Planning Needs/Help for A Biochar Kiln to improve Environmental Stewardship

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The Happy Berry
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Clemson University ME 4020 Biochar Kin Project

- "Adding Value Through Environmental Stewardship"
  - Genius of place and history of place

What is The Happy Berry Inc ?

- A small (22 ac) subsistence,100% direct marketing, family farm doing $100 to 200 K/yr gross sales, supporting one full time employee, two family employees and a 401K for mom and dad that is not fully built out.
- Our crops are in order of ripening, blackberries, blueberries, seedless table grapes, Figs, eggs, muscadines including seedless, gojii berries, tea, mulberries, persimmons and willows in the winter.
- Our visions are to improve sustainability of “place” through resilience
- We carry very little debt and do much of our work by hand or back pack, but do have a small tractor, mist blower and 4 wheel drive lawn mower.

We Are Sustainable?

- Birth, growth, maturity, death and decay the “wheel of life” Must turn continuously in place

  We are a perennial farm vs Annual =“waste stream”
- Must interface with the cultural cycle –the transfer of info from old to young of a community and it too turns in place… on affection
- This is what we consider/mean by sustainable
  - We spend a great deal of time providing how to information including digital communication
  - Digital info broadens the definition of “Place/community and culture” but we caution… if someone is outside of our bioregion…
  - The biochar kiln we hope will not only enhance sustainability/resilience –it will become a model for others to follow

What are the “Environmental Stewardship” things we do to add value?

- Over 37-8 years we have established them by determining our **Threats** an addressing them
  - Global warming -Mitigation and Adaptation

Global warming …Mitigation and Adaptation

- Days over 95 Degrees up in summer, Days over 85 degrees in spring up, Spring frosts risk earlier and longer, Winter warm cold extremes up, Summer violent storms up
- Our Adaptation and Mitigation plan is at our web site www.thehappyberry.com (it is long)
  - Trees – Cooling for plants and customers, slows storms, recalcitrant carbon,
  - Biochar project – soil health
    - Winter cover crops
  - Diversifying and changing crops

Threat – Powering Down – How will the customer get to us

- Energy Return on Energy Invested –The ratio is declining rapidly from 100 plus to 1 to 10-1 now
- Natural resource availability decline– Substitution and efficiency also have end points
- There will be a transition – we have worked on what we see as the vision for the future
  - We installed a car charging station with infrastructure for more
  - Bicycle racks and have talked with our Electric bus system about having a bus docking station within electric cycle distance to the farm
- Our vision includes biomass steam electric and solar electric on-farm

Water and Community Disconnect with farming

- Water $4.24/1000gal. No Aquifers' but lots of development with septic treatment plant effluent needing tertiary treatment – work with County Council
- Picture with me again the two wheels… one of life and… one of culture turning together like cogs producing food, healthy soils, and people with survival of local memory of what works in our place of the bioregion
  - Patience is needed to establish a perennial farm and establish a local culture and economy to support it

Your Questions – What is biochar?

- From your questions I detected thinking in terms of Immediate input = immediate output – conversion costs
  - Biochar is a long term investment in soil health
    - Improved cation and anion exchange capacity
    - Improved water holding capacity for flora/fauna use
  - Biochar is a long term investment in the health of our planet
    - Biochar is very recalcitrant meaning it is not easily converted back to Co2 by soil flora and fauna 100's to 1000's of years
    - In turn water holding capacity impacts the hydrologic cycle

How do you make biochar?

- You make charcoal first – temperature at which it is made is important (400-600 degrees C)
  - As the temperature goes up you are started “on the way to diamonds”
    - You loose edges
    - You lose pores
  - As the temperature goes down digestibility increases and recalcitrance declines
- The charcoal is crushed and converted from hydrophobic to hydrophilic
- Then you compost the charcoal with “soft carbon” and nutrients
  - In our case the vision is with chicken liter

Biomass pyrolysis

- The break down of chemicals by addition of heat with out oxygen
  - In our case it becomes exothermic at 300 C producing various products that are flammable in the presence of oxygen
  - In our case the products exit the chamber and are piped under the chamber where they ignite with the help of the starter fire initially
  - The process goes to completion – No more gas from the inner chamber
- The end result is hydrophobic charcoal

Questions – Team A

- 1. Starter fuel? Same woody waste stream As that used for Pyrolysis
- 2. How to grind charcoal chunks? We were thinking of a grinder powered by bicycle
- 3. Net power? We use currently about 50 kw per month. My guess is at 20% efficiency we will generate 30-33 kw
- 4. Location and foot print. Near the our existing facility here water electric is nearby. We would gather and place waste stream pruning's near also. I am visualizing 20-30 feet long and 10 to 12 feet wide. As small a foot print as possible but still comfortable working room for loading, unloading and grinding and composting.

Questions – Team A

- 5. Drying pruning's – Yes, In field, then at gathering place, typically about 11% moisture. If a problem we will build a little lean-to.
- 6. Dimensions of drum? Roughly 2 feet in diameter and 3 feet tall. We are not stuck on a drum…I was looking for something that could be replaced if needed in time. The issue is maintenance …special made stuff is costly to replace. I was visualizing that I could take a new drum to the local muffler shop and have a new exhaust pipe welded on
- 7. Exhaust manifold attachment – worried about slight differences in barrel size- a snap in place might make replacement difficult – then again the muffler shop may go away

Questions – Team A

- 8. Single or multiple barrels? More than one might be handy but the kiln would only fit one barrel given our waste stream…we are not interested in selling biochar
- 9. Wind Mill generator. It is not actually a wind mill it is a continuously variable speed generator
- 10. Particular specifications – It visualized that the set up would last 100 plus years with occasional repairs. Easily repairable. Low cost … for example we have a rock pile on farm. The kiln and pad are under a tree and we would like not to hurt it. I am available- call me if in doubt

Questions – Team A

- 11. What do I expect? A design for a kiln that considers
  - Moving barrel in out easily
  - Tilting of barrel for ease of dumping then up right for loading
  - Energy considerations – objective 500 degree charcoal and capture waste heat as electricity
    - Door system that will increase efficiency in conserving heat yet allow air draft
    - Chimney system that would do the same with perhaps automation
  - A long life
- 12. No model/prototype needed but a high degree of confidence that it would work

Questions – Team B

- 13. Storing biochar – about 3000 to 3500 lbs expected that would be composted with fresh chicken litter at 4 to 6 ration of chicken litter to biochar. Not sure of volume this represents but would visualized that as storage area(maybe 10 by 10 feet with divider in middle) fills up we would apply to farm. Aeration pipe is needed under each bin to facilitate composting.
- 14. What cycle time? 24 hours

Questions – Team B

- 15. Steam engine included in budget? Yes
- 16. Any aspect a must? No. Biochar and electricity at the end. Open to new ideas but think steam should at least be considered.
- 17. Dimensions of steam coil? Do not know …would need to consult greensteammachine.com or someone
- 18. Mobile or stationary? Stationary ie longer lasting
- 19. Dry chemical extinguisher – I was thinking off the shelf but of adequate size

Questions – Team B

- 20. Upstream and downstream – basically none but wanted you to know what thinking was
- 21. Cleaning the kiln? Good question? The by products of pyrolysis are liquid and gas. I expect the cooler the more liguid and hence cleaning problem… but that liguid should burn???
- 22. Combing nutrients and biochar? Water and composting. The processs requires air inlet from bottom of compost pile…it is an art.

Questions – Team C

23. Tortuous exhaust? Most high efficiency cast iron fire places use this concept. Instead of exhausting directly up the pipe it must go up down several times before exhausting
24. Time to field apply – Do not know …perhaps a day or two to a week
25. Payback period on steam generator? Depends – in my initial thinking 4 to 8 years
26. How many workers? My wife and I, one full time and two daughters

Questions – Team C

- 27. Auto draft control ? Would be great if you could include this in design. There is a visible change in smoke color as you move through the various stages of pyrolysis
- 28. Biochar application? Farm crew will handle this.
- 29. Target values for nutrients in soil? No. Growth and flower bud set from previous season and the soil is a dynamic microbial, nutrients on the exchange, water availability and available energy in the soil as sugars complex that changes from one foot to the next. It is all about soil health.
- 30. What to design? From the grid to biochar is ideal.

Invitation to Farm

- The farm is located at 510 Gap Hill Road in Six Mile SC
- My email is Walker@thehappyberry.com
- Our web site is www.thehappyberry.com
- My phone is 864 350 9345
- There is lot of information at our website under “Farm management” and then “Carbon”
- **Any questions feel free to ask**
- **Thank you for your help !!**