Summary of Invasive Species Biomass Testing, 2011–2012

Center for Invasive Species Management and Missouri River Watershed Coalition CIG Project

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Introduction

The purpose of Objective 2 is to investigate and demonstrate innovative bioenergy technologies that promote the use of Russian olive *(Elaeagnus angustifolia)* and saltcedar *(Tamarix* spp.) biomass as new raw materials or "feedstocks" for bioenergy generation. Russian olive and saltcedar are hugely problematic invaders that presently infest at least one million acres within the Missouri River Watershed region and are virtually untapped sources of biomass. The project proposes that the tons of mostly herbicide-treated biomass, much of which has simply been left in piles throughout the region, can be processed on location by producers and used as a new, free bioenergy source. The intent of this report is to provide initial documentation regarding the feasibility of Russian olive and saltcedar as potential feedstock sources for bioenergy applications.

Bioenergy Testing

As a preemptive and precautionary step prior to the start of the project, the MRWC began conducting tests on Russian olive and saltcedar in 2010 to determine that herbicide-treated biomass: (1) does not contain high levels of toxic residues; (2) can safely be used as a bioenergy source; and (3) has a heat value/energy content competitive with other vegetative materials currently used as fuel sources. The results indicated that calorific value (BTUs generated per pound of material) and ash content levels for both species fall within the "acceptable" BTU range for bioenergy generation.

In 2011 and 2012, additional samples were collected and sent for laboratory testing to determine calorific value and ash, volatile matter, and moisture content. The results were then compared with data from forestry species traditionally used in bioenergy applications. The first round of tests, conducted by Hazen Research, Inc. (Golden, Colo., www.hazenusa.com) and Keystone Materials Testing, Inc. (Newton, Iowa, www.kmtlabs.com), was completed in fall 2011.

In late 2011, the Project Field Leader solicited expert feedback on the test results from bioenergy experts from the government sector (Angela Farr, USDA Forest Service State and Private Forestry; Julie Kies, Department of Natural Resources Conservation Forestry Division), universities (Tom Javins, University of Montana; Dale Grant, Chadron State College), and the private and commercial sector (Adam Sherman, Biomass Energy Resource Center; Andrew Haden, Wisewood, Inc.; Tom Miles, T.R. Miles Technical Consulting, Inc.). Two of the experts recommended further testing, including additional ultimate and proximate testing for calorific values and ash, moisture, and volatile matter; elemental analysis to identify specific compounds within the plant materials; and ash fusion testing to identify the temperatures at which the materials can produce or influence the formation of slag or clinkers in a biomass conversion operation.

Results

The results of the tests conducted on the Russian olive and saltcedar biomass samples are included in Table 1. Comparisons were then drawn between the target species and thermal test data for seven forestry species currently used as biofuel sources (Table 2). Data comparisons indicate that Russian olive appears to be a more viable candidate species for bioenergy utilization than saltcedar, with an average calorific value of 90.2% of traditional forestry species, as well as a very low average ash level (1%). The average ash level of Russian olive is also low when compared to the average ash level of forestry species analyzed. The BTU values of saltcedar indicate a calculated average of 16% below the average BTU values found in the forest species currently used for biomass purposes. In addition, the ash content levels of saltcedar are somewhat higher than the majority of forest species listed in Table 2, which may be a limiting factor for some bioenergy uses.

In early 2012, upon recommendations from bioenergy experts, additional testing was conducted to accurately determine the overall potential of Russian olive and saltcedar as viable biomass feedstock materials. An additional set of ultimate and proximate tests were conducted on the Russian olive and saltcedar materials by Hazen Research, Inc. The elemental composition of Russian olive and saltcedar was also tested to further establish the fuel qualities of the invasive species material. In addition, the elemental composition of ash generated from burning the plant materials was tested to determine the ash fusion temperatures of the plant materials. Upon completion of the bioenergy testing, the project test data was then evaluated by T.R. Miles Technical Consulting, Inc., a biomass combustion analyst.

Ash fusion temperatures of woody biomass are important in that when plant material is burned in a biomass unit, if the material has a low ash fusion temperature (below 1800°F), the material tends to melt into solid "clinkers or slag", and reduces the efficiency of the system. According to the 2012 ash fusion test data, the ash fusion temperatures of Russian olive and saltcedar, (over 2700°F and 2141°F – 2185°F, respectively), are high, and when burned, it is unlikely to cause fouling or the formation of "clinkers" in a biomass system. Additionally, high levels of certain elements found in plants such as; sulfur or nitrogen can be problematic for certain bioenergy conversion forms. Sulfur can be corrosive to biomass conversion systems (pellet or wood stoves) and will damage the system over a period of time. High nitrogen levels (Russian olive 1.15% oven dry), under certain conditions can contribute to nitrogen oxide emissions. In many cases, elemental concerns such as: high nitrogen or sulfur levels, can be mitigated through either modification of the biomass system design, or by simply diluting/blending the biomass material (T. Miles).

Discussion

Extensive amounts of biomass information and analysis exists relating to forest species, but little information relating to woody invasive plant species bioenergy utilization has been documented. Current management and treatment practices for Russian olive and saltcedar are generally considered cost prohibitive by many landowners and managers, and require integrating herbicide treatments with mechanical cutting and removal efforts. Depending on plant density, management practices can generate fairly large amounts of biomass (estimated at 5–10 tons per acre). Historically, biomass has been stockpiled and removed using on-site prescribed burning. While prescribed burning may be cost effective, exploring the beneficial use of the material as a solid biomass feedstock is an innovative alternative approach, and may create an incentive to expand existing levels of management being dedicated to control these invasive species.

A report produced by T.R. Miles Technical Consulting, Inc., titled "Fuel Property Analysis and Bioenergy Potential of Saltcedar and Russian Olive Wood" is available on the project website and contains further analysis of the bioenergy test information generated from 2011 and 2012, in addition to an overview of existing bioenergy technologies.

Table 1. Thermal test data for Russian olive *(Elaeagnus angustifolia)* and saltcedar *(Tamarix* spp.)

Sample	Location of collection site	Test date	Laboratory[1]	Calorific value (BTU/#)[2]	Ash (%)[3]	Volatile matter (%)[4]	Moisture (%)[5]
Russian olive (Elaeagnus angustifolia)							
A	Yellowstone County, MT	12-02-11	Keystone	8,102	1.00	76.67	2.97
B	Yellowstone County, MT	12-02-11	Keystone	8,098	0.96	75.76	3.53
C	Yellowstone County, MT	02-15-12	Hazen	7,571	1.24	73.81	10.33
Russian olive mulch (mulched one year prior to collection and left outside)							
D	Goshen County, WY	08-16-11	Keystone	6,318	2.50	75.47	6.69
E[6]	Goshen County, WY	08-18-11	Hazen	6,302	29.31	45.02	17.24
		08-18-11	Hazen	6,527	29.73	44.74	17.95
		09-12-11	Hazen	—	27.55	—	—
Saltcedar (Tamarix spp.)							
F	Goshen County, WY	08-16-11	Keystone	7,581	2.00	74.20	6.47
		08-18-11	Hazen	7,453	1.57	76.61	8.59
G	Goshen County, WY	08-16-11	Keystone	7,420	2.80	73.63	8.05
		08-18-11	Hazen	7,427	1.97	74.30	10.18
H	Yellowstone County, MT	08-16-11	Keystone	7,500	2.40	76.96	6.47
		08-19-11	Hazen	7,517	2.84	78.60	8.13
		08-16-11	Hazen	7,561	2.27	76.64	8.32
I	Yellowstone County, MT	08-16-11	Keystone	7,444	3.30	75.91	6.96
		08-18-11	Hazen	7,484	2.99	79.46	8.40
		08-18-11	Hazen	7,564	2.48	76.23	8.61
J	Yellowstone County, MT	02-15-12	Hazen	7,666	2.60	74.82	9.92

[1] Samples were tested by two laboratories: Keystone Materials Testing, Inc. and Hazen Research, Inc.
[2] Calorific value: the BTU levels generated per pound of material.
[3] Ash (%): the amount of inorganic wmatter that remains after the material is burned.
[4] Volatile matter (%): the overall amount of material, exclusive of moisture, that generates gas and vapors from burning.
[5] Moisture (%): the amount of water contained in the material, which is critical for biomass conversion processing.
[6] Due to abnormally high levels of ash and volatile matter identified in the initial results from Hazen Research, Inc. for Russian olive sample E (taken from Goshen County, WY), it was determined that the material should be retested. Results of both retests indicated abnormally high levels of ash and therefore, lower levels of corresponding volatile matter. These results may be due to the fact that the sample material was mulched one year prior to collection, thus allowing the samples to decompose and become contaminated with high levels of debris.

Table 2. Thermal test data for seven forestry (conifer) species [7]

Species	Calorific value (BTU/#)	Ash (%)	Volatile matter (%)
Douglas fir	9,050	1.10	89.00
Ponderosa pine	9,028	1.70	79.90
White pine	8,900	0.10	78.00
Western red cedar	9,155	2.40	78.90
Grand fir	8,505	1.30	78.80
Lodgepole pine	8,800	0.50	73.50
Western spruce	8,740	3.80	69.60

[7] *Source:* R. Folk, University of Idaho College of Natural Resources. Source did not include moisture content data.