intent is to bring this proven system out of the tropics and into heavier use in temperate climates on marginal land such as our own. Land like this is simply unsuited to conventional agriculture use and is therefore much more affordable, lowering the barrier to entry for many perspective land owners.

Implementation Stage Four - Long Term System Management as a Zone 4 System

This section will be brief as management of a zone 4 system is well understood by most with a permaculture background. It is a soft management style involving continued chop and drop, observation and interaction along with harvest of yields to the end of the systems primary goals. The entire point of a zone 4 agro forestry designs is to minimize maintenance and simply harvest as necessary.

There are a few notes to include even at this time though as to our design and the planned system about this stage. First was the decision to design this food forest as a full on zone 4 system in the first place. There was a strong consideration to design this system more as a zone 2 style system with heavier pruning's, additional maintenance and greater yields in total to go along with it.

Had we done so the total number of trees planted would be much higher and the need for support species much lower. Additionally the area is adjacent to the living area and again directly abuts a zone one system. Conventional thinking even in permaculture would have been to make this area a zone two system.

There were quite few design considerations though that led to our decision to make this area a large scale design system. There were…

1. Labor and Maintenance – the property is inhabited by two adults, maintenance of such a large area as a zone 2 system would require a lot of time. While we at times have an intern on property the entire property is designed to be run and maintained by only two people.

2. Educational Opportunity – The area in question was without a doubt simply the best area we had for this type of system to exist on our current property of only three acres. Given part of the goal is to be a demonstration property for a zone 4 style system, we simply chose the best area for it to be successful.

3. Social Design Consideration – As noted elsewhere we have only one close neighbor and they are on the property line that the food forest intersects. This design will give them a sense of privacy from our activities and will do the same for us as well.

4. Water Catchment – Again if you read the catchment numbers in Implementation Stage One it becomes very evident that the ability to run a system in our climate without irrigation is much higher on this site then in other sites on our property.