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November 1, 2016

The Honorable Jay Inslee
Governor of the State of Washington
PO Box 40002
Olympia, WA 98504

The Honorable Barbara Baker
Chief Clerk of the House
PO Box 40600
Olympia, WA 98504

The Honorable Hunter G. Goodman
Secretary of the Senate
PO Box 40482
Olympia, WA 98504

Subject: ESHB 2380 Sec. 6004

Dear Governor Inslee, Chief Clerk Baker, and Secretary Goodman:

Please accept this letter and accompanying document as the report from the Department of Natural Resources (DNR) being submitted pursuant to ESHB 2380 Sec. 6004.

The 2016 Supplemental Capital Budget included Sec. 6004 which directed the Department of Natural Resources (DNR), the Department of Fish and Wildlife (WDFW), and the State Parks and Recreation Commission to evaluate the use of locally-produced renewable biofertilizers and fiber from dairy digester systems. The budget directed the agencies to assess the use of these products; looking into cost-competitiveness and suitability as a substitute for imported conventional fertilizers. The budget requested the agencies to develop a report to the legislature and the Governor's Office due November 1, 2016.

In assessment of these products and in development of this report, DNR met with State Parks, WDFW, the Department of Commerce along with representatives from the biofertilizer industry. While very supportive of treating and recycling dairy waste as biofertilizers, our analysis found that the majority of products from dairy waste are not entirely suitable for use in DNR operations. We do believe that fiber products from anaerobic digester systems, when specifically produced and tested as a peat moss substitute, may warrant evaluation in our greenhouse container program at Webster Nursery.

The attached report discusses DNR forest nursery operations and challenges in relation to the use of biofertilizers from dairy waste. Please don't hesitate to contact me at 360-902-1355 if you have any questions on this.

Sincerely,

Angus W Brodie.

Angus Brodie
Division Manager for Forest Resources

c: Members of the Senate Ways & Means Committee
Members of the House Capital Budget Committee
JT Austin, Office of the Governor
Jon Noski, Director of Legislative & External Affairs

NATURAL RESOURCES

Response to Dairy Biofertilizer and Fiber Bill Language Cited in Section Sec.6004 of FY16 Authorization Bill

November 1, 2016

WASHINGTON STATE DEPT OF NATURAL RESOURCES

Department of Natural Resources Response to Dairy Biofertilizer and Fiber Bill Language Cited in Section Sec.6004 of FY16 Authorization Bill

"A new section is added to 2015 3rd4sp.s. c 3 (uncodified) to read as follows:
The department of natural resources, the department of fish and wildlife, and the state parks and recreation commission shall evaluate the use of locally-produced renewable biofertilizers and fiber from dairy digester systems <u>*when such products are cost-competitive and provide a suitable substitute*</u> *(emphasis added) for imported conventional fertilizers and fiber when blended with or used in place of conventional fertilizers and fiber. By November 1, 2016, the agencies shall report to the legislature and governor with the results of the demonstration projects."*

Response Summary

The Webster Forest Nursery is the only location where Washington State Department of Natural Resources (DNR) uses fertilizer in any quantity on an annual basis. The nursery produces roughly 8 million conifer and hardwood seedlings a year for reforestation. There are three main concerns with the implementation of biofertilizers from dairy digester systems at this time: 1) fertilizer form, consistency and potential for seedling burn; 2) changes to soil water holding capacity and impacts on soil drainage and 3) pathogen inputs to the system. After consultation with Washington State University (WSU) Extension faculty and direct contact with the dairy industry, we are unaware of any anaerobic digestion facility that currently has the technology to develop biofertilizer products to meet the challenges outlined below. For a further list of specific biofertilizer products and implementation concerns, see Appendix A. Note that very few of these products are even available at this time as dairy digester technology is still in the development phase.

First, tree seedlings are very sensitive to nitrogen burning, where high levels of nitrogen at critical stages of growth can reach toxic levels. The ammoniacal form of nitrogen that predominates in dairy-based products is also implicated in promoting fungal root disease in conifer seedlings. Applied fertilizers need to have a repeatable lab-tested analysis in order to grow a consistent crop. If fertilizer sources such as biofertilizers and fiber vary within or between production cycles, this can complicate the growing of highly-sensitive conifer seedlings. Along with precision timing of fertilizer inputs at seedling growth stages, field nutrition requirements vary across soil type and crop history. Consistent fertilizer analysis is required in order to blend bulk materials to meet nutrition needs across the nursery.

Second, fiber additions in the already high organic matter soils where Webster Nursery is located can lead to water holding capacity issues. The nature of reforestation requires lifting seedlings in the wet months of Pacific Northwest winters. Fiber inputs can increase water holding capacity of soil, a benefit in some agricultural systems, but a likely detriment at Webster Nursery where lifting operations need to take place as soon as 24 hours following significant rains in order to meet reforestation planting windows.

Third, the nursery requires an independently verified pathogen-free analysis of any product, including biofertilizer and fiber inputs. Potential negative effects can include fungal, nematode (insect) and weed pathogens. Once added to an agricultural system, these pathogens can be exceedingly difficult, if not impossible, to successfully remove.

We do believe that fiber products from anaerobic digester systems, when specifically produced and tested as a peat moss substitute, may warrant evaluation in our greenhouse container program. Nutrient content and consistency, physical properties and pathogen and weed content would need to be assessed. The next cycle of container production begins in February 2017, and that would be the soonest a demonstration project could be installed.

In summary, the nursery produces a high-value crop that is particularly sensitive to fertilizer inputs and timing, balance of soil structure for optimal soil drainage, and pathogen-free growing conditions. While biofertilizers from dairy digester systems will likely play a role in many agriculture sectors as the technology develops, we do not feel that our unique industry is a good fit due to lack of current processing technology. However, we do see a potential market for fiber products in greenhouse production, specifically where developed as a peat moss substitute and developed to quality standards for commercial production.

DNR Response to Dairy Biofertilizer and Fiber Bill

Nursery Background

The Washington State Department of Natural Resources (DNR) operates Webster Forest Nursery in Tumwater, Wash., to grow seedlings for the reforestation of state trust lands that have been harvested to generate timber revenue for the benefit of schools and counties. In addition to the 5.8 million seedlings per year that Webster Nursery grows for state trust lands, the nursery also grows 1.5 million seedlings per year for sale to private landowners required to reforest after harvest and 1 million on contract for large landowners, with the Oregon Department of Forestry being the largest contract customer. The value of the seedling crop is about $3.5 million per year, but the value of future timber revenue is much greater.

Nutrition Concerns

The first step in growing the seedlings is a soil nutrient analysis for each of 21 discreet production fields, which average about 7 acres per field. There is considerable variation in nutrients between fields, demonstrated by the comparison of fields 22 and 31, Table 1.

Nutrient		Field 22	Field 31	Percent difference between high and low values
Phosphorus	mg/kg	113	84	35%
Potassium	mg/kg	73	57	28%
Boron	mg/kg	0.1	0.06	67%
Zinc	mg/kg	0.2	0.1	100%
Manganese	mg/kg	1.7	1.0	70%
Copper	mg/kg	0.5	0.3	67%
Iron	mg/kg	18	14	29%
Calcium	meq/100g	1.8	1.5	20%
Magnesium	meq/100g	0.3	0.3	0%

Soiltest Farm Consultants, Inc., February 2016

Table 1. Comparison of soil nutrient analysis for two fields at Webster Forest Nursery in Tumwater, Wash. This comparison illustrates the differences in soil nutrients and the need for custom fertilizer blends for each field.

Based on the nutrient analysis for each field and the species being grown, an agronomist prescribes a custom blend of pre-plant fertilizers (Table 2). Webster Nursery grows 14 species of conifer and hardwood reforestation seedlings that have various nutrient requirements. The seedling stocktype (one or two-year cycle) also factors in to pre-plant nutrient prescription.

Nutrient	Field 22	Lbs. per acre	Field 31	Lbs. per acre	Percent difference between high and low values
Total Nitrogen	5.06%	43.01	4.72%	49.85	16%
Available Phosphorus (P2O5)	7.94%	67.49	12.36%	112.48	67%
Soluble Potash (K2O)	20.70%	175.95	18.15%	165.17	6.5%
Boron (B)	0.18%	1.53	0.16%	1.46	5%
Zinc (Z)	0.62%	5.27	0.58%	5.28	0.2%
Manganese (Mn)	0.72%	6.12	0.85%	7.74	26%
Copper (Cu)	0.14%	1.19	0.27%	2.46	107%
Magnesium (Mg)	4.94%	41.99	4.03%	36.67	13%
Sulfur (S)	10.61%	90.19	8.86%	80.63	12%
Application Rate	Total Custom Blend	850	Total Custom Blend	910	7%
Gypsum		1500		1500	0%

Wilco-Winfield L.L.C., July 2016

Table 2. Based on the soil nutrient analysis presented in Table 1, an agronomist prescribes a custom blend of fertilizers for each field. This comparison illustrates the differences in fertilizer blends needed to grow reforestation seedlings at Webster forest nursery in Tumwater, Wash..

The amount of nitrogen in the pre-plant blend is low to prevent damage to germinating seed or small transplant seedlings. High rates of nitrogen can cause damage called "burning", sometimes resulting in seedling mortality. The ammoniacal form of nitrogen, likely to predominate in dairy-based products, is also implicated in seedling burn as well as fungal root disease in conifer seedlings (James 1997).

Nitrogen is supplied in small frequent applications of soluble calcium nitrate. Application rates vary by species, stock type and seedling age. We start with low application rates early in the spring, increase inputs during periods of rapid growth, then decrease fertilizer additions in late summer to induce seedling dormancy and prepare the seedlings for fall freeze events. By applying customized doses of nitrogen only when the seedlings need it, we can grow a better quality seedling and prevent excess nitrogen from leaching into the ground water (Duryea and Landis 1984).

Water Holding Capacity and Soil Drainage Concerns

A unique aspect of forest seedling production is that the whole plant is harvested, and a healthy intact root system is critical to survival after outplanting in the forest. Another important factor is that harvest is during the rainy season in western Washington, December through March. In order to harvest the crop in the winter, roots and all, the soils need to have excellent drainage. Too much clay, organic matter or silt and the lifting equipment will not be able to work in the fields and roots will be torn and damaged during lifting (Boyer 2003). The soil at Webster Nursery is predominantly a Cagey loamy sand, which is a very deep, moderately well drained soil with rapid permeability (NRCS 2016). The average soil organic matter (O.M.) is 3.6%, and ideally it would be best with a lower O.M. around 3.0%. Consequently, it would be detrimental to seedling quality and reforestation success if we increased soil organic matter by adding additional organic matter, including fiber from dairy digesters.

Pathogen Concerns

We are currently unfamiliar with the consistency of bulk inputs into the dairy waste processing stream. In many cases, it appears that multiple waste streams are used in the digesting process, including food, poultry and other waste sources. Schwarz and Bonhatal (2016) have reported variable and sometimes high populations of bacterial concentrations in anaerobic digested products, whether inputs are from single or multiple source inputs. The bacterial populations seem to be more closely associated with seasonal patterns, with higher bacterial concentrations from waste processed in summer months. Neither are we familiar with the level of sophistication of dairy digester processing quality as compared to biosolid processing quality controls, for example. The nursery requires an independently verified pathogen-free analysis of any product we incorporate into our system, and this would include biofertilizer and fiber inputs. The rationale is to avoid the potential introduction of unwanted fungal, nematode (insect) and/or weed pathogens. Once added to an agricultural system, these pathogens can be exceedingly difficult, if not impossible, to successfully remove (Cram et al 2012).

Anaerobic Digestion Products and Limitations to Unique Requirements of Growing Conifer Seedlings

Appendix A lists potential dairy-based biofertilizer options and limitations to use at DNR Webster Nursery. Products are listed from Yorgey 2014. The specific challenges have to do with inconsistent analysis due in part to multiple upstream inputs (for example, chicken manure and food wastes). All products listed have a high ammoniacal nitrogen component, which as described above is detrimental to Douglas-fir culturing. Other issues include potential pathogens, difficulty of uniform application and lack of fertilizer blending at our facility. Fertilizer blending would be required to develop the custom blends of applications we apply at our nursery to meet all nutrient needs.

Lack of Nursery-Specific Biofertilizer Products From Anaerobic Digesters

WSU has worked most extensively in western Washington with Werkhovens Dairy out of Monroe, Wash., and the partnered Qualco anaerobic digester facility. As of October 10, 2016, Qualco Energy had composted manure available and was not extracting struvite (Darryl Williams, Qualco, personal communication). WSU energy and soils staff have indicated that dairy digester technology systems are still in development and that marketable products are limited at this time, though some products from the biosolids (human waste) industry are further along.

Fiber as a Peat Moss Substitute

The most logical anaerobic digester product to test at this time would be fiber to serve as a peat moss substitute. Ideally, this material would have minimal number of input sources, meet horticultural grades for aeration porosity, bulk density, cation exchange capacity and other parameters necessary for culturing in containers. A specific product developed to quality standards for commercial production might fit in our program and would be worth testing. The next cycle of container production begins in February 2017, and that would be the soonest a demonstration project could be installed. The nursery does not have soil blending capabilities at this time, which are required for custom-batching soilless media mixes.

Conclusion

In summary, the nursery produces a high-value crop that is particularly sensitive to fertilizer inputs and timing, balance of soil structure for optimal soil drainage, and pathogen-free growing conditions. While biofertilizers from dairy digester systems will continue to develop and likely play a role in many agriculture sectors, we do not feel that our unique industry is a good fit due to lack of current processing technology.

We do believe that fiber products from anaerobic digester systems, when specifically produced and tested as a peat moss substitute, may warrant evaluation in our greenhouse container program. Nutrient content and consistency, physical properties and pathogen and weed content would need to be assessed. The next cycle of container production begins in February 2017, and that would be the soonest a demonstration project could be installed.

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Appendix A

Potential dairy-based biofertilizer options and limitations to use at DNR Webster Nursery. Products listed from Yorgey 2014.

Product	Unstable	Inconsistent analysis (due to variable inputs)	High ammoniacal N content	Potential Pathogens	Difficult to apply uniformly	Lack of fertilizer blending capacity at our facility
Manure	x	x	x	x	x	*
Bio-ammonium sulfate crystals (21:0:0:24[S])			x		x	x
Phosphorus-rich solids (3:2:1 + micronutrients, dry weight)		x	x	x	x	*
Struvite crystals (6:29:0:10[Mg])			x		x	x

*denotes inability to blend