

**The State of the Biochar Industry in
Mendocino, Humboldt, and Sonoma Counties**

**A Marketing Report for the Redwood Forest Foundation, Inc. and
the Mendocino Biochar Demonstration Project**



**Raymond Baltar
Biocarbon Associates
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Confidential

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Forward

Opportunities for building an integrated, synergistic biochar industry in Mendocino, Humboldt and Sonoma Counties

Given the nascent stage of the biochar industry, the Redwood Forest Foundation, Inc. (RFFI) is now presented with a significant opportunity to help guide local development through leadership that reflects RFFI's strong sustainability ethic and triple bottom line philosophy (see Figure 1). The US Department of Agriculture (USDA) has recognized that RFFI's Mendocino Biochar Demonstration Project represents an important test case for the economic viability of a forest-based biochar production facility. Moreover, USDA expects that RFFI, in conjunction with the local Biomass Working Group, will take a responsible and systemic approach when analyzing both the upsides and potential downsides inherent in biochar's production, distribution, and use.

Biochar isn't simply an agricultural commodity—its production and use can serve as a catalyst for building awareness and momentum for the better use of forest, urban and farm resources; as an example of the use and profitability of leveraging the byproducts from one industrial process into valuable inputs for another; and as a way to build cooperative, commercial alliances within communities. Our thought process while preparing this market analysis has taken into account these synergistic opportunities for true sustainability while also seeking to provide specific usable market research data.

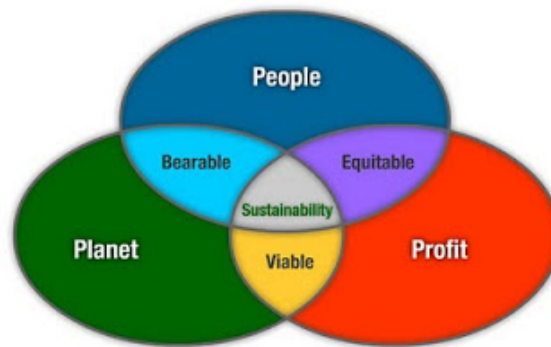


Figure 1 Triple Bottom Line Structure

This marketing report was prepared as part of a USDA Conservation Innovation grant (CIG) project awarded to The Redwood Forest Foundation, Inc. that was funded to determine the economic viability of operating a small-scale biochar production unit in the Usal Forest in northern California. The report seeks to meet four main objectives:

- determine the current state of the market for biochar products in Mendocino, Humboldt and Sonoma counties
- identify 3 to 5 emerging or potential markets for biochar products in the 3-county survey area

- assess current or potential distribution channels for delivery of the product to existing and new markets here
- detail top marketing strategies for these existing and emerging markets.

Biochar is a specialized form of charcoal that is suitable for use as a soil amendment (typically combined with compost) to enhance soil health, increase agricultural crop yields, and conserve nutrients and water. Biochar is able to fulfill these functions due to its unique physical structure (see Figure 2), with literally millions of tiny pores able to hold nutrients, water and microbes for the plants' roots to access and enjoy. In many ways it is akin to a coral reef in the ocean, acting as a natural attractant, sanctuary, and incubator in soil by creating infrastructure in which billions of organisms can thrive.

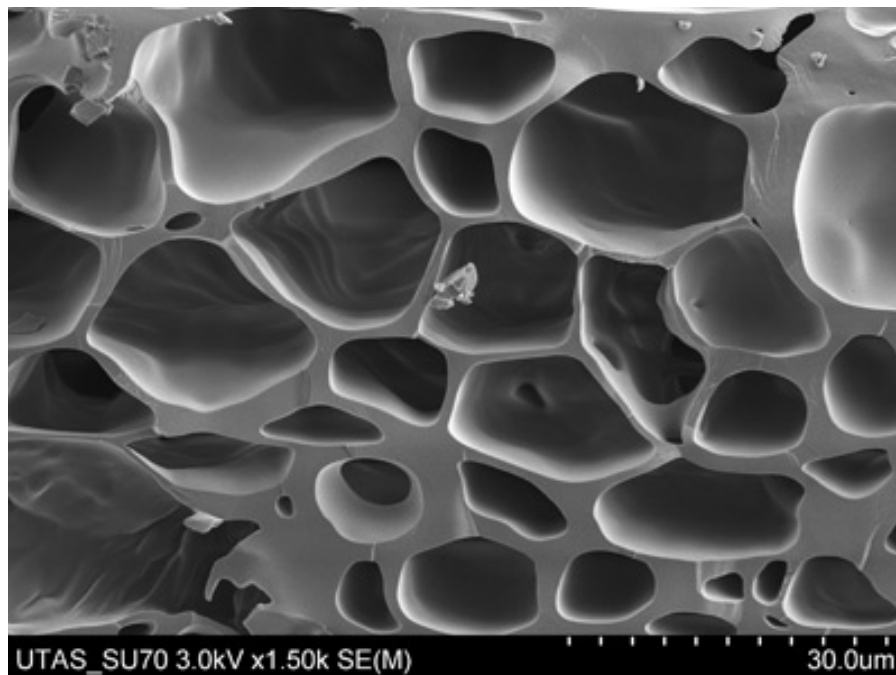


Figure 2 Microscopic photo showing biochar's porous structure

Biochar is made by heating woody waste materials (of many different types) in the absence of oxygen, in a process called "pyrolysis." The material is not burned, but at temperatures of about 450 to 700 degrees C gases are produced from the wood that feed the pyrolysis process, leaving behind essentially pure carbon with its millions of microscopic pores. These gases can be captured and processed as fuel for renewable energy generation (in some technologies), and the heat generated can also be used to heat greenhouses or put to other profitable uses.

Biochar holds particular promise for farmers in improving their waste management practices, lowering nutrient input costs, reducing water use, improving crop productivity, reducing CO₂ emissions, and for production of renewable energy for the farm. Biochar is also being studied as a cheaper replacement for activated carbon in some industrial processes, as a feed supplement and odor mitigation tool in animal agriculture, as a material that can be used by

environmental services companies to help control pollution runoff, as a building material, as well as for many other potential applications.

I THE EXISTING LOCAL MARKET FOR BIOCHAR

To determine the current state of the market for biochar we identified and reached out to a representative sample of local brick-and-mortar businesses in the 3-county survey area that were most likely to be selling biochar. These include compost companies, landscape supply firms, nurseries, stores catering to home gardeners, and small farm supply businesses, along with those firms catering to the medical marijuana growing community. A total of 52 such businesses were surveyed either by phone or in-person interviews during March – May 2014. We also talked to a number of row crop, orchard and vineyard managers as well as farm bureau personnel to determine their knowledge of and current use of biochar. And we contacted a number of companies advertising both bulk and bagged biochar products on the internet that indicated they would ship their products to Ukiah, California. Figure 3 shows the scope of businesses contacted; Figure 4 documents their basic knowledge of biochar at this point; Figure 5 further explores their current use of biochar in blended products.

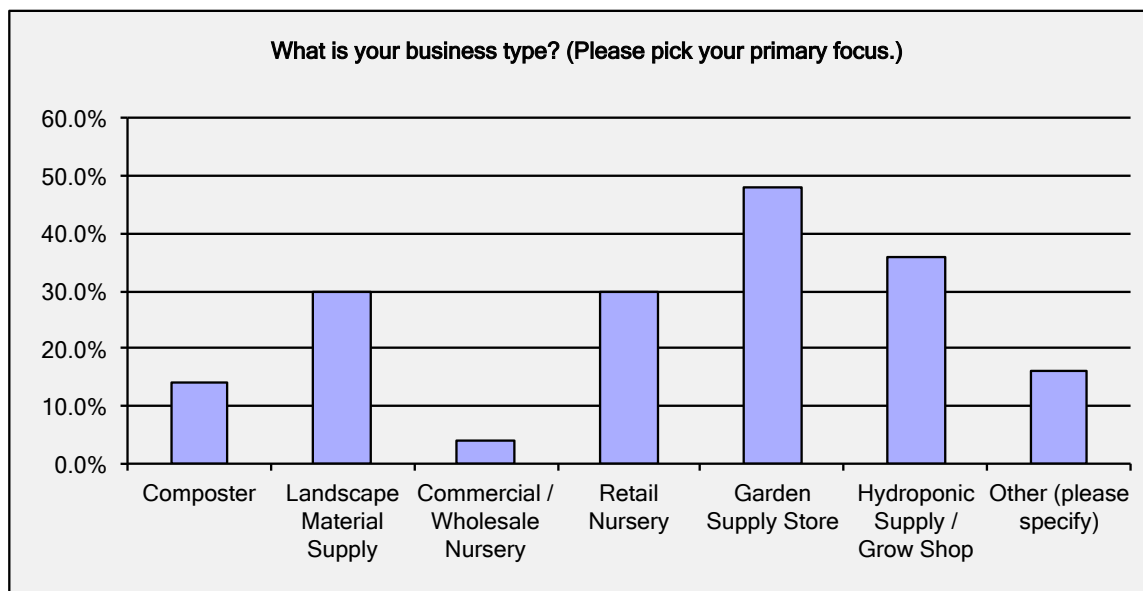


Figure 3 Types of businesses surveyed (total exceeds 100% because some businesses were counted in two categories)

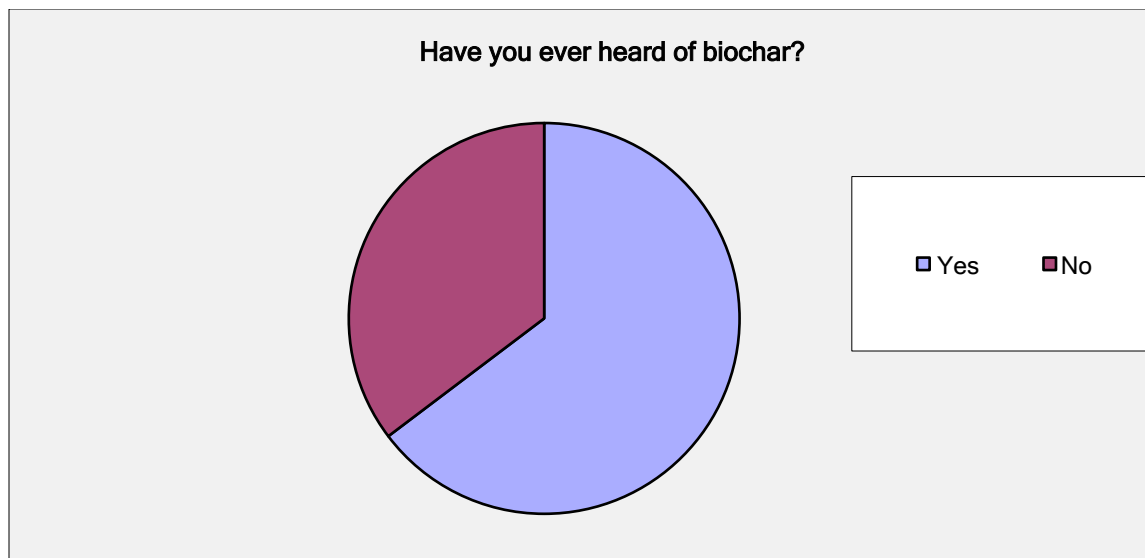


Figure 4

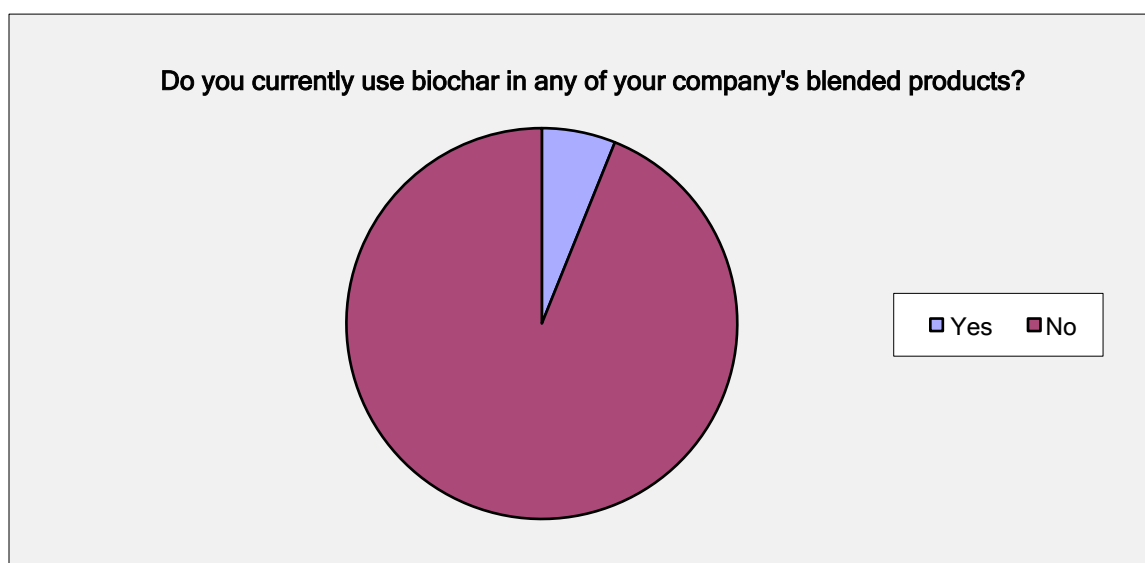


Figure 5

Nearly two-thirds of all respondents (64.7%) indicated that they had heard of biochar, but most said they had only a basic understanding, if that, of what it was. Perhaps somewhat surprisingly, 63.6% stated that they had been asked by at least one customer if they carried biochar products, a query to which nearly all of these firms (60.6% of respondents) had to reply that they did not yet carry any. Figure 5 illustrates how few of the surveyed businesses use biochar in any of their blended products—just 6% at this time.

Of the few respondents from whom we were able to obtain price information, 4 of them sold pure biochar by weight for over \$2.50 per pound. Those firms selling pure biochar by volume (more common) priced it as follows per cubic yard: 1 charged between \$251 and \$300; 4 charged between \$301 and \$350; and 2 sold it for over \$350.

Key Results

The key results of this survey indicated that:

- Though we cannot pinpoint an actual number, our best estimate is that between 500 and 1000 yards of biochar were likely purchased and used in the three-county survey area in the last year.
- Most of this was sold either in bulk quantities (1 yard or more) of pure biochar or as biochar blended with compost, soils, and other ingredients. Biochar sold in 1.5 cubic foot or smaller bags or 5-gallon buckets represent a much smaller percentage of the total volume—at least for now.
- Of the vendors that do sell biochar or biochar products locally, 21.9% said they would definitely be interested in carrying RFFI branded biochar, 28.1% said they might be interested, and 43.8% said they might be interested depending on quality and price, for a total 93.8% who said they would consider carrying a local, RFFI-made and branded biochar product.
- There were two soil blending companies—*Dirt Cheap Landscape and Garden Supply* in Ft. Bragg and *Willits Soils, Inc.* in Willits that were very interested in exploring a relationship with RFFI to either purchase most or all of the biochar produced, or to partner with RFFI on producing a co-branded product. Names and contact information for these and other interested vendors who expressed an interest in selling RFFI biochar are listed in Appendix A.
- 79.2% of the people surveyed indicated they would or might attend a biochar presentation in the future.
- The only products available in most brick and mortar locations that carry biochar are currently supplied by only one vendor, The *GreenGro* company based in Windsor, California, and they offer blended or inoculated product lines (Earthshine and Nature's Pride brands) at premium prices. *Biocharm*, a blended product produced by a Marin County company called Energy Anew, Inc., is available in limited quantities in a few selected garden supply stores in Marin and Sonoma counties.
- Based on the number and type of vendors carrying products containing biochar, and in interviews with producers, the marijuana cultivation market segment is the largest by far, and is estimated to account for some 80% of the biochar product purchases in the survey area.
- A few composting and soil manufacturing companies, such as Sonoma Compost and Willits Soils, Inc., as well as some stores catering to home gardeners and small farmers offer bulk biochar sales in one and two-yard supersacks, in barrels, and in small bags.

Bulk sales were available at the following 5 locations:

- *Beneficial Living Center* in Arcata (biochar supplied from *eGenesis Industries*—no longer producing)
- *Humboldt Ag Supply* (biochar supplied by *Biochar Supreme*)
- *Sonoma Compost* in Petaluma (unsure of biochar source)
- *Sparetime Supply* in Willits (biochar supplied by *NaturaTech*—no longer producing), and
- *Willits Soils, Inc.* (biochar supplied by *NaturaTech* and other sources)

The following six companies indicated they would ship bulk biochar to the 3-county area:

- *Biochar Solutions* in Colorado
- *The Biochar Company* in Pennsylvania
- *Biochar Supreme* in Washington state
- *Phoenix Energy* in Merced and Modesto
- *US Biocarbon* in Michigan
- *Cool Planet Energy Systems* in Colorado

Details on a sample of companies that sell biochar, and what they charge for it, are presented in Figure 8 and in the section on existing national markets for biochar starting on Page 19.

This research showed that, though the area's biochar market is currently small when compared to the overall market for soil products, awareness of the material's unique qualities has been spreading quite rapidly in recent years. Demand is starting to increase beyond the current early adopter purchasers (mostly the marijuana cultivation community) due to research indicating biochar's unique characteristics, including water and nutrient retention, efficacy in seed germination, and increased plant production. Figure 6 shows the estimated amount of biochar sold in the 3-county survey area during the last year.

Estimated Annual Biochar Sales In the 3 County Survey Area (4/13 to 4/14)			
			Cu. Yd.
Business Name	Location	How Sold	Equivalent
Willits Soils, Inc.	Willits	50 tons	295
Humboldt Ag. Supply/Est.		100 yards	100
Sales directly to farms/Est.	From all over U.S.	yards	100
Online Sources/Est.	From all over U.S.	70 yards	70
Sonoma Compost	Petaluma	40 yards	40
Spare Time Supply	Willits	11 yards	11
GreenGro Product Line/Est.	Windsor	gallons/quarts	11
Harmony Farm Supply	Sebastopol	4500 quarts	6.48
Beneficial Living Center	Arcata	571 gallons	2.29
Total Yards			636

Figure 6 Estimated size of the biochar market (Amount sold in the last year)*

* It should be noted that there could be a wide margin in error in this figure since several major suppliers declined to reveal their annual sales figures, which is why we estimated the range of sales at 500 to 1000 yards.

This growing awareness has been sparked by outreach from RFFI, the Sonoma Biochar Initiative (SBI), and other groups such as the International Biochar Initiative (IBI). The introduction of a new product line (Nature's Pride Fertilizer and Earthshine Biochar Blend) in local stores catering to the marijuana trade has also increased the awareness and availability

of biochar. In addition, one soil blender in Mendocino County, *Willits Soils, Inc.*, has used a large amount of biochar in its bulk blended soil products for the last 2½ years, building a solid base of customers.

Research Challenges

In attempting to determine an accurate estimate of the quality and volume of biochar sold and used in the survey area we encountered four challenges:

- 1) There is no accepted standard for biochar quality in the survey area. Most vendors and their customers do not understand the qualitative differences between biochar of different types made in different ways.
- 2) The companies selling blended biochar products in the survey area consider their blends to be proprietary and do not divulge the amount of biochar they contain by volume—it could be 2%, 5%, 20%, or even 50%—making it impossible to accurately determine the total amount of biochar being sold in this pre-blended form.
- 3) Some vendors sell unblended biochar by weight and others by volume. Accurately converting pounds to yards (the more accurate and reliable measurement) through testing of individual products was beyond the scope of this report. Since the weight of a yard of biochar can vary from 150 pounds to as much as 500 pounds or more depending on a number of factors (such as the production process, feedstock, particle size, and moisture content), we used an average conversion number of 338 pounds per yard to come up with an estimate of the total estimated volume being sold by those firms surveyed.
- 4) We could not obtain accurate sales figures of biochar or biochar blends supplied from internet sources to customers in the survey area; most of our inquiries went unanswered. However, according to sales figures obtained in a recent *Inc. Magazine* article on The Biochar Company—a well-established and well-funded company selling a bagged product on the internet called Soil Reef—20% of their revenue comes from internet sales.¹ So we simply used that figure when estimating the total sales volume in Figure 6.

No consistent biochar characterization standard

The quality of biochar and its characterization can vary greatly from one producer to the next, and also from supplier to supplier. At this early stage of the biochar industry's development nationally, as well as in our three-county area, there is little if any consistency or regulation for biochar products. Moreover, vendors' general knowledge about what constitutes good quality—and bad quality—biochar is very limited. Without running a characterization analysis

¹Mochari, Ilan. "When Two Small Startups Tackle an Industry Together". *Inc. Magazine* Online 15 January 2014. <http://www.inc.com/ilan-mochari/reinvention-biochar-merger.html>.

on each product and comparing it to that produced by RFFI's production unit, we could not offer a valid quality comparison.

We do believe, however, that RFFI's biochar will likely have several qualitative and quantitative advantages in the current marketplace. Educating potential customers, both wholesale and retail, about these advantages of RFFI's product will be a key sales strategy we will outline later in this report.

Blended biochar products lack ingredient transparency

Up until 2013-2014, the last year or two most of the biochar available in the survey area was sold as a stand-alone soil amendment by the pound, barrel, or yard, and it was available in just a few outlets as detailed in Figure 6.

In 2013, however, a line of blended products containing biochar and many other ingredients, aggressively marketed locally by *GreenGro*, was introduced into many stores in the survey area that cater primarily to the marijuana growing community. As noted before, these products are Nature's Pride Fertilizer Blend, Earth Shine Biochar Blend and Earth Shine Soil Booster.



Figure 7 GreenGro's Earth Shine & Nature's Pride Products

According to our survey 23% of all the retail businesses surveyed offered biochar products, and in most of those the products produced by *GreenGro* were the only ones they carried that contained biochar. We were only able to obtain very limited sales information on these products since *GreenGro* declined to answer repeated requests for information, and most retailers carrying their products were hesitant to reveal their sales information. In addition, the products are relatively new, and the percentage of biochar used is considered proprietary and is not listed on their packaging or sell sheets. We were therefore unable to accurately determine how much biochar they actually contain. Still, we did attempt to assess the impact that the *GreenGro* line of blended products is having on the market in the survey area. We made an educated guess as to how much is being sold in this form and this figure is listed in Figure 6.

Our research produced just one company that listed the percentage of biochar used in their blended product—the Soil Reef brand blend—that contains 50% biochar by volume.

Biochar in bulk is sold both by weight and volume

As noted earlier, some vendors sell biochar by weight (usually by the pound), while others sell it by volume (usually in supersacks or by the cubic yard or cubic foot). Since biochar produced from different feedstocks and at different temperatures has differing volume and weight profiles (dry bulk density), it is difficult to accurately translate the weight of an amount of biochar to the more accurate volumetric measurement. Complicating this calculus is the fact that biochar can pick up a significant amount of moisture just being exposed to the open air, and this can significantly skew accurate weight measurements.

With all this being noted, to provide an estimate of the amount of biochar sold in bulk we used the volume measurement protocol and an averaged standard conversion weight figure of 338 lbs per yard to convert pounds and tons to yards.²

Internet Sources of Biochar

A number of vendors on the internet are willing to ship their products to customers in our local area from their production facilities in Colorado, Southern California, the Northwest, and elsewhere. In Figure 8 we have listed a selection of these vendors and the prices they are charging for both bagged and bulk products. While it was not possible to accurately determine how much is being shipped to Mendocino, Humboldt and Sonoma counties on an annual basis, it is fair to assume that some is being purchased online, though the cost for shipping bags of biochar and soil makes the products more expensive than bulk biochar available locally.

Some vendors sell unblended biochar by weight and others by volume. Accurately converting pounds to yards (the more accurate and reliable measurement) through testing of individual products was beyond the scope of this report. We could not obtain accurate sales figures of biochar or biochar blends from internet sources to customers in the survey area as most of our inquiries went unanswered. However, according to sales figures obtained in a recent *Inc. Magazine* article on *The Biochar Company*—a well-established and well-funded company selling the previously mentioned bagged product called Soil Reef on the internet —20% of their revenue comes from internet sales.³ So we simply used that figure when estimating the total sales volume in Figure 6.

² Since the weight of a yard of biochar can vary from 150 pounds to as much as 500 pounds or more depending on a number of factors (such as the production process, feedstock, particle size, and moisture content), we used an averaged conversion number of 338 pounds per yard to come up with an estimate of the total estimated volume sold by those surveyed.

³ Mochari, Ilan. "When Two Small Startups Tackle an Industry Together". *Inc. Magazine Online* 15 January 2014. <http://www.inc.com/ilan-mochari/reinvention-biochar-merger.html>.

Figure 8 shows a sampling of products containing biochar available in the 3-county survey area, and their costs. Additional price comparisons are available in the Existing National Markets for Biochar section on Page 19.

Comparison prices for products / Surveyed 5/13/14					
Biochar available from local vendors			11.22 gallons	27 Cu. Ft.	Price per Cu. Yd.
	35 lb, 5 gallon bucket	Price per gallon	1.5 Cu. Ft.	Price per Cu. Yd.	Spare Time Supply
			Equivalent	Equivalent	15% off sale
	GreenGro Nature's Pride Veg Fertilizer	\$139.99	\$28.00	\$314	\$5,655
	GreenGro Nature's Pride Bloom Fertilizer	\$139.99	\$28.00	\$314	\$5,655
	GreenGro Earthshine Biochar Blend	\$134.99	\$27.00	\$302.92	\$5,453
Earth Shine Biochar is fortified with humic acid and worm castings.					
Nature's PrideVeg Fertilizer (6, 3, 3.5) is derived from biochar, mycorrhizae, feather meal, bat guano, biochar					
fish meal, seabird guanos, oyster shell, alfalfa meal, volcanic ash, blood meal, crab meal, rock phosphate,					
fish bone meal, glacial rock dust, sulphate of potash, langbeinite, kelp meal, with 3% humic acid					
			45 Qts	27 Cu. Ft.	
			1.5 Cu. Ft. bag	Price per Cu. Yd.	
	15 Qt bag	Price per Qt	Equivalent/Retail	Equivalent/Retail	
	\$15	\$1	\$45	\$810	Shipping not included
Energy Anew, Inc.'s Biochar					
Blend of biochar, composted blend of poultry manure and plant material, & natural zeolite					
			1.5 Cu. Ft. bag		
	1 Cu.Yd.	Price per Cu. Ft.	Equivalent		
	\$300	\$11.11	\$16.67	\$300	Shipping not included
Sonoma Compost					
Pure biochar					
Biochar available from non-local vendors					
		Shipping from CO.	1.5 Cu. Ft bag	Total	
	1 Cu. Yd.	Per Cu. Yd.	Equivalent	Price per Cu. Yd.	
	\$360	\$132.00	\$27.33	\$492	Shipping Included
Cool Planet / Cool Terra					
Includes rinsing and screening to 1-2mm, ph adjustment to 6.5, and inoculation with bacteria and fungi.					
		Shipping from CO.	1.5 Cu. Ft bag	Total	
	1 Yard / 275 lbs	Per Cu. Yd.	Equivalent	Price per Cu. Yd.	
	\$250	\$168.75	\$23.26	\$419	Shipping Included
Biochar Solutions					
Pure biochar					
				27 cu ft	
			1.5 Cu. Ft bag	Price per Cu. Yd.	
	1 Cu. Ft. bag		Equivalent	Equivalent	
	\$49.95		\$74.93	\$1,348.65	Shipping Included
Soil Reef Brand Pure Biochar					
Soil Reef Brand Biochar/Compost Gardener's Blend					
Soil Reef Gardeners Blend is 50% biochar blended with top grade compost, worm castings and kelp meal.					
	\$47.95		\$71.93	\$1,294.65	Shipping Included
U.S. Biocarbon					
Pure biochar					
	1 Cu. Ft. bag		1.5 Cu. Ft bag	Price per Cu. Yd.	
	\$49.95		Equivalent	Equivalent	
	1 Cu.Yd.		\$74.93	\$1,348.65	Shipping Included
	\$547.50			\$547.50	Shipping Included
(Closed for business May 2014) NaturaTech					
Pure biochar					
	1 Cu. Yd.		1.5 Cu. Ft bag	Price per Cu. Yd.	
	\$238.81		Equivalent	\$238.81	No longer available
Phoenix Energy					
Pure biochar					
	Per ton @ \$0.79 / lb	Shipping from Merced		27 Cu Ft	Based on 450 lbs per yard
	\$1,580	\$68 per yard		Price per Cu. Yd.	
				Equivalent	
				\$356.00	\$424 per yard inc. shipping

High price for blended product 1.5 Cu. Ft. bag equivalent	\$314	GreenGro	Not inc. shipping	5 Gallon Bucket
Next highest price for blended product 1.5 Cu. Ft. bag equivalent	\$72	Soil Reef	Inc. Shipping	Bagged product
Low price for blended product 1.5 Cu. Ft. bag equivalent	\$27	Cool Planet	Inc. Shipping	By the yard only
High price for pure biochar 1.5 Cu. Ft. bag equivalent	\$75	Soil Reef	Inc. Shipping	Bagged product
Low price for pure biochar 1.5 Cu. Ft. bag equivalent	\$17	Biochar Solutions	Inc. Shipping	By the yard only
High price for blended product 1 Cu. Yd. equivalent	\$5,655	GreenGro	Not inc. shipping	5 Gallon Buckets
Next highest price for blended product 1 Cu. Yd.	\$1,295	Soil Reef	Inc. Shipping	Bagged Product
Low price for blended product 1 Cu. Yd.	\$492	Cool Planet	Inc. Shipping	By the yard only
High price for blended product 1 Cu. Yd.	\$5,655	GreenGro	Not inc. shipping	5 Gallon Buckets
Next highest price for blended product 1 Cu. Yd.	\$1,348.65	Soil Reef	Inc. Shipping	Bagged Product
Low price for blended product 1 Cu. Yd.	\$731	Cool Planet	Inc. Shipping	By the yard only

Figure 8 A comparison of costs for a sampling of biochar and biochar products available in the 3-county survey area.

MARKET PROFILE

Top Markets for Biochar

Our research indicates that four demographic groups are, and will likely continue to be, the major purchasers of biochar-related products in the 3-county survey area over the near-term:

- soil manufacturers and blenders (composters, soil supply companies, etc.)
- home gardeners
- small traditional farms growing high-value crops, managed by wealthy owners or operators, or those with early adopter tendencies willing to experiment with new soil-building products
- marijuana farmers

Secondary market sectors that are reported to be important sales channels for biochar manufacturers around the country and the world include:

- animal agriculture operations (as a silage agent, feed additive/supplement, litter additive, slurry treatment, manure composting component, water treatment in fish farming.)
- universities (research and application)
- landscaping services (client application)
- government (research and application)
- reclamation and restoration (particularly on former mine sites, military bases and landfills)
- green builders (particularly of green roofs)
- tree care services

Promising emerging markets include:

- activated carbon replacement*
 - wastewater treatment (urban bioswales, water treatment facilities)
 - stormwater treatment (particularly to capture dangerous metals like zinc from roofs and copper from auto brake pads)
 - air filtration for industrial processes
 - air filtration products (work, home & auto)
 - potable water filtration (well water treatment, consumer products)
 - chemical industry uses
- nurseries/commercial greenhouses (as a substitute for peat and/or vermiculite)
- nutrient filtration and retention in agricultural field runoff (to capture and reuse nitrates and phosphates in water coming off fields under agriculture management)

**It is important to note that the generally recognized definition of biochar is “charcoal made and utilized specifically for agriculture”. Some in the industry feel strongly that non-agricultural uses of biochar, such as for wastewater treatment or mine restoration, do not fit this definition and that biochar is too valuable to use in these and other non-agricultural applications. It is this author’s opinion, however, that at this very early stage of biochar’s development biochar producers will likely need to diversify and stay open to all potential markets.*

The Large-Scale Agriculture Market

At this time the largest and arguably the most important market for biochar—traditional large-scale agriculture—will remain mostly a longer-term objective for biochar producers. Biochar is currently much too expensive for row crop farmers at this stage of the industry's development. The reasons for this are threefold:

- 1) The modern technologies used to produce biochar are mostly custom-built and not mass-produced, making them expensive to purchase.
- 2) Most of these technologies are currently unable to make biochar at the scale that would be necessary for its diffusion into large-scale farming operations (see Figure 9). Smaller production runs (such as the 2-yard per day yield from the Biochar 1000 unit) make it much more expensive to produce. A lack of available, large-scale biochar production technologies, other than gasification and co-generation facilities that make high-temperature biochar as a by-product of their focus on electricity and heat generation, will slow the diffusion of biochar into the industrial or organic agricultural sectors.
- 3) Biochar production facilities and the wood-based feedstocks most often used to make it can be located a far distance from farms, making it cost-prohibitive or considered a barrier to transport where it is needed.

The chart below (Figure 9) illustrates the costs to treat the average US farm with biochar at three application rates and three bulk purchase prices. (Note: The lowest purchase price found during the research for this report was \$238 per yard wholesale, with the company offering it at this lowest price recently going out of business!) These estimates do not include the costs to blend the biochar with compost or other nutrients prior to application, application expenses (including labor), or shipping expenses from the biochar producer to the farm.

Assumptions				
1 Hectare = 2.47 Acres				
Biochar Application Rates		Yards needed per hectare		
5 Tons per hectare		30		
10 Tons per hectare		59		
20 Tons per hectare		118		
Weight Conversion Factor*				
338 Pounds per yard				
5.9 Yards per ton				
	Bulk retail price	Cost per hectare at 5 ton application	Cost per hectare at 10 ton application	Cost per hectare at 20 ton application
Price Per Yard	\$100	\$2,959	\$5,917	\$11,834
	\$200	\$5,917	\$11,834	\$23,669
	\$250	\$7,396	\$14,793	\$29,586
Average Farm Size in U.S.	172	Hectares		
Price to treat the average farm**		Yards needed		
5 tons per hectare/\$100 per yard	\$508,876	5,089		
5 tons per hectare/\$200 per yard	\$1,017,751	5,089		
5 tons per hectare/\$250 per yard	\$1,272,189	5,089		
10 tons per hectare/\$100 per yard	\$1,017,751	10,178		
10 tons per hectare/\$200 per yard	\$2,035,503	10,178		
10 tons per hectare/\$250 per yard	\$2,544,379	10,178		
20 tons per hectare/\$100 per yard	\$2,035,503	20,355		
20 tons per hectare/\$200 per yard	\$4,071,006	20,355		
20 tons per hectare/\$250 per yard	\$5,088,757	20,355		
*Biochar can weigh as little as 150 lbs. per yard and as much as 500 lbs per yard or more. We used an averaged figure for this calculation.				
**The biochar does not have to be applied all in one year. It could be applied, and paid for, over a 10 year period.				
Production output / Biochar 1000 Unit	2	Yards per day		
	10	Yards per week		
	480	Yards per year	Conservative uptime estimate	
	5 tons per hectare	10 tons per hectare	20 tons per hectare	
Number of years needed to produce enough biochar to treat one average-sized U.S. farm using production capabilities of the Biochar 1000 Unit	10.6	21.20	42.41	

Figure 9 Costs to treat the average-sized farm with biochar.

High-quality compost costs \$20 to \$40 per yard wholesale, blending can run \$5 to \$10 per yard, and shipping can add \$50 to \$70 per pallet (each pallet can hold two 1- or 2-yard supersacks) making the shipping costs that range from \$12.50 to \$35 per yard. These expenses, then, can add \$32.50 to \$85 *per yard* to the cost of applying the biochar to the field—*independent of application expenses*.

Comparison of production costs and income potential of corn, wine grapes, and marijuana.

To better understand the economic challenges of selling biochar to large-scale agriculture, and why marijuana growers are currently the largest demographic purchasing biochar in the 3-county survey area, we prepared a chart (Figure 11) that compares production costs with the return on investment of a hectare of corn, wine grapes, and marijuana—the latter two being by far the most valuable local crops. This comparison shows that even at the lowest application rate of 5 tons per hectare, and at the lowest purchase price of \$100 per yard, the price tag for biochar at nearly \$3,000 per hectare could not be justified for corn production, as current prices paid for corn do not even cover production costs.⁴



Figure 10 Corn plants

Production costs to grow one hectare of corn (following corn) 457 bushels per hectare (1)	\$2,212	4.84 per bushel		
Income per hectare for corn	\$2,148	July 2014 Futures @\$4.70 per bushel (4)		
Production costs to grow one hectare of wine grapes once established (2)	\$44,134			
(Does not include vineyard establishment costs or harvesting)				
Income per hectare for wine grapes (2012)	\$56,830			
Production costs per hectare for marijuana (Outdoor grow, not inc. processing) (3)	\$11,362	at \$8.00 per lb		
Income per hectare for marijuana	\$1,420,250	1420 lbs @\$1000 per lb.		
(At 6175 lbs per hectare, yielding 1420 lbs. per hectare of high-end bud material.)				
1) Corn statistics: Estimated Crop Production Costs in Iowa. 2014. Ag Decision Maker. File A1-20 (http://www.extension.iastate.edu/agdm/crops/pdf/a1-20.pdf)				
2) Wine grape statistics: Cooper, Monica, Klonsky, Karen, De Moura, Richard, Sample Costs to Establish and Produce Wine Grapes. 2012. UC Cooperative Extension				
3) Marijuana statistics: Caulkins, Jonathan P., Estimated Costs of Production for Legalized Cannabis, Rand WR764, July 2010				
4) Corn Futures statistic: Schober, Marc. Farmland Forecast. Agweb.com. http://www.agweb.com/blog/Farmland_Forecast_148/				

Figure 11 Chart comparing production expenses and income per hectare for corn, wine grapes and marijuana.

Depending on the age and type of the vineyard to which the biochar is applied and the per-year amortized expenses that must be deducted for establishing the vineyard, farm managers may or may not be able to afford to purchase and use biochar at current prices. Other factors, such

⁴ According to a report comparing national averages for U.S. corn production costs vs income per acre (<http://www.iowarfa.org/documents/HistoricalCornProdCost.v.Price.REVISED.pdf>), farmers only made a profit 9 years out of 30—from 1981 to 2011. Average prices paid per-bushel have also dropped significantly this year, down \$1.50 from 2011 and \$2.93 from its peak of \$7.63 in August 2012 (http://ycharts.com/indicators/corn_price).

as biochar's ability to increase soil moisture content (which may be used as a climate change adaptation strategy) and the studies showing improvement in some characteristics of wine grape vines⁵, may also act as motivators to help justify the expense. Should carbon credits become available for sequestering carbon in soil this may also alter the cost/benefit ratio somewhat for grape growers and other farmers, but it is unlikely this income would be a significant economic driver in the early years of the program sufficient to offset biochar's high cost.



Figure 12 B.R. Cohn Vineyard in Spring

Use of biochar in the cultivation of medical marijuana is a different story entirely. Here price and yield comparisons of the return on investment show why these farmers are currently the largest single market segment now purchasing biochar products in the 3-county survey area, and will likely continue to be over the near- and medium-term. The revenues generated are so great compared to any other crop they can afford to use biochar to increase their yields. Though it is likely that legalization of recreational marijuana use and cultivation in California—if it occurs— will significantly reduce the per-pound wholesale price for this product (perhaps by as much as half off of the \$1,000 figure used in Figure 11), its revenue potential in relation to production costs should still remain much greater than for most and perhaps all other crops. In addition, if biochar increases marijuana plant production, as it has in some research studies with other types of plants⁶, even a 5% yield increase would result in significant additional income.

⁵ Niggli, Claudio, Schmidt, Hans-Peter. Biochar in European Viticulture: Results of the Season 2011. *Ithaka Journal*. <http://www.ithaka-journal.net/pflanzenkohle-im-europaischen-weinbau-ergebnisse-2011?lang=en>.

⁶ Citizen Science Project. 2012. Sonoma Biochar Initiative. (www.sonomabiocharinitiative/citscience).

Existing National Markets for Biochar

To understand who is purchasing biochar in other parts of the US, we researched three important companies in the industry: *The Biochar Company* (TBC) of Berwyn, Pennsylvania, *Biochar Supreme* of Everson, Washington, and *Biochar Solutions* of Carbondale, Colorado (now part of *The Biochar Company*).

A recent *Inc. Magazine* article⁷ profiled ***The Biochar Company***—one of the few biochar companies positioning itself as a national brand. TBC sells several biochar products from their web site under the Soil Reef brand name. They also sell bulk biochar regionally and have merged or are collaborating with regional companies such as *Biochar Solutions* in Colorado (manufacturers of the Biochar 1000 unit that will be used in the Usal Forest) and *Hawaii Biochar*. TBC has also contracted with various companies in the southern and western United States to provide large quantities of biochar made as a byproduct of biomass power plants.



Figure 13 Bagged biochar available from *The Biochar Company*

According to the article, TBC's customer breakdown is roughly this:

- 35% are landscapers;
- 30% are industrial users working on remediation and reclamation sites such as mines, roadside construction & restoration, etc. (Note: The actual customer here varies; it could be a contractor who has won a government contract, a local department of transportation, an environmental consultancy, a mining company, or a gas company.);
- 20% of sales are to consumers with gardens or small farms.

⁷ Mochari, Ilan. "When Two Small Startups Tackle an Industry Together". *Inc. Magazine Online* 15 January 2014. <http://www.inc.com/ilan-mochari/reinvention-biochar-merger.html>.

- 10-15 percent goes to "blenders" and other organizations (including businesses) that in some way or another use or add value to the product.

Our research found no Soil Reef products being sold in the 3-county survey area. From their web site they offer their two products at the following prices: \$49.95 per cubic foot bag for their Pure Biochar (\$1349 per cubic yard equivalent) including shipping, and \$47.95 per cubic foot bag for their Gardener's Blend, which contains 50% biochar by volume, (\$2589 per cubic yard equivalent) including shipping. A request for a quote for bulk biochar sales went unanswered.

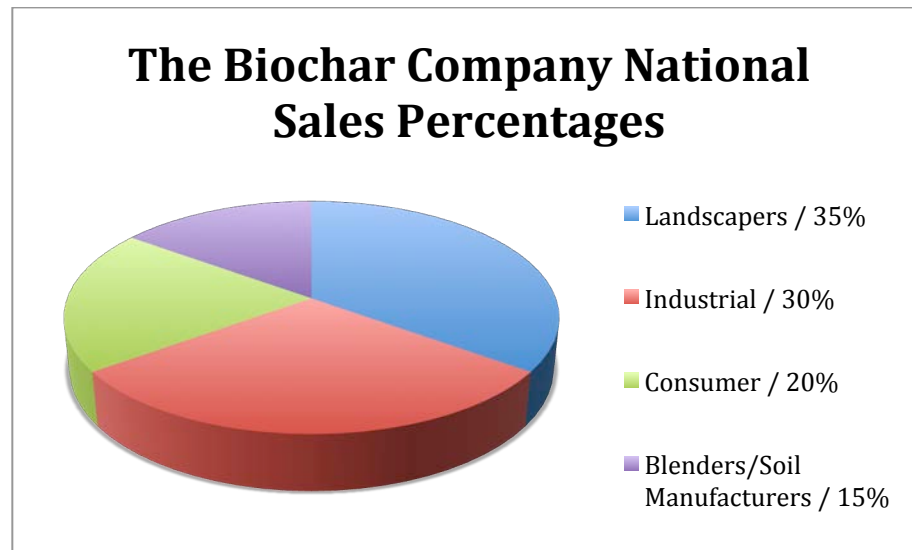


Figure 14 *The Biochar Company's Customer Breakdown*

Biochar Supreme co-founder, Renel Anderson, reports that they produce and sell both retail and wholesale quantities of high-quality biochar (we were not able to obtain specific production or sales estimates). Their brand, Black Owl Biochar, is made on their flower farm using a proprietary hybrid pyrolysis/gasification process. Biochar products with different characteristics are made for the specific markets that this company is targeting: primarily agriculture and environmental services.⁸ They have done extensive testing of these biochar products with several large environmental services firms as well as universities. Figure 15 shows 3 of their 8 different products, which are available in both bagged and bulk form. They sell their products throughout the western US, and recently obtained a distributor in Humboldt County, *Humboldt Ag Supply*.

⁸ Environmental services is one of the emerging markets we see as important to helping biochar scale up production and use in the short- and medium-term. We discuss this in more detail in the Emerging Markets section.



Figure 15 Three Black Owl Biochar Products

Pricing for *Black Owl Biochar* products is as follows:

By the bag:

1.25 quart bags:	\$13 (646 1.25 quart bags per cubic yard—\$8398 per cubic yard equivalent) Plus shipping	
1 cubic Foot bags:	\$39 (\$1053 per cubic yard equivalent) shipping	Plus

By the Yard from *Humboldt Ag Supply*

1 cubic yard:	\$420 cubic yard plus \$35/cu. yd. shipping—\$455 cubic yard
22 cubic yards (1/2 truckload)	\$370 yard plus \$35/cu. yd. shipping—\$405 cubic yard
44 cubic yards (1 truckload)	\$300 yard plus \$35 cu. yd. shipping—\$335 cubic yard

While our research did not identify any *Biochar Supreme* products being sold in local stores in Humboldt or Mendocino counties, this company could become a competitor should they choose to aggressively market to the area’s marijuana growing community. *Biochar Supreme* has the capability to make very large quantities of biochar (500 yards is a typical order for an environmental services firm according to Renel Anderson), so they could compete with RFFI’s product—though RFFI’s local biochar does not require long-distance shipping.

Biochar Solutions, the company that is providing the technology for the Mendocino Biochar Demonstration Project, has been selling bulk biochar to a variety of customers since 2009. Figure 16, taken from a PowerPoint presentation entitled “Biochar 2009-Present—Business Perspective” given by one of *Biochar Solutions’* founders, Jonah Levine, shows the significant growth rate of this firm’s biochar sales over this period as well as how much his company sold from 2009 to 2013, and to which market segments.

Material Sales By Year

BIOCHAR MATERIAL SALES -- All figures are estimates and only from J. Levine sales						
Time	Annual Transactions	Buying Group Type by %				
Calendar Year	Mass (tons)	Government	University	Non-Profit	For Profit	Comment
2008	NA	NA	NA	NA	NA	No Data
2009	5	40	40	10	10	
2010	40	32.5	32.5	10	25	
2011	135	25	25	10	40	
2012	405	22.5	22.5	5	50	
2013	1215	30	10	5	55	Projected

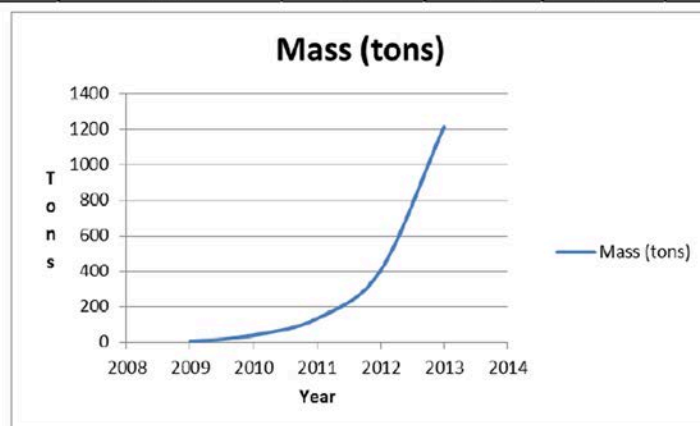


Figure 16 *Biochar Solutions'* sales growth from 2009 to 2013

It is particularly significant to note that all of the growth in sales percentages over the 5- year period occurred in the for-profit market sector, indicating that while there is still research being conducted there is a strong shift in sales from research towards the commercialization of biochar.

In a quote obtained from *Biochar Solutions* for the sale of 4 yards of biochar delivered by truck to Ukiah, California, the price was \$250 per yard, and the shipping was \$675, for a total of \$1675, or \$418.75 per yard. This shipping expense well-illustrates the competitive difficulty in shipping biochar over long distances.

II SECONDARY AND EMERGING BIOCHAR MARKETS

Biochar is generally described as a form of charcoal specifically produced for use in agriculture. Though biochar shows promise when used for other purposes, such as a replacement material for activated carbon in certain water and air filtration applications, as a building material, and as an adsorptive material for various environmental services applications such as toxic chemical or heavy metals cleanup, by definition when it used for these alternate purposes some believe biochar should be called by another name, such as restorative carbon or building carbon.

Increasingly, there is an understanding in the biochar industry and its existing customers that biochar products are not all made the same -- that major differences exist between biochar produced using specific processes, at specific temperatures, at specific process residence times, and using different feedstocks. Clearly, much work needs to be done to discover the best uses for specific products and to articulate those specific uses to potential customers of different kinds. Some companies are working to produce “designer” biochar products that target specific markets, as was highlighted in Section I. The more producers understand how to alter their production processes and feedstock choices to suit certain market needs, and can tailor their blends to provide specific benefits in specific soils with specific plant types, the more biochar will be successfully commercialized.

Some people in the industry, however, strongly believe that the highest and best use for biochar is simply to build healthier agricultural soils, and that using it for one of the purposes listed above is a less important use of its unique properties. While this may arguably be true, as discussed previously the current small market for agricultural use of biochar is limited primarily to specific high-value crops, backyard gardeners, community gardens, and enlightened (and wealthy) small farmers looking to experiment with biochar, or to turn a waste product (like walnut shells) into a profit center rather than an expense. So producers will likely need to find other outlets for their products in the short- and medium-term to pay their bills, achieve required ROIs, and help the industry develop.

Of all the secondary or emerging markets for biochar, we believe that the following three are very promising and worth pursuing over the next 5 years:

- environmental services
- animal agricultural operations
- forest restoration

Though the biochar produced by the Biochar Demonstration Project will likely be absorbed easily by the marijuana farming community alone in Mendocino and Humboldt counties, it would be worth RFFI pursuing one or more of these additional markets to help restore more local environments, improve soil health in marginal areas, create more local jobs, and to reduce financial risk through diversification of sales channels as well as to pave the way for more biochar to be produced and marketed locally. This strategy supports the triple bottom line ethic so well entrenched in RFFI’s mission.

1. **Environmental Services:** The use of biochar for reclamation and restoration (particularly on former mine sites, military bases and landfills).

During a presentation at the U.S. Biochar Symposium in Amherst, Massachusetts in October 2013, Jonah Levine of *Biochar Solutions* showed preliminary results of the Hope Mine reclamation study he worked on during 2010 and 2011. The before and after photos in Figure 17 record a section of hillside near the mine, located outside of Aspen, Colorado, that was treated with an inoculated biochar blend. Though the hillside had resisted previous restorative efforts, the biochar treatment showed impressive results after just one year.



Figure 17 Colorado Hope Mine Restoration Project

Another company, *PermaMatrix*, an Oregon firm specializing in environmental restoration work using proprietary biochar blends, has also reported excellent results with their products. Several case studies are available here: <http://www.permamatrix.com/case-studies/>. Biochar is currently under study as a less-costly substitute for activated carbon by municipal governments, universities, and environmental engineering firms that use it for a variety of uses, according to Renel Anderson of *Biochar Supreme*. Activated carbon is used for remediation of organic toxins, sediments, and heavy metals, as well as myriad industrial uses such as flue-gas mercury removal, air filtration in some water treatment facilities, and potable water treatment. As previously mentioned, *Biochar Supreme* has done extensive research to develop biochar products that meet the specific needs of organizations working on watershed restoration, stormwater runoff and other environmental cleanup projects.

According to their web site⁹, their *Black Owl Biochar Environmental Ultra* product can address the following issues:

- remediate sediments and wetlands
- remove 99.5% of most problem heavy metals
- filter stormwater
- remove DOD, TSS, toxins
- immobilize biopathogens such as E.coli/Salmonella

While the research needed for RFFI to develop and offer such a product could be costly and time consuming and beyond the scope of the USDA grant project, RFFI may find a partner willing to foot the bill if a locally available, high-quality (and cheaper) replacement product for activated carbon was found to meet their needs.

Environmental engineering firms that could be approached about establishing such a partnership include:

CH2M Hill, (888) 242-6445

Trinity Consultants, (800) 229-6655

Anderson Environmental, (888) 705-6300

- 2. Animal Agriculture Operations:** An intriguing article entitled “55 Uses for Biochar” written by well-known European biochar researcher and businessman Hans-Peter Schmidt appeared in his excellent blog, *The Ithaka Journal*.¹⁰ Schmidt advocates a multi-faceted, continuous “cascading use of biochar.” He makes a strong case that biochar is too valuable to simply put in the ground without first gaining many additional benefits from its unique properties. He lists dozens of possible such uses. One of the most compelling and complimentary uses involves synergistic application of biochar in animal agriculture, where it can be used sequentially as a silage agent, feed additive/supplement, litter additive, slurry treatment, manure composting component, and as a water treatment and filtration medium in fish farming and aquaculture. Here is a quote from the article:

“At present some 90% of the biochar used in Europe goes into animal farming. Different to its application to fields, a farmer will notice its effects within a few days. Whether used in feeding, litter or in slurry treatment, a farmer will quickly notice less smell. Used as a feed supplement, the incidence of diarrhea rapidly decreases, feed intake is improved, allergies disappear, and the animals become calmer. For in-depth articles on the use of biochar in cattle and poultry farming, see: [Treating liquid manure with biochar](#), [Biochar in poultry](#)

⁹ *Biochar Supreme*. Environmental Solutions: Environmental Ultra. 20 May 2014. (<http://www.biocharsupreme.com/collections/biochar-remediation-products/products/bob-s-environmental-ultra>).

¹⁰ Schmidt, Hans-Peter. “55 Uses for Biochar”. *Ithaka Journal for ecology, winegrowing, and climate farming*. <http://www.ithaka-journal.net/55-anwendungen-von-pflanzenkohle?lang=en>.

[farming, The use of biochar in cattle farming.](#) Over 80 farmers in Germany, Austria and Switzerland are currently (as of January 2013) being surveyed with the aim of creating a statistic on the effects of biochar in the cowshed.”

Since biochar needs to be inoculated (or charged) with nutrients prior to its use in land agriculture, feeding it to cattle or chickens first provides a natural, highly efficient and cost-effective method of doing so. Once excreted by the animals, the “charged” biochar can be composted and, when properly aged, added to fields. Research is ongoing regarding the efficacy of adding biochar at the beginning of the composting process rather than blending it with compost and other nutrients once the compost has matured, but given biochar’s adsorptive characteristics this may turn out to be a best practice within the industry.

Magruder Ranch, a large, well-known, sustainably-raised beef operation located in Potter Valley, CA (Mendocino County) has used biochar as an optional feed supplement for its cattle and swine operations for several years. As a previous purchaser of biochar they may be a potential future customer for RFFI’s product. *Mendocino Organics* and *Anderson Valley Farm* are other businesses that may be interested in studying biochar as a feed supplement. In Humboldt County, *Humboldt Grassfed Beef*, *Anderson Ranch*, *Range Brothers*, and *Lost Coast Grassfed Beef* are animal operations particularly interested in treating their animals ethically and sustainably, making them potentially interested in biochar as an optional supplement.



Figure 18 Pigs foraging at Magruder Ranch

3. Forest Restoration: Studies have shown that some pre-charged biochar products can greatly increase germination and agronomic production rates in certain plants¹¹. The use of biochar in forest restoration projects could increase both the success rate and growth curves of such tree planting efforts. While results have not been universally positive depending on factors such as the application rate, feedstocks, process used to make the biochar, and the plants studied, RFFI may be particularly interested in using some of the biochar it produces for such further field studies in the Usal Forest. A secondary study could be undertaken in partnership with one or more local tree nurseries (many operate in Mendocino and Humboldt counties) and students from Mendocino Community College (MCC) or Humboldt State University, using pot trials to determine the efficacy of using biochar to germinate and treat tree seedling plantings.

A conversation with Orion Walker, a MCC instructor and administrator, confirmed likely interest in such a study. (His contact information is listed in the Appendix.) If results prove to be positive, such a study would likely create demand for biochar by the local commercial nursery community, thereby expanding the market and leading to recommendations from nursery staff to the public.

Figure 19, from the cited study, illustrates biochar's positive effects on both germination and plant productivity.

Germination and plant-survival increased significantly in the cases of wood biochar and sewage-sludge biochars (samples a and c respectively). However, grapevine wood biochar resulted in similar germination rates than un-amended pots.

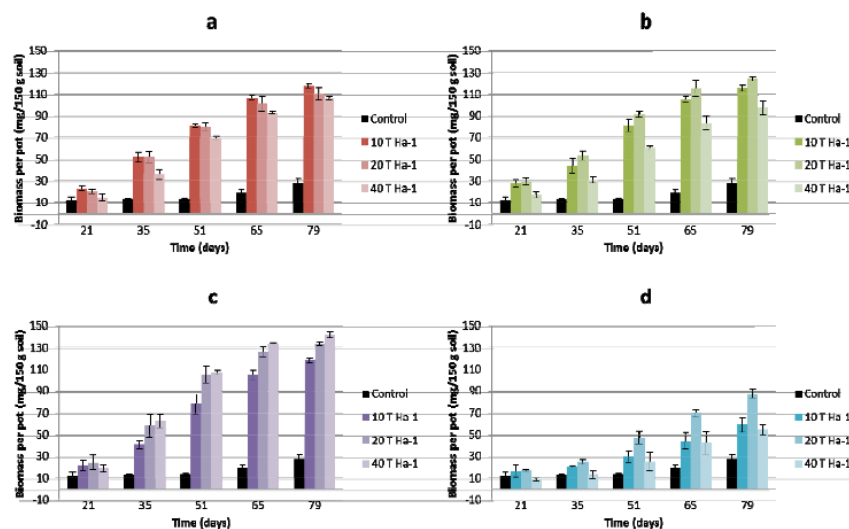


Figure 1. Cumulative agronomic productivity. (a) wood biochar, (b) paper-sludge-bran biochar, (c) sewage-sludge biochar, (d) grapevine wood biochar.

Figure 19 Assessment of effects in the germination and agronomic production of four contrasting biochars

¹¹ Carmona Paneque, Jose M. de la Rosa Arranz, & Heike Knicker. "Assessment of effects in the germination and agronomic production of four contrasting biochars. An incubation study." 13 November 2013.

While the potential size of these three secondary and emerging markets is difficult to ascertain, the *Biochar Solutions* sales growth curve and the interview with Renel Anderson of *Biochar Supreme* both reinforce the belief that each market segment could likely absorb all of RFFI's planned annual production volume in the years ahead if it were properly developed.

III DISTRIBUTION CHANNELS

Research indicates that two firms that should be considered as prime customers and/or partners for the biochar produced by the Mendocino Biochar Demonstration Project: *Dirt Cheap Landscape and Garden Supply* in Ft. Bragg and *Willits Soils, Inc.* in Willits. Both companies are interested in negotiating to purchase, market and distribute ALL of the biochar that RFFI produces. It is our recommendation that direct discussions be held with each company owner, who would then be asked to develop and submit a purchase and marketing proposal for RFFI to consider. Depending on RFFI's desire to simply sell all the biochar in bulk (least profitable) or to increase its own revenue stream by partnering on development of a co-branded, blended line of products, each business could also be asked to submit a proposal for that approach as well. RFFI could structure this co-branding as a simple commission on each bag sold, accompanied by information on each bag devoted to spreading RFFI's mission. Conversely, a deal could be more of a partnership, requiring shared expenses as well as a bigger share of the ongoing profits from these sales.

Both companies are roughly 50 miles from the proposed landing and production site in the Usal Forest and each location would take about 1 to 1.25 hours to reach from portal to portal. Both companies have bagging capabilities, and both have existing customer bases and distribution networks that could be accessed. The owners of both firms were interviewed for this report, and outlined below are the potential advantages and disadvantages of using each company as a purchaser/distributor. Additional information about developing strategic alliances with each firm is presented in Section IV of this report.

A third potential distribution partner, Kazimir Wisniewski at *Green Future Soil Products* in Arcata, also has bagging and distribution capabilities. However, this location is almost 100 miles from Leggett, making transportation much more expensive. Since this company may be interested in purchasing biochar in the future (they do not use it currently) their contact information is listed in Appendix A.

A fourth potential partner, *Grab and Grow Soil Products* in Santa Rosa, is also interested in adding biochar products to its offerings. It too has bagging capabilities. It has a large existing distribution network in Sonoma County, San Francisco, and elsewhere in the Bay Area, and several very successful, well-known products including *Mango Mulch*, *Tango Mulch*, and a 420 mix tailored to the marijuana market. Its location is about 132 miles from the landing and production site in the Usal Forest. The Sonoma County Biochar Project (SCBP) has already started negotiations with this company to develop a co-branded product using the excess production from their Adam Retort that is scheduled to start operations in July 2014, but the additional capacity of the Adam Retort is not large and there may be a need for *Grab and Grow* to find additional sources of biochar once a blend is developed and marketed.

Willits Soils, Inc.

John Mayer has owned and operated *Willits Soils, Inc.* (WSI) for about 4 years. He makes his own compost on a 2½-acre property, and he recently purchased a third property (30 acres) that he is developing to significantly expand the composting operation starting in the latter part of 2014. This increased land and capacity will give him plenty of room to store, blend and bag biochar.

Our research showed that, of the firms surveyed for this report, WSI is currently the largest single purchaser (and seller) of biochar. Mayer reports that WSI already has a clientele willing to pay a premium for his products and he sells all of the products that he now produces. He indicated his hope to negotiate an exclusive deal to purchase ALL of the biochar produced by RFFI. WSI currently owns two trucks that would be available to pick up and transport the biochar from the Usal Forest to Willits, and he quoted an hourly price of \$85 per hour for an 8-ton truck, which would need to make a trip once per month to pick up approximately 5.5 tons (20 1-yard supersacks or 10 2-yard supersacks) of biochar with each run. Assuming a total round trip time of 4 hours including loading time, each monthly transportation cost would be \$340/month, resulting in an expense of roughly \$0.06 per pound, or about \$17 per cubic yard. If the larger 24-ton truck were used (\$120 per hour) and fewer trips were made this expense could be cut to about \$15 per yard.

WSI currently does not sell any labeled, bagged products, so they have no experience in this area. However they do have bagging capabilities. Initially most, if not all of the biochar would likely be sold by the yard and picked up by truck by customers from WSI's two locations. *It is important to note that WSI is looking into producing their own biochar with equipment built by John Mayer, though no set date for building a production unit was mentioned.*

Dirt Cheap Landscape and Garden Supply

Dirt Cheap Landscape and Garden Supply (DCL&GS) is over 11 years old. It is the Mendocino coast's only full-service landscape supply firm. DCL&GS has 12 full-time employees and a fleet of bio-diesel vehicles that deliver "millions of pounds" of products to its customers each year. According to owner Scott Zerambi, a well-known and highly respected agricultural consultant and lecturer, DCL&GS sells over 40,000 bags of potting soil annually from its Ft. Bragg store alone. He anticipates that RFFI could easily sell 100,000 bags of a blended biochar product within Mendocino County on an annual basis—if the product were positioned in the market correctly. DCL&GS currently bags products for Cold Creek Compost in Potter Valley as well as for other soil companies. Though DCL&GS has sold some biochar products in the past, they currently do not, so they would have to develop the market. In a recent conversation Zerambi stated that he has spoken to several distributors interested in carrying or purchasing RFFI's biochar and he feels confident that he could move the material and make a profit. Zerambi also expressed an interest in an exclusive deal to purchase ALL of RFFI's production capacity.

Zerambi is very experienced in navigating the labeling protocols required by the California Department of Food and Agriculture (CDFA), having gone through the process both for his own products and those of others. He notes that it usually takes 3 to 6 months to comply with this regulatory process. If RFFI is interested in pursuing this option it should start soon on this process. If RFFI decides to develop a bagged, value-added product line it is recommended that Zerambi be hired as a consultant for the labeling process whether or not he is chosen as a development partner for an RFFI-branded product, as his expertise could save RFFI both time and money. Labels are critical for marketing purposes and the CDFA is rigorous in requiring firms to justify and prove any claims made on their labels. Zerambi charges \$225 per hour for

consulting and a quote can be obtained from him should RFFI decide to proceed with a bagged product.

Zeramby quoted an estimated price of \$2.75 to \$3.00 per mile for biochar transportation costs to and from the Usal Forest; he is prepared to recommend several local companies for this service. Given the 100 mile round trip, this would come to \$275 to \$300 per run, or from \$13.75 to \$15 per yard to transport the biochar to his blending facility.

Outside Distribution

Additional distribution channels are available, including through west coast garden supply distributors such as *L & L Nursery Supply* and *Excel Garden Products, Inc.*

Excel Garden Products Inc.

Central Garden & Pet Company, Lilly Miller Brands
15750 N Lombard Street # 200
Portland, OR 97203
Phone: (503) 205-3272
www.central.com

L&L Nursery Supply Inc.

Delivery Area: CA, NM, AZ, NV, UT, OR, WA
5350 G St., Chino, CA 91710-6215
909-591-0461
cstsvc@llynurseriesupply.com
www.llynurseriesupply.com

Both of these companies would require RFFI to submit a written proposal for approval, provide coop marketing money to retailers, attend expensive garden shows, and make available a large amount of material for distribution. They also would charge a significant fee for handling the biochar distribution. Ron Shoof, a consultant to companies wanting to enter or improve their marketing efforts and sales in the retail lawn and garden business, said in an interview that a rough margin breakdown for sales in the retail garden sector is:

Distributor's Share:	25% of the retail price.
Retailer's share:	30% to 40% of the retail price.
Other incidentals:	5% of the retail price
Manufacturer's share:	30% to 40% of the retail price

Given all these factors, coupled with the fact that two local businesses with existing relevant distribution channels have already expressed a strong interest in working with RFFI, we would not recommend working with an outside distributor until production volume, and consumer demand, increases substantially. We did, however, obtain a quote for the consulting services of Ron Schoof—a longtime advisor to companies looking to enter the retail market, and who has expressed an interest in working with RFFI to market their biochar to a wider audience—and we recommend that he be contacted and consulted should RFFI choose to increase the volume

of material it produces in the future. This quote will be submitted along with this report as a separate document.

Two trucking companies were recommended as potential carriers in the 3-county survey area:

Steve Wills Trucking 1576 State Highway 36, Fortuna, CA 95540 (707) 768-3781

Shusters Trucking 750 E Valley St, Willits, CA 95490 (707) 459-4131

IV RECOMMENDED MARKETING STRATEGIES

Outlined below are short-term and long-term strategies for selling and distributing the biochar produced in the Usal Forest. The short-term strategies will generate an early return and a significant source of cash flow for the Biochar Demonstration project, some of which could in turn provide funding for the longer-term strategy if desired.

First and foremost, the strategic advantage and power of the Biochar Demonstration Project's story itself is compelling from a marketing standpoint. This story should be documented and then highlighted front and center in all of RFFI's marketing efforts in print, web, radio, video, and personal communications. These are the main components of the story:

- A well-known, local non-profit, whose mission is to manage and maintain forest resources sustainably, has found a way to utilize biomass that needs to be thinned out of the forest in a better way by producing biochar.



- Biochar, a highly valuable and beneficial material, can be used in many ways, including as an agricultural soil conditioner to build healthier soils, improve seed germination and plant production, and retain water and moisture. There are potentially many other uses for it as well that could help invigorate the local economy.
- Success in this project could provide a replicable model that could help other organizations pay for their forest restoration and management activities.
- Producing biochar and its placement in the ground prevents about 50% of the CO₂ that would normally be released into the atmosphere as a plant decays, helping to address climate change—one North Coast farm and garden at a time.
- Using biochar empowers people to be proactive about climate change, and can open up conversations about sustainable agriculture, better use of “waste” resources, and the important work that RFFI is doing.

Short-term Strategy 1: Sell To One Buyer

In the short-term, the easiest way for RFFI to sell its biochar would be to negotiate a sales contract with John Mayer, owner of *Willits Soils, Inc.* or Scott Zerambi of *Dirt Cheap Landscape and Garden Supply* (DCL&GS) in Ft. Bragg. Both have expressed a strong interest in purchasing

all of the biochar that RFFI can produce—an amount estimated to be about 66 tons¹² annually, or approximately 480 yards.¹³ Our research found that *Willits Soils, Inc.* is the largest single purchaser of biochar in the 3-county survey area (approximately 50 tons in the last year); thus their annual use of the material is about the same as RFFI's projected output. If RFFI can negotiate a selling price of \$1-per-pound (\$275 per yard)—a figure that John Mayer said was in the acceptable range—the contract would generate annual revenue of \$132,000.

Advantages to this strategy:

1. Just one contract has to be negotiated, and one business entity dealt with, for the USDA study.
2. A potential income of \$132,000 is possible.
3. WSI and DCL&GS are both relatively local—each is approximately 50 miles from the production site in the Usal Forest. This proximity will reduce transportation costs and the GHG footprint of getting the RFFI biochar to market.
4. WSI has two trucks available to pick up and transport the biochar: an 8-ton truck renting for \$85 per hour and a 24-ton truck renting for \$120 per hour. Given the expected production capacity, the 8-ton truck could make one four-hour round-trip run once per month, picking up approximately 5.5 tons of biochar at a cost of \$340. As the purchaser, WSI may be willing to cover some or all of this cost since they are used to paying for shipments from their current biochar vendors. DCL&GS has relationships with freight companies that would charge approximately \$300 for the round trip to and from the Usal Forest.
5. RFFI would not have to deal with developing the market for biochar, other than promoting it on their website, in their newsletter, and in other public forums.
6. Both Zerambi and Mayer have strong ties to the customers most likely to purchase biochar.

Disadvantages/risks to this strategy:

1. Our research has shown that much more income could be generated from sales of a blended, value-added product than from selling biochar alone—especially in bulk quantities. An addendum to this report—an analysis of the costs associated with developing a blending and bagging operation—will give RFFI a comparative analysis of this income differential. This analysis is a second contracted deliverable that will be available a few weeks after this report is submitted.
2. If an exclusive deal is signed, diffusion of biochar into agricultural and gardening communities could be limited to the distribution network and clientele already served by each company. RFFI may want to consider splitting sales and

¹² 2 yards per day, 10 yards per week, 480 yards per year X 275 pounds per yard = 132,000 pounds / 2000 = 66 tons. Using a production schedule of 48 instead of 52 weeks allows for weather and feedstock delays and/or unit down time. If there is excess production we recommend using it for samples, field trials at 3 to 5 farms in cooperation with Humboldt State University, and for a possible Citizen Science project.

¹³ There may be other companies that come forward to bid for the contract for the RFFI biochar, such as The Biochar Company. But since WSI and DCL&GS are local they may be given preference over an out-of-state company.

distribution between the WSI and DCL&GS. As previously stated, production and use of biochar can act as an important catalyst for teaching and promoting sustainable, non-chemical agriculture. While this is certainly an important ethic for the marijuana-growing community to adopt, the Biochar Demonstration Project could serve to educate a greater number of people in the general community about biochar's benefits if more vendors carried its product(s). Note, however, that at the prices listed above the only market segment that could afford to purchase this biochar could be marijuana growers and possibly grape growers.

3. It is possible new entries into the market in the 3-county area could undercut pricing, decreasing projected income.

Short-term Strategy 2: Sell some of the biochar at wholesale prices and partner with *Willits Soils, Inc.* (or another company such as *Dirt Cheap Landscape and Garden Supply* of Ft. Bragg) to sell a co-branded, blended product.

This strategy would provide a portion of the biochar produced -- perhaps 50% of the total yearly volume, or 240 yards -- to WSI (and/or to DCL&GS) at the wholesale price of \$275 per yard. This step would be —worth an estimated \$66,000/year. The other half of RFFI's biochar would be blended with soil, compost and other nutrients and sold as a premium, co-branded product that would be distributed more widely throughout the community, but marketed primarily to marijuana growers. This option could require more investment in areas such as product development, bagging, sales, and distribution, depending on how an agreement was structured. But the increased selling price of blended products containing biochar in bags or tubs, which our research showed could be as high as \$5655 per cubic yard¹⁴, coupled with the advantages of helping to build increased local market awareness for the RFFI/WSI brand, could be significant, making it well worth the investment. Figure 20 shows how significant this income differential could be.

¹⁴ See Figure 8

WHOLESALE PURE BIOCHAR IN BULK	
50% Total production of unit per year	240 yards
Sold at the wholesale rate of \$1 per lb, or \$275 per yard	\$66,000

WHOLESALE PURE BIOCHAR BY THE CUBIC FOOT	
50% total production of unit per year	240 yards
Number of 1 cubic foot bags in 240 yards	6,480
Number of 1 cubic foot bags multiplied by a wholesale price of \$15	\$97,200

WHOLESALE BIOCHAR BLEND	
50% Total production of unit per year	240 yards
Number of 5-gallon Containers per yard	40.5
Total number of 5-gallon containers (@ 50% biochar by volume)	19,440
Number of containers multiplied by a wholesale price of \$35. Would retail for \$70 - \$100	\$680,400

Figure 20 Sample income potential of biochar sold by the cubic yard, in cubic foot bags, and as a blended product with soil, compost and other amendments.

The total potential income from selling 50% of the biochar in bulk and 50% as a blend in 5-gallon containers could be as high as \$746,000, as opposed to \$132,000 from selling bulk biochar alone. While it may or may not make economic sense to sell 1 or 1.5 cubic foot bags of pure biochar because the expense of bagging, labeling, sales, and distribution may outweigh the additional income potential, given the significant income potential of selling biochar blends—at least in the current market environment which is very likely to continue through the end of the grant period—it is our recommendation that this option be seriously considered.

Advantages to this strategy:

1. Vastly increased revenue generated per yard of biochar would accrue to RFFI. While a complete analysis of expenses related to a biochar blending operation has not yet been done, it appears likely that the revenues generated would far exceed these costs.
2. Partnering with an established blending and bagging operation:
 - Reduces capital expenditures and other startup expenses
 - Provides access to an existing distribution network
 - Reduces RFFI staff time
 - Supports one or more local businesses
 - Shares the risk of the venture

Disadvantages/risks to this strategy:

1. Increased staff time, or that of a contracted project manager, would likely be required for RFFI's share of the marketing, promotion, and outreach for the product.
2. If the blended product produced were only available for the life of the Biochar Demonstration Project, and a long-term view for developing the market for biochar is not adopted, vendors may be less willing to carry these biochar products in the short-term and into the future.
3. Some upfront funding (shared with blender) would likely be required for buckets or bags, labels, labor, and legal/accounting setup. It is possible this could be covered through a prepayment on the contract for bulk sales.
4. Increased business risk. Any time working relationships are entered into there is always an increased financial and related risk to both parties.
5. Given the current of the industry, it is possible new players could enter the market and undercut sales.

Long-term Strategy

Depending on RFFI's long-term goals for the Biochar Demonstration Project, and its plans for continued support and operation of the biochar production unit past the life of the USDA grant, this strategy may or may not be a consideration. Coupled with Strategy 1 or 2 above, this approach would add significantly greater educational outreach components and spend additional resources growing the awareness and advantages in using biochar in the community. Ideas for increasing education about the ability of biochar to build healthier soils, to increase plant production and soil water retention capability in the face of climate change thereby increasing local food security, and expanding its use in emerging markets, could include the following:

- Building a web site for the ongoing activities and results for the Biochar Demonstration Project. This web site would be focused on biochar's benefits but could also include a shopping cart feature allowing viewers to purchase biochar and/or biochar blends directly over the internet.
- Creating a 2- to 5-minute video telling a compelling story about the project, educating web site visitors about the numerous benefits of biochar, and generating interest from the public in purchasing RFFI-branded biochar products. Whether RFFI chooses to sell some or all of the biochar produced as a bulk product or to partner on a blended product, making a video would be a useful tool in promoting the project and generating sales. (A quote for this service from a video production company, Green Gorilla Media, is attached as a separate document.)
- Building a social media presence for biochar with blog posts, photos, and videos of the project as well as links from around the web. This would include setting up a Facebook page, Twitter account, YouTube account, Instagram account, etc., all designed to promote biochar.
- Placing advertisements for RFFI's biochar products/or articles on biochar in Farm Bureau publications, the Farms Reach web site, and local grange newsletters.

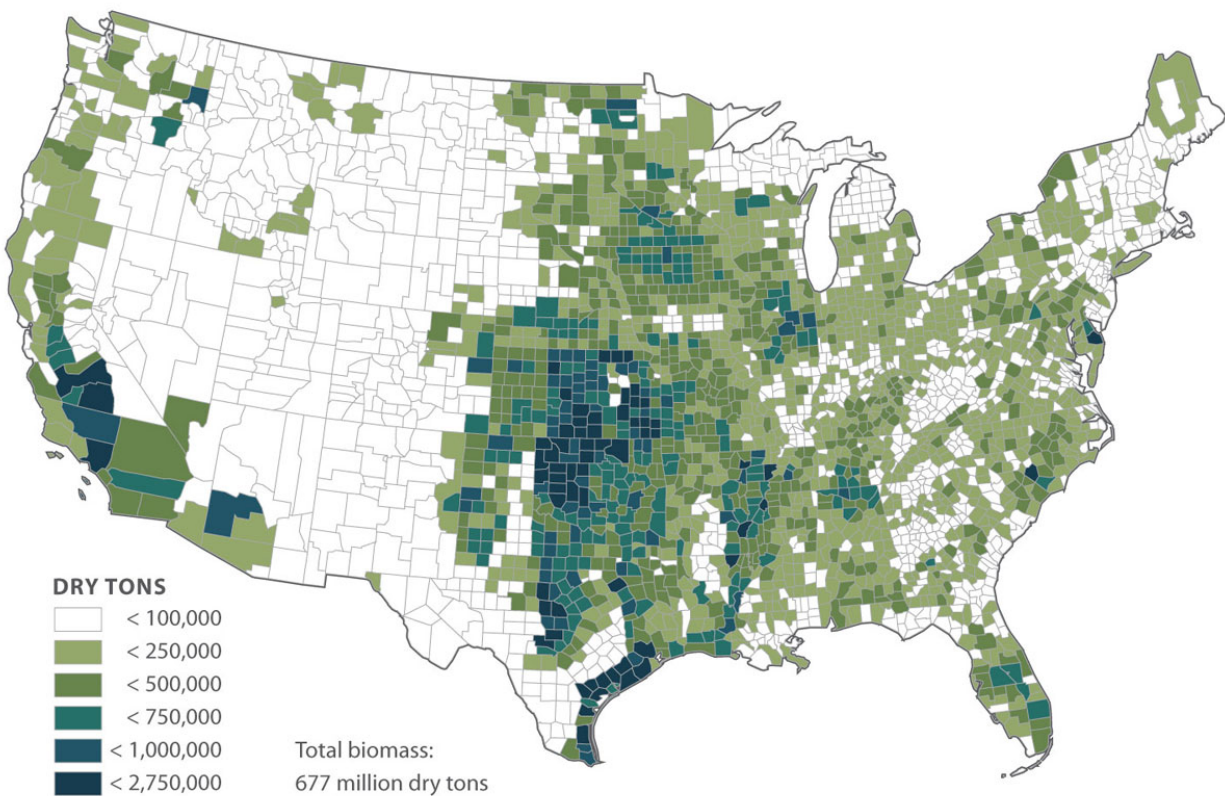
- Attending Vendor or Customer Appreciation Day's at local nurseries and garden supply businesses when and where allowed. Several contacts made during this research invited RFFI to give talks or have a booth at such events. (These included the Beneficial Living Center in Arcata, Harmony Farm Supply in Sebastopol, and Northcoast Horticultural Supply in McKinleyville.)
- Developing a Citizen Science Project patterned after the Big Biochar Experiment in England (<http://www.bigbiocharexperiment.co.uk/>) and the project developed by the Sonoma Biochar Initiative (<http://sonomabiocharinitiative.org/citscience/>). These projects, which distributed bags of biochar or biochar blended with compost for free to backyard gardeners, school gardens, and community gardens in exchange for providing plant growth data, challenged and educated the public in unique ways regarding the use of biochar.
- Developing field trials, in conjunction with local universities, at high-profile CSAs or commercial growing operations. Given the importance marijuana farmers both to the local economies of Mendocino and Humboldt counties, as well as their importance as purchasers of biochar, field trials should be arranged with legal, medical marijuana growers where possible.

The Ethical and Sustainable Development of the Biochar Industry

The Sonoma Biochar Initiative, as well as many other individuals and organizations in the biochar community, promote the ethical and sustainable production and use of biochar. This includes, but is not limited to, the following ideas:

1. Biochar should be made from available woody waste materials only—it is unnecessary and unsustainable to use cropland suitable for food production to produce feedstock for biochar. According to the Union of Concerned Scientists¹⁵:
2. Biomass resources totaling just under 680 million dry tons could be made available, in a sustainable manner, each year within the United States by 2030.
3. This amount of biomass is enough to produce more than 54 billion gallons of ethanol (4 times as much corn ethanol as the United States produced in 2010) or 732 billion kilowatt-hours of electricity (19 percent of total U.S. power consumption in 2010).
4. Biomass resources are distributed widely across the United States, ensuring that communities across America can benefit both financially and environmentally from increased biomass production.

¹⁵ Union of Concerned Scientists. Clean Vehicles. "Biomass Resources in the US". 2012. http://www.ucsusa.org/clean_vehicles/smart-transportation-solutions/cleaner_fuels/ethanol-and-other-biofuels/biomass-energy-resources.html.



Total potential biomass availability across the continental United States

Though biomass production is generally widespread, it is most concentrated in the southern plains, California, the Corn Belt, and along the Mississippi River. Counties that are not shaded may have biomass available, but in comparatively small amounts.

© Union of Concerned Scientists 2012; www.ucsusa.org/biomassresources

Figure 21 Total potential biomass availability across the continental U.S.

Biochar operations incorporating renewable energy production as a part of the business model would likely be better able to compete for feedstocks with existing or future biomass energy plants, and a second revenue stream would be available as well.

Because biomass feedstocks are available in many parts of the US, as shown in Figure 21, the biochar industry could be developed as a model similar to the development of a highly distributed power grid.

There are several important reasons why there is a push for development of a distributed energy grid in the US, and why many in the biochar community would like to see biochar production and distribution developed on a regional carbon-shed, or biomass-shed model.

Like biomass, electrical energy is expensive and inefficient to move over long distances—according to the US Energy Information Administration an estimated 6% of electricity is lost each year due to transmission losses.¹⁶ Transmission lines are expensive to maintain, and large

¹⁶ US Energy Information Administration. Frequently Asked Questions. “How much electricity is lost in transmission and distribution in the United States?”. 7 May 2014.

<http://www.eia.gov/tools/faqs/faq.cfm?id=105&t=3>

centralized power plants and the large populations they support are much more vulnerable to cyber attacks than smaller, renewable power sources such as community-based biomass generation, wind energy or rooftop solar. Similarly, smaller community or regional-sized biochar production facilities and distribution networks would reduce transportation costs and therefore the carbon footprint of bringing the products to market.

Figure 21 shows the distribution of biomass resources around the US, and illustrates how biochar production facilities could be placed around much of the country to serve their own local markets. This distributed model would produce many more local jobs (facility operators, material handlers, sales personnel, truckers) and add to the tax base of more local communities while better utilizing local underutilized biomass resources. Once robust, off-the-shelf technologies are developed that can successfully alternate between energy and biochar production, these communities can benefit from locally produced renewable energy as well.

In conclusion the Biochar Demonstration Project holds great promise for developing a model that can be replicated around the country. While it is fortunate that a market does already exist for biochar in the three-county area we surveyed, the overall market for biochar is expanding rapidly, and with strong guidance from triple-bottom-line focused organizations such as RFFI, the biochar industry can develop in a way that is safe and appropriately-sized, yet scaled to make an impact.



Figure 22 Oak Hill Farm / Sonoma

V Appendix A

Contact information

Companies considered hot leads for purchasing RFFI biochar and/or partnering on product development:

Willits Soils, Inc., John Mayer, owner, 345 N Main Street, Willits, California 95490 (707) 744-8626

Dirt Cheap Landscape and Garden Supply, Scott Zerambi, owner, 17975 N Highway One, Fort Bragg, California 95437 (707) 964-4211

Companies expressing particular interest in purchasing or carrying a RFFI branded product:

Contact Name	Business Name	Address	City	State	Zip	Phone
Gary Portal	Harmony Farm Supply	3244 Hwy. 116 N.	Sebastopol	CA	95448	(707) 823-9125
Brendan	Humboldt Nutrients	6 Fifth Street	Eureka	CA	95501	(888) 420-7770
Chad Waters	Royal Gold Soils		Blue Lake	CA	95525	(707) 822-4653
Kazimir Wisniewski	Green Future Soil Products LLC	4651 West End Rd	Arcata	CA	95521	(707) 825-1225
Nate Fontaine	Northcoast Horticulture Supply	1580 Nursery Rd	McKinleyville	CA	95519	(707) 839-9998
Seth	Beneficial Living Center	148 S G St #1	Arcata	CA	95521	(707) 633-6125
Chris	Spare Time Supply	208 E San Francisco Ave	Willits	CA	95490	(707) 459-6791
Shawn Dawson	Mendocino Garden Shop	44720 Main St.	Mendocino	CA	95460	(707) 937-3459
Buddy	Thrive Hydroponics	30 Mill St	Healdsburg	CA	95448	(707) 433-4068
Cooper	Mendocino Farm Supply	303 Talmage Rd	Ukiah	CA	95482	(707) 462-1492

Other biochar-related companies and individuals contacted or interviewed for this report:

Biochar Supreme: Renal Anderson, (360) 927-9974, renel@biocharsupreme.com
<http://www.biocharsupreme.com/>

PermaMatrix: Robin Cook, (503) 241-7333, info@permamatrix.com
<http://www.permamatrix.com/>

Cold Creek Compost: Martin Mileck, (707) 485-5966, info@coldcreekcompost.com
<http://www.coldcreekcompost.com>

Sonoma Compost: Will Bakx and Alan, (707) 664 9113, will@sonomacompost.com
<http://www.sonomacompost.com/>

T.R. Miles, Technical Consultants, Inc.: Tom Miles, 503-292-0107, tmiles@trmiles.com
<http://www.trmiles.com>

Biochar Solutions: Jonah Levine, jonah@biocharsolutions.com
<http://www.biocharsolutions.com/index.html>

L & C Carbon, LLC: Matt Delaney, (503) 345-9777, info@lccarbon.com
<http://www.lccarbon.com/>

Beneficial Living Center: Seth Geddes, (707) 633-6125
<http://beneficiallivingcenter.com/>

Mendocino Community College: Orion Walker, (707) 228-0986, walker.orion@gmail.com

<http://www.orionwalker.com>

Solar Living Institute: Karen Kallen, (707) 472-2450, karen.kallen@solarliving.org

<http://www.solarliving.org>

Royal Gold Soils: Chad Waters, (707) 822-4653, chadrgc@gmail.com

<http://royalgoldcoco.com/>

New England Biochar, LLC: Peter Hirst, (650) 804-0498, peter@newenglanbiochar.com

<http://www.newenglanbiochar.org>

PermaMatrix: Robin Cook, (503) 241-7333, info@permamatrix.com

<http://www.permamatrix.com>

Full Survey Contact List (see attached Excel document)

Contact Name	Company Name	Address	City	State	Zip	Email	Phone
Diane	The Garden Spout	260 Margie Dr	Willits	CA	95490	diane@gardenspout.com	(707) 456-0196
Phil	Wyatt Irrigation Supply	747 Yolanda Ave.	Santa Rosa	CA	95404	info@wyattsupply.com	(707) 578-3747
Fionula	California Flora Nursery	2990 Somers St	Fulton	CA	95439		(707) 528-8813
Jani	Cottage Gardens of Petaluma	3995 Emerald Drive	Petaluma	CA	95452		(707) 778-8025
Bill	Emerisa Gardens	555 Irwin Ln.	Sant Rosa	CA	95401		(707) 525-9644
Jennifer	Empire Nursery	2227 Gravenstein Hwy S.	Sebastopol	CA	95472	empire1nursery@gmail.com	(707) 823-3108
Gary Portal / Warehouse Manager	Gaddis Nursery, Inc. / Wholesale	3050 Piner Road	Santa Rosa	CA			(707) 542-2202
Robin	Harmony Farm Supply	3244 Hwy. 116 N.	Sebastopol	CA	95448		(707) 823-9125
Leslie	Healdsburg Nursery	12950 Old Redwood Hwy.	Healdsburg	CA	95448		(707) 433-8904
	Friedman's Home Improvement	4055 Santa Rosa Ave.	Santa Rosa	CA	95407		(707) 584-7811
	Hydro Depot	6731 Sebastopol Ave.	Sebastopol	CA	95472		(707) 829-1510
John and Joey	WSF (Willits Soils Inc.)	345 North Main St	Willits	CA	95490	Willitssoilsinc@gmail.com	(707) 744-8626
Christen Thompson	Fox Farm	2200 Bendixsen St.	Samoa	CA	95564		(707) 443-4369
Brendan	Humboldt Nutrients	6 Fifth Street	Eureka	CA	95501		(888) 420-7770
Chad Waters	Royal Gold Soils		Blue Lake	CA	95525		(707) 822-4653
	Wes Green Landscape Materials	6360 West End road	Arcata	CA	95521		(707) 822-8035
Kazimir Wisniewski	Green Future Soil Products LLC.	4651 West End Rd	Arcata	CA	95521		(707) 825-1225
	Bayside Garden Supply	4061 Hwy 101	Arcata	CA	95521		(707) 826-7435
Ces	Sonoma Hydro	3535 Industrial Drive, Suite B3	Santa Rosa	CA	95403		(707) 544-3383
Nate Fontaine	Northcoast Horticulture Supply	1580 Nursery Rd	McKinleyville	CA	95519		(707) 839-9998
Brian and Gavin / Co-owners	Water Planet Garden Supply	76 S G St	Arcata	CA	95521		(707) 822-9888
Roy	A Fertile World	5565 W End Rd	Arcata	CA	95521		(707) 825-0255
Seth	Beneficial Living Center	148 S G St #1	Arcata	CA	95521		(707) 633-6125
Chris	Spare Time Supply	208 E San Francisco Ave	Willits	CA	95490		(707) 459-6791
Shawn Dawson / Owner	Mendocino Garden Shop	44720 Main St.	Mendocino	CA	95460		(707) 937-3459
Jason	Mendocino County Hydrogarden	1240 North Main St. #1A	Ft. Bragg	CA	95437		(707) 962-9252
Jim	Big Daddy Garden Supply	42400 U.S. 101	Laytonville	CA	95454		(707) 984-7181
	Big Daddy Garden Supply	310 Mason St.	Ukiah	CA	95482		(707) 467-9234
Buddy	Thrive Hydroponics	30 Mill St	Healdsburg	CA	95448		(707) 433-4068
Dave	Sonoma Materials Incorporated	21040 Broadway	Sonoma	CA	95476		(707) 938-3243
Marty / Dougherty	Wheeler Zamaroni	3500 Petaluma Hill Rd	Santa Rosa	CA	95404		(707) 543-8400
	United Forest Products	1051 Todd Rd, Santa Rosa	Santa Rosa	CA	95407		(707) 585-6056
Mark Soiland	Soils Plus	4343 Stage Gulch Rd	Sonoma	CA	95476		(707) 996-3400
Mark Soiland	Grab N' Grow Soil Products	2759 Llano Rd.	Santa Rosa	CA	95407		(707) 575-7275
Karina	SBI Landscape Material	10540 Old Redwood Hwy	Windsor	CA	95492		(707) 431-1617
Brian	MIX Garden Materials	1531 Healdsburg Ave.	Healdsburg	CA	95448	bryan@mixgarden.com	(707) 433-4327
Jesse	Deep Roots Hydroponics	2661 Old Gravenstein Hwy, Ste.G	Sebastopol	CA	95476		(707) 829-7668
Will Bakx / Alan Co-owners	Sonoma Compost	550 Mecham Rd	Petaluma	CA	94952		(707) 664-9113
Amy or Jack (owner)	Sonoma Valley Worm Farm	1280 Sperring Rd	Sonoma	CA	95476		(707) 996-8561
Cooper (Soils guy, son of owner)	Mendocino Farm Supply	303 Talmage Rd	Ukiah	CA	95482		(707) 462-1492
Debroah and Gary Ratway	Digging Dog Nursery	31101 Middle Ridge Rd.	Albion	CA	95410		(707) 937-1130
Brenden/Nancy	Headlands Garden Supply	630 N Franklin St	Fort Bragg	CA	95437		(707) 964-4447
John Jensen	Oak Valley Nursery	1575 S State St	Ukiah	CA	95482		(707) 462-1200
Wanda	Fiddler's Green Nursery	525 S Franklin St	Fort Bragg	CA	95437		(707) 964-3555
John Vitak-owner	North Star Nursery	17901 California 1	Ft. Bragg	CA	95437	info@northstarnursery.com	(707) 961-1074
Scott Zerambi	Dirt Cheap Organics	17975 California 1	Ft. Bragg	CA	95437	dirtcheaphydro@mcn.org	(707) 964-4211
Sean	Mendocino Garden Shop	44720 Main St, Mendocino	Mendocino	CA	95460		(707) 937-3459
Correy	Spare Time Supply	208 E San Francisco Ave	Willits	CA	95490		(707) 459-6791
Dennis Kirwan	Geo Aggregates	P.O. Box 1457	Ft. Bragg	CA	95437	info@geoagg.net	(707) 964-4033
Alex Fosse / Albie?	3D Organic Solutions	3450 N State St	Ukiah	CA	95482		(707) 463-2339
Martin Mileck	Cold Creek Compost	6000 Westside Potter Valley Rd.	Ukiah	CA	95482		(707) 485-5966

Appendix B CITATIONS AND FOOTNOTES

- 1) Mochari, Ilan. "When Two Small Startups Tackle an Industry Together". Inc. Magazine Online. 15 January 2014. <http://www.inc.com/ilan-mochari/reinvention-biochar-merger.html>.
- 2) Since the weight of a yard of biochar can vary from 150 pounds to as much as 500 pounds or more depending on a number of factors (such as the production process, feedstock, particle size, and moisture content), we used an averaged conversion number of 338 pounds per yard to come up with an estimate of the total estimated volume sold by those surveyed.
- 3) Mochari, Ilan. "When Two Small Startups Tackle an Industry Together". Inc. Magazine Online. 15 January 2014. <http://www.inc.com/ilan-mochari/reinvention-biochar-merger.html>.
- 4) According to a report comparing national averages for U.S. corn production costs vs income per acre (<http://www.iowarfa.org/documents/HistoricalCornProdCost.v.Price.REVISED.pdf>), farmers only made a profit 9 years out of 30—from 1981 to 2011. Average prices paid per-bushel have also dropped significantly this year, down \$1.50 from 2011 and \$2.93 from its peak of \$7.63 in August 2012 (http://ycharts.com/indicators/corn_price).
- 5) Claudio Niggli and Hans-Peter Schmidt. "Biochar in European Viticulture: Results of the Season 2011". *Ithaka Journal*. <http://www.ithaka-journal.net/pflanzenkohle-im-europaischen-weinbau-ergebnisse-2011?lang=en>.
- 6) Baltar, Raymond. "Citizen Science Project Final Report." Sonoma Biochar Initiative. 18 February 2012. (www.sonomabiocharinitiative.org/citscience).
- 7) Mochari, Ilan. "When Two Small Startups Tackle an Industry Together". Inc. Magazine Online. 15 January 2014. <http://www.inc.com/ilan-mochari/reinvention-biochar-merger.html>.
- 8) Environmental services is one of the emerging markets we see as important to helping biochar scale up production and use in the short- and medium-term. We discuss this in more detail in the Emerging Markets section.
- 9) Biochar Supreme. Environmental Solutions: Environmental Ultra. 20 May 2014. (<http://www.biocharsupreme.com/collections/biochar-remediation-products/products/bob-s-environmental-ultra>).
- 10) Schmidt, Hans-Peter. "55 Uses for Biochar". *Ithaka Journal for ecology, winegrowing, and climate farming*. <http://www.ithaka-journal.net/55-anwendungen-von-pflanzenkohle?lang=en>.
- 11) Carmona Paneque, Jose M. de la Rosa Arranz, & Heike Knicker. "Assessment of effects in the germination and agronomic production of four contrasting biochars. An incubation study." 13 November 2013.
- 12) 2 yards per day, 10 yards per week, 480 yards per year X 275 pounds per yard = 132,000 pounds / 2000 = 66 tons. Using a production schedule of 48 instead of 52 weeks allows for weather and feedstock delays and/or unit down time. If there is excess production we recommend using it for samples, field trials at 3 to 5 farms in cooperation with Humboldt State University, and for a possible Citizen Science project.
- 13) There may be other companies that come forward to bid for the contract for the RFFI biochar, such as The Biochar Company. But since WSI and DCL&GS are local they may be given preference over an out-of-state company.
- 14) See Figure 8
- 15) Union of Concerned Scientists. Clean Vehicles. "Biomass Resources in the US". 2012. http://www.ucsusa.org/clean_vehicles/smart-transportation-solutions/cleaner_fuels/ethanol-and-other-biofuels/biomass-energy-resources.html.
- 16) US Energy Information Administration. Frequently Asked Questions. "How much electricity is lost in transmission and distribution in the United States?". 7 May 2014. <http://www.eia.gov/tools/faqs/faq.cfm?id=105&t=3>

Appendix C ACKNOWLEDGMENTS

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Additional attachments to this report:

Full survey results from Survey Monkey

Quote for video production from Green Gorilla Media

Quote for retail marketing development from Ron Schoof

Contact list as an Excel document

Price comparison chart as an Excel document