

NORTHWEST BIOCHAR COMMERCIALIZATION STRATEGY PAPER

*Prepared for the Oregon Department of Forestry and
the USDA Forest Service, Pacific Northwest Region.
February 24, 2015*

ABSTRACT

Biochar is a growing industry in the Pacific Northwest. Near-term potential market value is estimated to reach \$5 billion dollars on a national basis. The biochar industry faces several barriers including the absence of policy incentives, lack of product standardization, demonstration projects, and marketing collateral for end-users. Targeted public and private resources are needed to help the industry biochar reach its full potential regionally and nationally.

Matt Delaney

Delaney Forestry Services
mdelaney1@centurytel.net

Acknowledgements

I would like to thank those who contributed to this document including those who reviewed and edited early drafts (Marcus Kauffman, Ron Saranich, Erin Rasmussen, John Miedema, David Ford, Tom Miles, Dusty Moller, Myles Gray, and Kelpie Wilson). I also wish to thank the attendees of the biochar meeting in Salem, Oregon on December 11th 2014, and for sharing their perspectives on biochar market development.

Special thanks to the U.S. Forest Service and the Oregon Department of Forestry for funding support for the Salem meeting and the development of this document.

Citation:

Delaney, M. (2015). Northwest Biochar Commercialization Strategy Paper. A white paper developed for the U.S. Forest Service and the Oregon Department of Forestry.

http://nwbiochar.org/Biochar_Commercialization_Salem-2014

Table of Contents

Executive Summary	1
1.0 Introduction and Overview	2
<i>1.1 Working group priorities: meeting participant surveys</i>	2
<i>1.2 From “What is it?” to “Where can I buy it?”</i>	3
<i>1.3 Break-out groups</i>	5
2.0 Northwest Biochar Industry Status.....	5
<i>2.1 Biochar use in the Pacific Northwest</i>	5
<i>2.2 Biochar company highlights</i>	6
<i>2.3 Biochar market opportunities</i>	6
<i>2.4 Biochar market barriers</i>	10
3.0 Resources needed to overcome market barriers	12
4.0 Conclusions	15
5.0 Resources cited	16
 Appendix 1. Biochar company profile narratives	 17
Appendix 2. Summary of existing markets that have biochar potential	20
Appendix 3. Biochar product labelling info ODA.....	24

Executive Summary

Biochar has the potential to make significant economic and ecological impacts in the Pacific Northwest and other parts of the country. Northwest companies are actively engaged in developing commercial scale opportunities in biochar. Examples include BioLogical Carbon, Sunmark Environmental, Freer Organics, Biochar Supreme, Walking Point Farms, and others. The near-term national market potential is estimated at more than \$5 billion dollars within the agriculture, horticulture, environmental remediation, and stormwater filtration sectors. Current market value of biochar is about \$400,000 on an annual basis in the region. Prices for raw biochar are highly variable, reported costs ranged from \$90 to as high as \$600 per yard.

Biochar has a number of commercial uses in the Pacific Northwest including expanding use in horticulture and agriculture. Some commercial uses include biochar as part of a soil blend and in a prill or prill-like form as a fertilizer supplement. Biochar is also used commercially as filtration media to remove pollutants from stormwater and wastewater.

Like any new industry, the biochar industry faces several barriers. These include, lack of policy incentives for biochar use, lack of product standardization, an incomplete understanding of end-user customer needs, as well as a lack of demonstration projects. These barriers hamper market demand for biochar currently. During the December 11th meeting in Salem, Oregon biochar stakeholders noted that “market creation” represented the main challenge for the emerging biochar sector (54% of survey respondents).

Public and private sector resources are needed to overcome current market barriers for biochar. The most pressing include:

1. Policy priorities that can be shared with USDA, elected officials
2. Marketing collateral for different market segments
3. Customer and end-user needs assessment
4. Funding for demonstration projects
5. Collaborators and strategic partnerships

The strategic objective is to attract more private and public resources to address current market hurdles. To achieve that objective, it is suggested that industry stakeholders form a committee of NW Biochar Working Group to develop an action plan. This action plan would describe the steps necessary to garner more resources to propel the biochar industry forward. The action plan could be fashioned around the key priorities identified during the NW Biochar Working Group meeting as described in this document.

The biochar community has numerous opportunities for collective action that could form the basis of a robust action plan. Regional stakeholders should also highlight the environmental and job-creation potential of biochar products—particularly what it could mean for rural areas to engender more support with elected officials. To grow a robust biochar sector in the Pacific Northwest, public and private investments are needed to help realize the environmental and economic development benefits of the emerging biochar industry.

1.0 Introduction and Overview

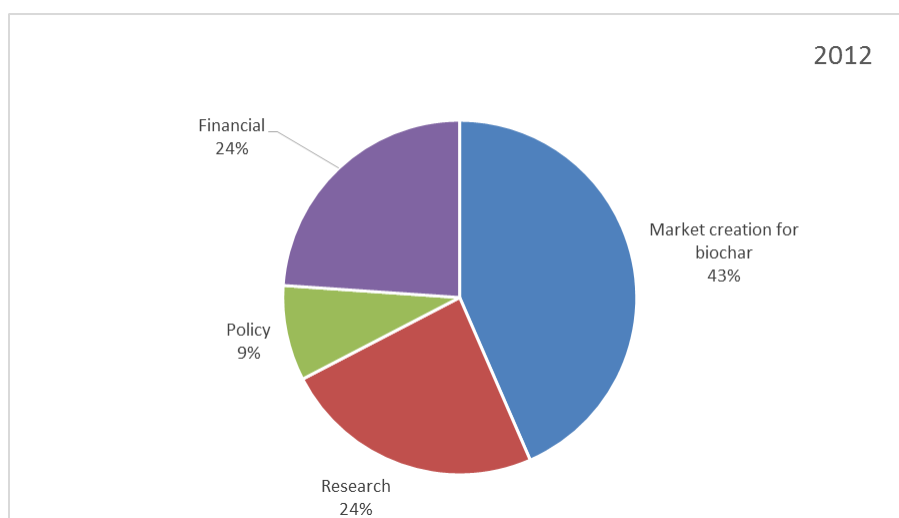
For the last three years, the Northwest Biochar Working Group and its stakeholders have been working to advance the biochar industry in the Pacific Northwest. On December 11th of 2014, the all-volunteer working group met in Salem, Oregon to discuss market barriers to biochar commercialization. The meeting covered a wide range of topics, from product labeling, regulatory challenges, policy, and near-term options for collective action to propel the industry forward.

This document summarizes the key points of the meeting and articulates a strategy to support the development of a robust biochar industry in the Pacific Northwest. The Northwest (NW) biochar sector represents a diverse group, including business owners, entrepreneurs, public agencies (State & Federal), researchers, and community leaders. This paper provides biochar stakeholders and others with a clear and concise description of the opportunities for collective action that will support the development of commercial scale biochar enterprises in the Northwest and beyond.

Given the limited scope of this paper, it focuses on strategies to propel the NW Biochar industry. Although biochar technology and research are important to the development of the industry, they are not a central focus of this paper. The document does provide some useful references if readers wish to gather more information¹⁻² on other biochar topics.

1.1 Working group priorities: meeting participant surveys

In 2012, the Northwest Biochar Working Group met in Olympia, Washington. Attendees at this meeting were asked a series of questions on a range of topics. These same questions were posed to the 30 attendees of the Salem, Oregon meeting in 2014. The full data set can be found at the NW Biochar Working Group web page³. The data illustrate that market development represents a key challenge to future growth. In 2012, 43% of respondents noted that “market creation for biochar” was the main challenge for the emerging industry while 54% of respondents said the same in 2014 (Figure 1).



¹ WA Ecology 2011. Pyrolysis technologies: <http://www.biochar-international.org/biocharwashingtonstate>

² Waste to Wisdom project (2015) biochar, briquettes, and torrefied wood technology: <http://www.schatzlab.org/news/tag/torrefaction/>

³ NW Biochar Working Group : <http://nwbiochar.org/>

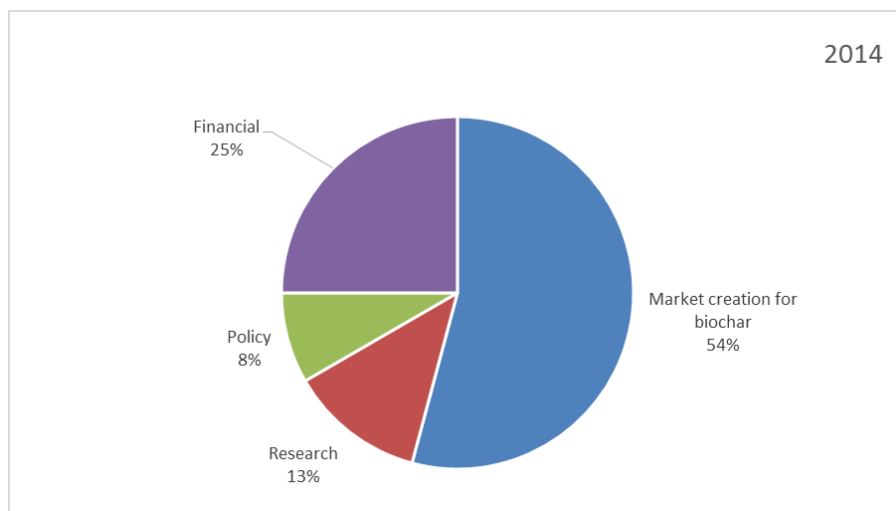


Figure 1. 2012 & 2014 meeting attendee responses to the question, “What type of support is needed to propel the biochar industry in the Pacific Northwest?”

The 2014 survey responses are, in part, due to the stated topic for the meeting—which was biochar markets and commercialization opportunities. Therefore the number of responses for “market creation” may be (in part) a reflection of the interests of those who attended the biochar meeting. That said, the need for “market creation” for biochar remains a key theme for the NW biochar community.

1.2 From “What is it?” to “Where can I buy it?”

In the formative years of the NW Biochar Working Group (2012) two areas of concern existed. First, respondents noted a lack of public education and awareness about biochar. Second, they voiced concern about biochar supply shortages and a lack of material. Currently, these issues are of lesser in importance than in past years. For example, in the biochar stormwater/wastewater filtration segment—some professional engineers and others are now aware of biochar and its potential as a less expensive alternative to granulated activated carbon. One member of the NW Biochar Working Group who attended a recent stormwater conference said, “*The question from stormwater engineers is no longer ‘what is this biochar stuff’? The question now is ‘I’ve heard about it and I’m interested in buying it’*”. There are numerous projects underway across the Pacific Northwest on biochar and stormwater filtration. Examples include two projects in Washington State, specifically the Port Townsend⁴ project (which involved BioLogical Carbon, researchers at Oregon State University and others) and the Port of Tacoma⁵ (which involved Biochar Supreme). Engineering firms, municipalities, and other customers in the stormwater market are beginning to understand biochar and its potential.

In agriculture, numerous education and awareness efforts are underway. For example, in 2014, a major farming publication (the Capital Press newspaper) ran a front page article on biochar⁶.

⁴ http://www.ptleader.com/news/paper-mill-biochar-may-help-filter-port-water/article_3b8e78f6-8583-11e4-8e37-eb4b861b936b.html

⁵ <http://portoftacoma.com/news-releases/2014-11-19/innovative-treatment-system-exceeds-water-quality-rules>

⁶ Capital Press: Bringing up biochar <http://www.capitalpress.com/apps/pbcs.dll/article?AID=/20140206/ARTICLE/140209932>



The coverage reflects a general awareness of biochar in the agricultural community. However biochar's value proposition for individual farmers remains an obstacle to broad adoption. Given biochar's cost—it is not clear if it offers enough benefit to the farmer to warrant broad-scale use. For the home gardener-retail level consumer, public awareness lags and additional communication is required to inform customers about the potential benefits of biochar.

Biochar supply, or lack thereof, represents another important element of the supply chain that has improved in recent years. Public and private entities have invested significant work and research into the development of mobile or semi-mobile pyrolysis units. Numerous examples in Washington, Oregon, Idaho, and other western regions reflect those efforts^{7-8,9}.

Recently, a relatively new source of biochar has been utilized in the market place, namely biochar made from the co-products of co-generation and gasification¹⁰. Regional biochar producers have shown that some of these co-products contain biochar that can be utilized if processed correctly. This development has increased supplies of biochar available in the marketplace.

Additionally, improved methods of burning forest slash and other biomass residues are being tested¹¹. These methods could lead to more economical sources of biochar, particularly in remote forest locations. This kind of “backyard biochar”¹² is also providing more people with hands on experience with the material, and contributes to public awareness of biochar.

In summary, the recent past was characterized by procurement and cost challenges in the biochar supply chain. Currently, the industry is experimenting with new approaches and new techniques that are ameliorating the supply challenges.

Industry players hold a variety of opinions about the production of biochar. Some believe that the highest quality biochar can only be made via pyrolysis techniques¹³, for certain product applications (for example home gardens) that could be the case. Others believe that other processes may produce chars

⁷ WA DNR: http://www.dnr.wa.gov/ResearchScience/News/Pages/2014_09_19_biomass_ma.aspx

⁸ BioLogical Carbon: OSU Terra Magazine <http://oregonstate.edu/terra/2013/10/an-elegant-matrix/>

⁹ Biochar Solutions: <http://www.biocharsolutions.com/>

¹⁰ Phoenix Energy: <http://www.phoenixenergy.net/>

¹¹ Learning to Burn and Make Biochar, Not Smoke. Kelpie Wilson. Tree Care Industry Magazine. February 2014. <http://tcia.org/news/publications/tci-magazine-february-now-available-0>

¹² Backyard Biochar.net: <http://www.backyardbiochar.net/>

¹³ Washington State University Extension: cru.cahe.wsu.edu/CEPublications/FS147E/FS147E.pdf

that are more suitable to other applications, such as stormwater filtration and environmental remediation. Organizations like the International Biochar Initiative are “*process neutral*” when it comes to biochar production¹⁴. The NW Biochar Working Group stakeholders may wish to clarify their own views about gasification/co-generation biochar as well as biochar generated from improved pile burning techniques, in the near future.

1.3 Break out groups

During the 2014 Salem meeting participants were separated into five groups, representing various biochar segments. The five groups were 1) soil amendments, 2) land remediation, 3) stormwater/wastewater, 4) policy, and 5) research. Each group was asked to respond to three questions. The questions were:

- a) What are the key market barriers for development of a NW biochar industry?
- b) What are the resources needed to achieve this goal? E.g. grants, financing, business planning, demonstration projects, others?
- c) What are the opportunities to advance the collective impact of the NW Biochar Working Group?

The following sections provide a description of information that resulted from the break-out sessions. This information forms the foundation of a regional commercialization strategy.

2.0 Northwest Biochar Industry Status

Biochar is being used in a variety of applications across the Pacific Northwest and California. Some end users blend it with compost and other soil media. Biochar is also used as a stormwater/wastewater filtration product.

The International Biochar Initiative in their “*State of the Biochar Market*” report¹⁵, estimated the global market for biochar at 800 tons, with an estimated annual market value of \$1 million dollars.

An informal survey of Pacific Northwest biochar companies indicates that the current biochar market in the region is worth approximately \$400,000 per year. Prices for biochar vary considerably and reported costs ranged from \$90 to a high of \$600 per yard.

2.1 Biochar use in the Pacific Northwest

The NW Biochar Working Group web page¹⁶ contains information on biochar enterprises in the Pacific Northwest. According to the site, approximately 20 businesses and organizations are active across the Pacific Northwest and beyond (Table 1).

They consist of companies that manufacture biochar kilns (like Best Biochar Kiln, Carbon Cultures) to those that use biochar as part of their soil or agricultural products (Walking Point, Freer Organics). Others use biochar as a filtration media (BioLogical Carbon, Sunmark Environmental, Biochar Supreme).

However, the volunteers that manage the Northwest Biochar Working Group website (T.R. Miles Technical Consultants¹⁷), are in need of resources to further refine this list and provide more detailed

¹⁴ IBI FAQ: <http://www.biochar-international.org/standardsFAQ>

¹⁵ State of the Biochar Market. IBI: <http://www.biochar-international.org/commercialization>

¹⁶ Biochar Producers Map: <http://nwbiochar.org/>

¹⁷ TR Miles Technical Consultants <http://www.trmiles.com/>

information on site listings. Particularly, segmentation of listed organizations into various categories—such as biochar suppliers, production and technology providers, biochar blending companies, those that use biochar for specialty filtration products, and biochar information providers.

Table 1. Biochar companies listed on the Northwest Biochar Working group web site.

Companies	Location
Best Biochar Kiln	ID
Char King	ID
Freer Organics	ID
IdaChar	ID
Rugged Biochar	ID
Algae Aqua-Culture Technology	MT
Montana Biochar Products LLC	MT
Real Montana Charcoal	MT
Biochar Products	OR
BioLogical Carbon, LLC	OR
International Tech Corp	OR
Permamatrix, Sunmark Environmental	OR
Sunriver Biochar	OR
Biochar Farms	WA
Biochar Supreme	WA
Carbon Cultures	WA
EcotracOrganics	WA
Pacific Northwest Biochar	WA
Miller Soils LLC	CO & WA
Pacific Biochar	CA

2.2 Biochar Company Highlights

Regional companies have developed a wide array of value-added products using biochar. Company examples include BioLogical Carbon, Sunmark Environmental, Freer Organics, Walking Point Farms, and Biochar Supreme. A description of each organization can be found in Appendix 1. Company representatives provided a brief narrative for each business.

2.3 Biochar Market Opportunities

An estimate of the national market potential of biochar can be obtained by aggregating the various market segments in which biochar could realistically gain market share. These markets include:

1. Agriculture
2. Compost
3. Commercial horticulture
4. Home gardening
5. Stormwater/Wastewater filtration
6. Environmental remediation

In summary, across all of these market segments biochar market potential is significant, totally over \$52 billion dollars (Table 2). The process utilized to arrive at this initial figure was through the use of publicly available data—such as USDA Agricultural Statistics and other sources of information. This data was quantified to determine the total value of individual market segments, where research and field trials indicate biochar has commercial potential. We focused on a subset of values to develop the numbers in Table 2. For example, the total value of all agricultural crops in the United States is \$198 billion dollars annually. The organic agriculture market (likely) presents the greatest near-term potential market for biochar. This is due to a number of factors, including the marketing value of biochar as a carbon-reductive soil amendment, the high price premiums that exist within the organic market, high price for organic soil nutrients and amendments, and the fact that many organic producers could be classified as “early-adopters” who are willing to try new technologies and approaches (Gray 2015 pers. communication). Therefore, for purposes of this work we only mention organic crop value (\$26 billion) which is a component of the broader agricultural market.

We repeated this same approach for the other market segments. For example, based on surveys of industrial filtration customers in Oregon and Washington conducted by Oregon State University (see Appendix 2 for more details)—an estimated \$30 million dollars is spent on an annual basis on stormwater filtration systems in the region. Of that amount, an estimated \$4.5 million is spent on filtration media. We therefore reference the stormwater media value in this analysis.

Certainly, for agriculture markets broadly (\$198 billion) or stormwater filtration media and systems (\$30 million) the market potential is larger than the numbers reported here (Table 2). However, the goal of this analysis is to organize these opportunities on a more meaningful and refined scale. We therefore estimate national market potential of biochar to be \$52 billion dollars per year and selected 10% of that value to estimate near-term potential, or \$5.2 billion dollars. It should be noted that some of the categories in Table 2 could overlap, for example the “horticulture” industry is worth an estimated \$11.7 billion dollars. The retail gardening potting mixes and soil conditioners (worth an estimated \$657 million) could be considered part of the “horticulture” value. A more refined analysis of each of these segments and sub-segments would be needed before arriving at an exact figure. However, for purposes of this analysis we are reporting them separately.

Table 2. National value of various market segments that have near-term biochar potential.

Sector	Total Value (\$)	10% market share value (\$)	Source
Agriculture—organic crops	\$26 billion	\$2.6 billion	USDA Ag statistics
Compost	\$600 million	\$60 million	US Composting Council
Horticulture	\$11.7 billion	\$1.1 billion	USDA Ag statistics
Potting mixes & soil conditioners	\$657 million	\$65.7 million	Kise (2013)
Stormwater nationally	\$5.0 billion	\$500 million	US EPA
Stormwater media OR & WA	\$4.5 million	\$450 thousand	OSU
Stormwater City of Portland	\$101 million	\$10.1 million	OSU
Environmental Remediation	\$8 billion	\$800 million	EBI
Total	\$52 billion	\$5.2 billion	

Detailed market-sector descriptions can be found in Appendix 2. The following summarizes key aspects of these markets:

Agriculture: the organic agriculture market presents near-term potential for biochar. U.S. sales of organic food and beverages grew from \$1 billion in 1990 to \$26.7 billion in 2010. Biochar is a carbon-reductive soil amendment, which appeals to organic agricultural producers. Organic agriculture also commands higher price premiums for their products. In addition, many organic producers are “early-adopters” of new production techniques like those involving biochar. Biospecific¹⁸ is one example of a company that currently sells biochar products into northwest organic agricultural market. Walking Point Farms via an Oregon Best biochar commercialization grant is also looking at biochar for agricultural and other applications¹⁹.

Compost: Biochar can reduce nitrogen leaching and overall nitrogen losses during composting – yielding a more nutrient-rich product. Annual revenue of the top composting companies in the U.S. topped approximately \$600 million in 2012. Biochar and compost can be used in combination to enhance overall product values.

Commercial Horticulture: Research has shown that tree seedling plant mixes amended with biochar show enhanced resistance to common fungal pathogens²⁰ such as *Phytophthora* that can form in many nurseries. A recent article states that biochar also has potential as a low-cost option for tree seedling growing medias (for example perlite and peat moss). Biochar also decreases nutrient leaching losses in seedlings (Nemati et.al 2015)²¹. The horticultural market in the U.S. was worth an estimated \$11.7 billion dollars in 2009.

Consumer Horticulture/Garden Markets are another market opportunity for biochar. The appeal of biochar for this sector are similar to the organic agriculture market. Home gardeners like biochar as a carbon-reductive material that can add organic matter to soil and enhance plant productivity (with proper blending). Potting soil media as well as fertilizers and soil conditioners in the consumer level horticulture market are approximately \$657 million annually (Kise 2013).

Stormwater filtration markets: Oregon State University estimates that companies in Oregon and Washington spend approximately \$30 million annually to comply with state pollution benchmarks for stormwater and wastewater treatment systems. Biochar effectively removes many of the problem pollutants (copper, zinc, etc.) that are part of state pollution benchmarks. The market potential for biochar’s application within the Oregon & Washington private-industrial stormwater sector (as a filtration media) is estimated at \$4.5 million annually (Berry and Seppalainen 2014). The OSU estimate is probably low since most spending on stormwater control systems and media is done by NW cities and municipalities. For example, the City of Portland has invested more than \$1.01 billion in stormwater management services and facilities in recent years (Portland, 2013). In fiscal year 2012 alone, Portland spent \$101 million on stormwater management and systems. Many municipalities in the northwest have to comply with Best Management Practices mandated by regulatory agencies (for example the Oregon Department of Environmental Quality and the Washington Department of Ecology). However, despite repeated inquiries by OSU, it proved difficult to get any statewide data on number of implemented BMP

¹⁸ BioSpecific <http://wearebiospecific.com/>

¹⁹ Oregon Best: <http://www.agprofessional.com/news/oregon-best-helps-build-commercial-market-biochar>

²⁰ <http://www.biochar-international.org/node/3861>

²¹ Nemati, R.M., F. Simard, J-P Fortin and J. Beaudoin. 2015. Potential use of biochar in growing media. *Vadose Zone Journal*. Soil Science Society of America.

stormwater practices for NW municipalities. As a result, the numbers reported here are for NW private companies only.

On a national basis, US Environmental Protection Agency (EPA) estimates the stormwater treatment and management market is worth between three and six billion dollars annually.

Environmental Remediation: Biochar captures pollutants on mine spoils, oil and gas fields, and other lands impacted by resource-extraction activities. Studies in Oregon, Colorado²², and Utah have shown promising results over the last several years. According to EBI, the US market for environmental remediation was valued at \$8 billion dollars in 2012.²³

Drought mitigation and water use: The above summary does not include the opportunity of biochar use in drought-stricken California. In response to recent and ongoing droughts, the agriculture industry increasingly emphasizes improving the water holding capacity of soils. **Research and field trials have shown that biochar increases water holding capacity in soils by up to 20% and increases plant water use efficiency**²⁴⁻²⁵. These effects could reduce water demands for irrigated crops and improve soil water holding capacity in marginal dry-land agricultural regions.

In November of 2014, California passed the Water Quality, Supply and Infrastructure Act²⁶, which includes a \$7.4 billion “water bond” for infrastructure projects involving stormwater & wastewater systems, improvements in water quality management on agricultural lands, and other activities. Therefore biochar market potential as part of a drought-mitigation and/or water management strategy may be worth exploring.

Other market opportunities: there are many other potential markets for biochar both regionally and nationally. One additional market that has potential in the Pacific Northwest is biomass utilization on public lands. The US Forest Service and other public agencies (like ODF and the Washington Department of Natural Resources) generate slash-piles from hazardous wildfire-fuel reduction efforts and other forest management activities on public forest land. The biomass material generated from these restoration activities generate biomass that is often piled and burned on site. Improved forest slash pile burn techniques can reduce emissions and particulates from fuel reduction projects compared to traditional forms of pile burning. The biochar generated from improved pile burning techniques has been shown to improve inputs of forest soil carbon, and creates other soil benefits (Sacket et. al 2014, Mitchell et. al 2014). Concerns about air quality emissions and the need for alternatives to pile burning may create new market opportunities for biochar on public forestland through improved pile burning approaches.

Biochar’s potential as a greenhouse gas mitigation strategy is another market opportunity. To develop carbon offset market revenue for biochar projects a carbon protocol (or methodology) is required. A

²² Hope mine Colorado: <http://www.coloradoindependent.com/98897/hope-mine-cleanup-demonstrates-power-of-biochar>

²³ EBI <http://ebionline.org/updates/1828-ebj-annual-survey-and-analysis-provides-comprehensive-assessment-of-us-remediation-markets>

²⁴ IBI soil moisture and biochar research summary <http://www.biochar-international.org/sites/default/files/IBI-RS-soil%20moisture-5-Feb-2010.pdf>

²⁵ Basso et. al 2012. <http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12026/abstract>

²⁶ AB 1471—Water bond in California : <http://awpw.assembly.ca.gov/waterbond>

biochar carbon offset methodology²⁷ is under development by the Prasino Group, the Climate Trust and the International Biochar Initiative.

A final market opportunity involves biochar applications in urban areas. The Morton Arboretum and Bartlett Tree Experts are using biochar soil amendments²⁸ to enhance soil productivity for urban trees (Figure 2). Biochar amendments can also mitigate salt contaminated soils (Thomas et. al 2013) a particular problem in urban areas of the Midwest and Northeast. In addition, urban wood resources (tree trimmings, woody debris) are potential feedstocks for biochar.



Figure 2. Applying biochar to an urban tree in Chicago (photo courtesy of Morton Arboretum and Bartlett Tree Experts)

Slash disposal, biochar carbon offsets, and urban biochar applications appear to have market potential both in the region and nationally. However, estimating potential market values for these market segments is difficult. Hence, they were not included in Table 2.

2.4 Biochar market barriers

Salem meeting participants identified five central barriers hindering the development of the biochar sector in the Pacific Northwest. They include:

- Lack of policy incentives
- Lack of product specifications & standardization
- Need for high-profile demonstration projects
- Lack of understanding of end user concerns
- Limited market demand

Policy—many participants stated the need for state and federal policies to incentivize the use of biochar. Examples include the US Department of Agriculture via their farm services programs which are implemented by the Natural Resource Conservation Service (NRCS) and USDA Rural Development. Participants felt that if tax rebates and other policy incentives could be adopted by farm programs it

²⁷ Biochar carbon methodology: <http://americancarbonregistry.org/carbon-accounting/standards-methodologies/methodology-for-emissions-reductions-from-biochar-projects>

²⁸ Bartlett biochar brochure: <http://www.bartlett.com/resources/Premium-Landscape-Biochar-Brochure.cfm>

would create demand for biochar, while also assisting agencies achieve their soil restoration and conservation objectives.

Product specifications— participants spoke extensively about the need for specifications for a variety of customer segments. Biochar is a complex material and its properties vary depending on the type of feedstocks used to make it as well as the manufacturing process temperature. That said, bags of fertilizer have a minimum specification that farmers understand. Engineers know the specifications for activated carbon (pore size, flow rates, etc.). Biochar products need a similar standardization process for various market segments. Appendix 3 contains some general information on product specifications and labelling (from the Oregon Department of Agriculture).

Demonstration projects and end-user concerns--Real-world demonstrations are needed to foster adoption of biochar in key market segments. These demonstration would inform potential end users about the costs and benefits of biochar. Demonstrations would also be useful for policy officials at the local, state, and national levels to show the potential of biochar. Real world demonstration projects can be more effective than other kinds of marketing approaches—such as ad campaigns or promotional strategies—because they allow potential customers and end users to experience the results in a real world context. Demonstration projects are also most valuable when implemented and evaluated by independent research institutions (such as a university, or a public agency such as the USDA Agricultural Research Service).

The biochar industry needs to better understand end-user concerns across various market segments. Concerns will vary by market segment. However, biochar stakeholders need a more complete understanding of customer concerns. For farmers, concerns may be nitrate concentrations in agricultural runoff, water scarcity issues or future regulations. Stormwater engineers and municipal government officials that run wastewater treatment facilities may be concerned about pollution benchmarks and complying with new operating permit requirements.

To illustrate this point, during the Sweet Home biochar demonstration project in Oregon²⁹, project proponents developed media blends that showed capacity to remove ammonia from wastewater. When this finding was reported to the facility engineer at the wastewater treatment plant, the engineer's response was "that's interesting, however we aren't too concerned about ammonia. I'm much more interested in the tests you've done on the ability of biochar to remove phosphorus. The reason is, we are likely have new standards that we'll need to comply with as part of our updated operating permit". Biochar's ability to capture ammonia could be of value for other customer segments (like compost producers for example) however for the wastewater filtration sector—phosphorus was key.

A second example can be found from an 1822 agricultural journal reporting on the benefits of charcoal (biochar) additions to manures spread on agricultural crops. "On stiff clay soils it (charcoal) will produce an increase of vegetation, but not sufficient to pay the expense of the manure."³⁰ Despite enhanced growth benefits associated with biochar additions—its costs stifled broad-scale use. The relatively low-cost of NPK fertilizers has also played a role in restricting biochar in agricultural applications (Wilson 2014).

²⁹ Sweet Home Oregon biochar demonstration project. <http://rffi.org/Biomass-Research-Library.html>

³⁰ Illinois biochar group, Kurt Spokas USDA <http://biochar.illinois.edu/ibg.shtml>

Market demand—as described in the introduction of this document, market creation for biochar represents an area of concern for NW Biochar Working Group stakeholders. If resources can be developed to comprehensively address the other four market barriers (policy, standardization, demonstration projects, and a more detailed understanding of end-user concerns)—market demand for biochar will increase over time. Increased demand for biochar would also attract more private sector investment capital, something that is sorely needed for the industry.

3.0 Resources needed to overcome market barriers

There are numerous opportunities to advance the collective interest of organizations involved in biochar in the Pacific Northwest and around the country. The top five are as follows:

1. Policy priorities that can be shared with USDA, elected officials
2. Marketing collateral for different market segments
3. Customer and end-user needs assessment
4. Funding for demonstration projects
5. Collaborators and strategic partnerships

Broadly speaking, the industry also needs better communication and outreach tools. As mentioned, the Northwest Biochar Working Group web site is currently managed on a volunteer basis. With more resources, the web page could be updated and serve as a clearing house of resources and information to help achieve the collective interests of biochar stakeholders.

Policy: creating policy incentives for biochar use particularly under various USDA programs is a top priority of biochar stakeholders in the Pacific Northwest. Development of policy documents can help overcome market demand barriers that face the biochar sector.

Resources are needed to articulate several policy priorities that can be used to communicate to local, state, and federal program officials. For example, a policy document that shows how biochar can be used to enhance water-use efficiencies (in some cases) when applied to soils. Policy documents that explain how biochar can help USDA Natural Resource Conservation Service or other federal agencies meet their objectives are needed.

Jobs: Biochar, as a new industry, has the potential to create new family-wage jobs. Highlighting the job creation potential of the biochar industry can help overcome current barriers to growth by attracting broader support from state and federal elected officials.

State policy in Oregon emphasizes jobs and economic development, particularly in rural areas. The Oregon Department of Forestry has worked to get a budget request for the 2015-2017 biennium into the Governor's Recommended Budget to the State legislature. This funding request could be used, in part, to support early stage business development for biomass related companies including those in the biochar sector. The ODF initiative is part of the governor's budget and the funds requested are approximately \$1.1 million dollars. This support is needed to encourage biomass business development in Oregon. However, in the same budget package there is:

“... \$648.9 million to Business Oregon to support job creation statewide as well as access to capital for small businesses”³¹

While \$1.1 million is a significant level of resources, and the efforts of ODF to obtain funds that support biomass business development are much appreciated—the number of dollars devoted to “job creation” and small business development is illustrative of state level priorities. Highlighting what biochar development can do for job creation, particularly in rural areas will be an important component of any policy document that is directed at state-level policy decision makers.

Highlighting job creation is something that the composting sector has focused on recent years³². For example, the “Waste to Wealth Composting” organization has highlighted job creation in their efforts to expand the composting sector in the United States.

Composting Supports Jobs and Healthy Watersheds, Say New ILSR Reports

In addition, job creation is an area of focus for the torrefied wood sector. The U.S. Endowment for Forestry and Communities highlighted the torrefied wood sector’s potential for creating jobs in an October 2014 report³³:

“.....a product with significant potential to create family-wage jobs, enhance forest health, and provide new green energy products” (U.S. Endowment President and CEO Carlton Owen)

Torrefied wood is similar, although distinctly different than biochar, however the commercial challenges facing both sectors are similar. In their 2014 report, U.S. Endowment identified four major challenges for developing the torrefied wood industry. Namely,

- conversion and densification technologies
- raw material supply and logistics,
- markets and economics, and
- regulatory/social issues

They also mentioned a need for demonstration scale facilities to “validate target markets”³⁴.

Customer and end-user needs assessment: The biochar community would benefit from market and customer surveys that can be used to form a more complete picture of what end-users require in a product, and the value-proposition for biochar use. This effort would help focus resources on customer segments of most interest to the private sector, and would help create more market demand for biochar products.

³¹ http://www.oregonlive.com/politics/index.ssf/2014/12/john_kitzhaber_unveils_two-yea.html

³² Waste to Wealth Composting: supporting jobs and health watersheds. 2013 <http://ilsr.org/paydirt/>

³³ US Endowment usendowment.org/images/CAWES_Issues_and_Knowledge_Gaps_10.1.14.pdf

³⁴ US Endowment <http://www.usendowment.org/news/latestnews.html>

As the work by Oregon State University and other research focused organizations have shown—understanding customer and end-user requirements is essential for biochar market development. Basic research may be helpful in determining a potential biochar application, however if an application “doesn’t pencil” for the end-user it will remain a concept for the research community rather than a commercially viable product. In addition, biochar can have benefits for particular applications (like ammonia removal) however if the benefits are not in demand by an end user then the business case is not valid.

Marketing collateral that establishes a linkage between public agency program objectives and biochar use. Establishing these linkages, will help create more demand for biochar.

Fact sheets and infographics are a potential first step. For example, the Electric Power Research Institute and the US EPA launched a “water quality trading project” in the Ohio River Valley recently. This project has some interesting infographics that succinctly explain the potential benefits of the project’s approach (see infographic on this web page: <http://wqt.epri.com/>).

Many of the objectives of the project are (coincidentally) consistent with what biochar has been shown to do at filtering pollutants from water and agriculture run-off. For example, the EPA states, “...the use of fertilizers and pesticides on farms and lawns and increasing stormwater runoff from development activities, nitrogen and phosphorus—collectively referred to as nutrients—are a leading source of pollution in rivers, lakes and estuaries”.³⁵ Communicating how biochar can assist EPA and other federal agencies with their objectives would be an important activity to develop in the near-term.

Demonstration projects: Resources are also needed for more biochar demonstration projects so that end-users can see biochar benefits in the real world. **Demonstration projects help early adopters and potential customers understand how biochar products can be used in their own businesses and amplify market demand for biochar.**

These demonstration projects should be implemented by independent research organizations (like universities and public research agencies). The projects would test biochar’s value proposition to customer segments of interest, for example grow trials of biochar soil-amendments on high-value agricultural crops. This kind of demonstration project could also showcase biochar benefits to federal program agency officials (like the USFS and NRCS). Other demonstration projects could be focused on stormwater filtration biochar medias, illustrating biochar benefits to stormwater engineers and municipal government officials.

Collaborative and strategic partnerships: Biochar is a unique material. However, the biochar industry shares many of the same challenges facing other emerging industries—such as the composting industry³⁶ and the torrefied wood sector. **Forming collaborative agreements with these or other related industries will help the biochar community by sharing lessons learned, discuss strategies for growth, and overcoming barriers to commercialization.** Strategic partnerships with economic development groups, conservation organizations, or public-private cooperatives could marshal more support for biochar.

³⁵ Bloomberg News: <http://www.bna.com/trading-programs-seen-n17179911763/>

³⁶ Biocycle magazine: state of the composting <http://www.biocycle.net/2014/07/16/state-of-composting-in-the-u-s/>

In October of 2014, the International Biochar Initiative released version 2.0 of their standardized³⁷ product definitions for biochar. Jim Ippolito³⁸ of the USDA Agricultural Research Service is working on scientific characterizations of a variety of biochars for various applications worldwide. His work is being conducted under a European Union Agriculture and Food Research Initiative focused on agriculture, food security, and climate change³⁹. Efforts like the IBI and the USDA may offer collaborative or strategic partnership opportunities for NW Biochar Working Group stakeholders interested in standardized biochar product efforts and related issues.

4.0 Conclusions

The near-term strategic objective is to attract more private and public resources to overcome current market barriers for biochar. To achieve that objective, a suggested first step is to form a committee of NW Biochar Working Group stakeholders to develop an action plan. This action plan would describe the steps necessary to garner more resources to propel the biochar industry forward. The action plan could be fashioned around the key priorities identified during the NW Biochar Working Group meeting as described in this document.

As NW Biochar Working Group members have shown through their individual efforts over the last several years—biochar has enormous potential in the Pacific Northwest and other parts of the country. The near-term market value for this new industry is estimated at more than \$5 billion dollars nationally. Northwest companies are actively engaged in developing commercial scale opportunities in biochar. Examples include BioLogical Carbon, Sunmark Environmental, Freer Organics, Biochar Supreme, Walking Point Farms, and others. Strategies to expand biochar market opportunities include reaching out to potential biochar customers in the agriculture, horticulture, and stormwater filtration sectors to collect more information about their needs and requirements.

Interested members of the biochar community have numerous opportunities for collective action, including the development of policy documents explaining biochar potential for state and federal programs, devoting resources to develop infographics and other marketing related materials, identifying grant funding opportunities, as well as exploring public-private collaboratives. Biochar stakeholders should also highlight the environmental and job-creation potential of biochar products—particularly what it could mean for rural areas (jobs in the woods, and rural based enterprise development). In order for biochar to grow into a robust sector in the Pacific Northwest and beyond, public and private resources are needed to support and develop these opportunities.

³⁷ IBI Standardization 2.0 <http://www.biochar-international.org/characterizationstandard>

³⁸ Jim Ippolito USDA ARS <http://www.ars.usda.gov/pandp/people/people.htm?personid=42001>

³⁹ EU Joint Program Initiative http://ec.europa.eu/research/bioeconomy/policy/coordination/jpi/index_en.htm

5.0 Resources cited

- Berry, M. and Seppalainen, O. (2014). Market Study: Biochar. Oregon State University Advantage Accelerator <http://advantage.oregonstate.edu/advantage-accelerator> for copy of report contact Matt Delaney: mdelaney1@centurytel.net
- Grabowski, G. (2012). Lawn and Garden Products—US—May 2012. Technical report, Mintel Oxygen.
- Gray, M. (2015). Personal communication. Faculty Research Assistant. Oregon State University.
- Mintel Oxygen. (2012). Lawn and Garden Products—US—May 2001. Technical report, Mintel Oxygen.
- Mitchell, P. J., et al. Shifts in microbial community and water-extractable organic matter composition with biochar amendment in a temperate forest soil. *Soil Biology and Biochemistry* 81 (2015): 244-254. <http://www.sciencedirect.com/science/article/pii/S0038071714004039>
- Portland (2013). Annual compliance report no. 18. City of Portland, Oregon : Oregon Department of Environmental Quality
- Stormwater Management Market Set for Growth. (2013, 12 8). *BlueTech*.
http://www.bluetechresearch.com/report_types_tax/market-insight-report/
- Spokas, K.A., Cantrell, K.B., Novak, J.M., Archer, D.W., Ippolito, J.A., Collins, H.P., Boateng, A.A., Lima, I.M., Lamb, M.C., McAloon, A.J., Lentz, O.D., Nichols, K.A. 2012. Biochar: A synthesis of its agronomic impact beyond carbon sequestration. *Journal of Environmental Quality*. 41(4):973-989.
- Sackett, T. E., et al (2014). Soil and greenhouse gas responses to biochar additions in a temperate hardwood forest. *GCB Bioenergy*.
<http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12211/abstract>
- Thomas, Sean C., et al. (2013). Biochar mitigates negative effects of salt additions on two herbaceous plant species." *Journal of environmental management* 129 (2013): 62-68.
<http://www.sciencedirect.com/science/article/pii/S0301479713003861>
- USDA (2009). 2009 Census of Horticultural Specialties.
http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Census_of_Horticulture_Specialties/
- Wood, L. (2013). Research and Markets: Global Greenhouse Horticulture Market 2012-2016. Market to grow at CAGR of 10.1 percent over the period 2012-2016.
<http://www.hortidaily.com/article/4971/Global-greenhouse-horticulture-market-to-grow-10-percent-between-2012-2016>
- Wilson K. (2014). Justus von Liebig and the birth of modern biochar. *The Biochar Journal*. Arbaz, Switzerland. www.biochar-journal.org/en/ct/5

Appendix 1. Biochar company profile narratives as provided by individual organizations

BioLogical Carbon is a biochar production and product-development business focused on creating commercial biochar product lines. Owned by John Miedema, BioLogical Carbon focuses on the development of biochar media and biochar systems to remove pollutants from stormwater in the Pacific Northwest. In addition, they are pioneering improved techniques for filtration systems or “biochar totes” for capturing and cleaning stormwater. John Miedema is a leading expert in the development of innovative biochar products, with expertise about biochar chemical qualities, biochar production methods⁴⁰, and providing customized biochar blends for various market segments (particularly pollution filtration medias). For more information see: www.linkedin.com/pub/john-miedema/8/93/a32



BioLogical Carbon patent pending stormwater tote.

⁴⁰ OSU Terra Magazine: <http://oregonstate.edu/terra/2013/10/an-elegant-matrix/>

Freer Organics: Idaho-based Freer Organics uses biochar as part of a soil blend. Using a fermenting process called “Bokashi” they recycle food and brewery waste throughout much of Boise Idaho, creating microorganisms, enzymes, and specialized organic fertilizers. Their business focuses primarily on pilot programs and sustainable initiatives in Boise city parks, schools, agriculture, residential, commercial, and urban gardens. They have found that biochar creates a favorable carrier material to help improve their soil and organic garden amendments. Biochar is “soaked” or inoculated with microbes, enzymes, and other organic & chemical compounds which are in turn applied to soils to sustain biological living organisms for the long term. Freer Organics has found that biochar can extend the efficacy of their soil amendment products and reduce the need for commercial fertilizer inputs, which creates value for their customers. By stabilizing important microbial populations in their amendments, biochar helps create healthy soil aggregates which in turn holds water for longer periods of time (helping with plant germination). For Freer Organics, biochar is a useful delivery mechanism to add carbon and other organic material to soils, in addition to providing a structure for enhanced microbial populations in soil products. For more information see: <http://freerorganics.com/>



Walking Point Farms is a certified Service Disabled Veteran Owned Small Business operating out of Tigard, Oregon. Walking Point Farms specializes in the development of biochar based seed coatings (prills) and soil amendments with a focus on sustainable natural resource utilization, providing viable retail offsets against global climate change, and ultimately building better soils for generations to come. Research into the efficacy of biochar in new applications continues as Walking Point Farms looks to add new products in addition to its existing line of Pro-Pell-It!™ biochar soil amendment, coated seeds and custom blended fertilizers. For more information see: <http://walkingpointfarms.com/>



Sunmark Environmental: Sunmark Environmental via their PermaMatrix BSP product also produces a biochar-based particlized product. The Oregon based company uses these products for a variety of applications, and industries. Their product shows improved plant yields from sports turf, agriculture and rangeland reclamation. In addition this biochar based product is restoring carbon to soils while reducing nitrate leaching into rivers and streams. Biochar is blended with other organic materials to create a product that can increase the survivability of vegetation, restore soil microbial function, and facilitate bio-remediation of contaminated soils. Sunmark also uses another biochar based product called “Earth-Lite” to filter pollutants from wastewater. For more information see:

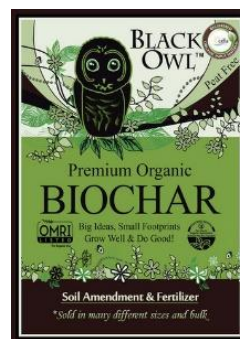
www.permamatrixbsp.com and www.earth-lite.com



PermaMatrix® BSP



Biochar Supreme, LLC, is national and international provider of numerous, professional-grade, Active Biochar products. As one of the few producers that can customize biochar properties with proprietary processing, Biochar Supreme, offers a variety of solutions to Nursery and Soil Mixing Professionals, Farms and Orchards, and Growers of Organic Crops. For the garden enthusiasts Biochar Supreme retail products, are marketed under the Black Owl Biochar label and can be found at garden centers and from local wholesalers. Biochar Supreme has also been making products for use in Environmental remediation projects to meet the critical criteria of the Stormwater and Water Pollution Remediation industries. Biochar Supreme has unique properties and high sorption of common pollutants, from metals to hydrocarbons, and has been utilized at large scale, high profile projects at the Ports of Tacoma, Seattle and Port Angeles, and even larger projects that have met the criteria for EPA permit approval of Industrial Sites, as well as injection into fracking locations where pollutants are a hazard. Professional Environmental Products range from use equivalency of some forms of Powdered Activated Carbon (PAC) and other Granulated Activated Carbon (GAC) at a fraction of the cost. For more information see: www.BiocharSupreme.com or call 360-927-9974



Appendix 2. Summary of existing markets that have biochar potential

Agriculture

Biochar has been used in agriculture for thousands of years and is particularly effective for improving poor and degraded soils. It is best thought of as a soil amendment rather than a fertilizer- that is, a component that is added to soil to improve its ability to sustain plant growth and retain nutrients and water. In the case of biochar, this effect is nearly permanent due to the fact that the material typically breaks down very slowly in soil.

In the Pacific Northwest and across the United States, projects are underway to quantify the benefits of biochar and biochar amendments in agriculture^{41,42}. Examples include, the dry-wheat trials being conducted in eastern Washington by the USDA Agricultural Research Service. In conversations with Dr. Steve Griffith, he has mentioned that biochar additions have shown increased yields however the mechanism may have to do with enhanced water holding capacity resulting from the biochar additions rather than any productivity enhancements. His work is being summarized and prepared for publication in the coming months.

It should be noted that for any biochar application—results of growth studies will be variable. Not all studies indicate positive effects on plant growth with biochar additions. There is a great deal of variability in the response of agronomic crop yield to biochar additions, negative to >2 fold improvements (Spokas et al., 2012). What biochar can (or cannot) do for soil & plant productivity will depend on many factors such as soil type & texture, biochar application method, and other variables.

Agriculture consists of a wide range of market segments; including industrial scale crop farming, commercial plant/tree nurseries, horticulture, organic gardening, vineyards, and livestock and poultry operations. According to the USDA, total value of agriculture in the United States was over \$198 billion dollars in 2012. The value of wheat crops in the US is approximately \$17 billion dollars⁴³.

The organic agriculture market (likely) presents the greatest potential market for biochar. This is due to a number of factors, including the marketing value of biochar as a carbon-reductive soil amendment, the high price premiums that exist within the organic market, high price for organic soil nutrients and amendments, and the fact that many organic producers could be classified as “early-adopters” who are willing to try new technologies. According to the Organic Trade Association, U.S. sales of organic food and beverages have grown from \$1 billion in 1990 to \$26.7 billion in 2010, and organic non-food sales reached \$1.97 billion in 2010. Certified organic acreage in the United States reached more than 4.8 million acres in 2008, according to data posted by USDA.

Compost

Biochar can be used in combination with compost to create enhanced benefits for both materials when applied to soil. Biochar has been shown to reduce odors, ammonia, and greenhouse gas emissions including nitrous oxide, and methane. A recent report regarding odor emissions from composting by the

⁴¹ Biochar and fertilizer applications influence phosphorus fractionation and wheat yield (2013) <http://www.biochar-international.org/node/4330>

⁴² <http://www.biochar-international.org/node/3782>

⁴³ USDA http://www.nass.usda.gov/Publications/Ag_Statistics/2013/index.asp

Washington State Department of Ecology⁴⁴ includes a summary of biochar research related to compost and gaseous emissions. Biochar has also been shown to reduce nitrogen leaching and reduce overall nitrogen losses during composting – yielding a more nutrient-rich product for agriculture. The soil amendment and composting businesses in the U.S. consist of more than 4,500 companies⁴⁵. Annual revenue of the top composting companies in the U.S. was approximately \$600 million in 2012.

Commercial Horticulture Market

Biochar has also been tested in horticultural applications, namely greenhouses and tree seedlings. Studies have shown that tree seedling plant mixes amended with biochar show enhanced resistance to common fungal pathogens⁴⁶ that can form in many nurseries, such as *Phytophthora*. A recent article has also shown that biochar has the potential as a low-cost option for tree seedling growing medias for example perlite and peat moss, while also decreasing nutrient leaching losses (Nemati et.al 2015)⁴⁷.

The horticultural market in the U.S. was worth an estimated \$11.7 billion dollars in 2009, which was up from \$10.6 billion in 1998. Horticulture covers a variety of sectors including tree nurseries, garden plants, perennial plants, flowers, and Christmas trees.

According to USDA 2009 Census of Horticulture Specialties (2009) there were 21,585 horticulture operations ranging from \$10,000 to \$2.5+ million annual revenue. The combined horticulture market expense on line-item Potting Soil and Media was \$350 million. The combined expense on Fertilizers and Soil Conditioners was \$307 million. Since biochar can be used in both categories, the estimated combined potential market for biochar is \$657 million (Kise 2013).

Consumer Horticulture/Garden Market

Biochar use in garden soil products is another market possibility within the horticultural sector. Mintel (2001) reports that consumer spending on garden supplies was \$26 billion. Seventeen percent of this was spent on gardening chemicals and growing media for a total of \$4.5 billion in 2001. In 2012 combined consumer spending on garden and lawn supplies was \$27 billion and projected to grow to \$36 billion by 2016. Assuming the percentage of media/total spending is relatively consistent, consumers purchased around \$6.1 billion worth of gardening chemicals and growing media in 2012 (Grabowski, 2012). The Wall Street Journal reported that spending in this sector was expected to grow by 10% from 2011 - 2016 (Wood, 2013).

Stormwater Market

There are several studies that are underway or that have been completed over the last couple of years on biochar efficacy to remove pollutants (metals, nutrients) from stormwater and wastewater⁴⁸.

⁴⁴ Kelpie Wilson for the WA Department of Ecology <https://fortress.wa.gov/ecy/publications/SummaryPages/1307066.html>

⁴⁵ BioCycle (2012) The State of Composting in the US <http://www.biocycle.net/2014/07/16/state-of-composting-in-the-u-s/>

⁴⁶ <http://www.biochar-international.org/node/3861>

⁴⁷ Nemati, R.M., F. Simard, J-P Fortin and J. Beaudoin. 2015. Potential use of biochar in growing media. Vadose Zone Journal. Soil Science Society of America.

⁴⁸ Biochar demo in Sweet Home, Oregon. <http://rffi.org/Biomass-Research-Library.html>

According to market survey work completed by students of Dr. David Smith at Oregon State University, the average company in Oregon and Washington spends approximately \$15,000 on stormwater filtration systems (filters and media) on an annual basis. This in turn produces a rough estimate of \$30 million in annual spending by private firms on filtration costs in order for companies to meet Oregon and Washington state pollution benchmarks for stormwater & wastewater treatment.

Of this cost, students at the OSU Advantage Accelerator program estimated that 30% or \$9 million dollars is spent annually on filtration related media for stormwater and wastewater systems. They estimated that activated carbon makes up about 50% of the medias currently in use for these stormwater systems. Since biochar could perform similar functions as activated carbon to remove pollutants, the students placed the market potential for biochar's application in industrial stormwater filtration to be approximately \$4.5 million annually for the two states (Berry and Seppalainen 2014).

The City of Portland, according to their annual compliance report from Oregon Department of Environmental Quality, "The City of Portland has invested more than \$1.01 billion in stormwater management services and facilities during permit years 1 through 18 (Portland, 2013)." In fiscal year 2012 alone, Portland spent \$101 million on stormwater management.

According to the US Environmental Protection Agency (EPA) the stormwater treatment and management market in the United States has been valued between three and six billion dollars annually. This market is expected to grow in the coming years (Stormwater Management Market Set for Growth, 2013).

Activated Carbon (AC) is the most closely related filter media to biochar on the market today. AC applications include automotive, pharmaceutical, mining, chemical, and industrial sectors. The current value of AC globally is approximately \$1.8 billion and is estimated to reach \$3.3 billion by 2017. The US Market demand for activated carbon is about 226,000 tons annually⁴⁹.

Environmental remediation

Biochar has been tested for its efficacy to capture pollutants on mine spoils, oil & gas fields, and other impacted lands. Studies in Oregon, Colorado⁵⁰, and Utah have shown promising results over the last several years. Biochar which typically has a high pH can be particularly effective on re-vegetation efforts on mine spoils. Steve Griffith⁵¹ of the USDA Ag Research Service in Corvallis, Oregon is just one of several researchers exploring the use of biochar for this purpose (Figure A2).

⁴⁹ <http://www.reportlinker.com/p0552741/Activated-Carbon-Industry.html>

⁵⁰ Hope mine Colorado: <http://www.coloradoindependent.com/98897/hope-mine-cleanup-demonstrates-power-of-biochar>

⁵¹ Steve Griffith Agricultural Research Service <http://www.ars.usda.gov/pandp/people/people.htm?personid=2136>



Figure A2. Potting trials of soils amended with 0% biochar (far left) and 4%, 9% and 10% biochar on right. Picture courtesy of Dr. Steve Griffith USDA ARS

Dusty Moller⁵² of the University of Nevada, Reno has been studying the use of biochar made from pinyon-juniper feedstocks as an amendment to enhance reclamation efforts at a gas-well pads in Utah (Figure A3).



Figure A3. Biochar amended soils at gas well in Utah. Picture courtesy of Dusty Moller.

The field work began in October of 2014 and initial results are expected later in 2015. Reclamation of degraded land with biochar like those at the Formosa mine in Oregon and the gas-well in Utah represents a potentially significant market opportunity for biochar. According to EBI, the US market for environmental remediation was valued at \$8 billion dollars in 2012.⁵³

⁵² Dusty Moller <http://www.unrbep.org/resource-conservation/woody-biomass-utilization/>

⁵³ EBI <http://ebionline.org/updates/1828-ebj-annual-survey-and-analysis-provides-comprehensive-assessment-of-us-remediation-markets>

Appendix 3. Biochar product labelling information from Oregon Department of Agriculture

Biochar

Donald Wolf <dwolf@oda.state.or.us>
To: Scott Hayes <scotthayes@wildblue.net>

Tue, Dec 2, 2014 at 8:53 AM

Scott,
Thanks for asking. It's easiest to do things right the first time.

Yes, if there are any claims made that a product affects plants or soil, then the material will have to be registered. Generally, biochar would fall under our agricultural amendment category. If marketed as a soil amendment, biochar would not require registration in Washington state, but it would in Idaho and California. If you plan to market more widely than just Oregon, let us know, and we'll try to help you develop labels that will comply with the requirements in the other states you're considering.

Another alternative would be to simply label the product "biochar" and make no claims whatsoever (not just the label, but anywhere), in the belief that those people who buy biochar already know why they want the product.

For registration, biochar is defined as "a solid material obtained from thermochemical conversion of biomass in an oxygen-limited environment. Labeling biochar materials shall be designated by prefixing the name with the feedstock from which it was produced; i.e. poultry litter biochar, green waste biochar, papermill biochar, etc. When more than one feedstock is involved, all feedstocks greater than 10% of the total volume are to be listed by decreasing volume. Their uses include soil amendments."

Registration requires four things--1) an approved label, 2) a heavy metals analysis (details below), 3) an application form, and 4) an application fee of \$25 per product.

1) The details of labels may vary from state to state, but there is a general format that is consistent. As an amendment, if no claims are made for specific substances, then the guarantees section of the label could be as simple as "Soil Amending Ingredients: 100% conifer biochar." All labels also need the following statement, printed without changes to wording or punctuation:

Information regarding the contents and levels of metals in this product is available on the internet at <http://www.aapfco.org/metals.htm>

2) The heavy metals analysis should be done for the total amounts of arsenic, cadmium, mercury, lead, and nickel in the product and be less than 18 months old. The lab analysis should use minimum detection limits no larger than:

arsenic 10 ppm
cadmium 5 ppm
mercury 0.2 ppm
lead 5 ppm
nickel 5 ppm

If you plan to register in California add cobalt (Co), copper (Cu), molybdenum (Mo), and selenium (Se).
If you plan to register in Washington add cobalt (Co), molybdenum (Mo), selenium (Se), and zinc (Zn).

Sometimes your supplier will provide you with a valid heavy metals report, or you can send it to a lab for analysis. Labs that can do this include, but are not limited to:

A & L Western Ag Labs
Modesto, California
(209) 529-4080

Anatek Labs
Moscow, Idaho
(208) 883-2839

North Creek Analytical, Inc. / Test America
Spokane, Washington
(509) 924-9200

Thornton Labs
Tampa, Florida
(813) 223-9702

A longer list of labs is available at: <http://www.puyallup.wsu.edu/analyticallabs/>

3) I've attached an application form, which includes information on where to send the form and payment. Application forms are also available in the forms section at: <http://www.oregon.gov/ODA/programs/Pesticides/Fertilizers/Pages/Fertilizers.aspx>

4) Payment may be submitted by mail or fax. See the instructions on the application form. Do not submit application by e-mail.

Also, as this product is made in Oregon, a Manufacturer-Bulk Distributor (FMBD) license is required. The application form for this license is attached.

As you have questions, feel free to drop me a line or give me a call.

Cordially,
Don Wolf
Fertilizer Program Specialist
Oregon Department of Agriculture
503-986-4587
Fax: (503) 986-4735

For more information visit us on the web at:
<http://www.oregon.gov/ODA/programs/Pesticides/Fertilizers/Pages/Fertilizers.aspx>

We want to know how well we are serving you. Please take our customer service survey at <http://www.surveymzmo.com/s3/1837307/ODA-Customer-Service-Survey>

On Dec 2, 2014, at 8:11 AM, Scott Hayes <scotthayes@wildblue.net> wrote:

Hello Don,

I got your name off the ODA website and hope you can help. I'm a member of the Oregon Woodlands Coop, a group of family woodland owners who market "non-traditional forest products", that is, stuff other than just logs. We are looking into the opportunity for our members to produce biochar.

It appears that biochar may be classified as an agricultural amendment, requiring some sort of testing and registration before sale in Oregon.

Can you provide me with the process?

Thanks,