

Contract No. R-023-032
“Application of Agricultural Byproducts for Energy Systems”
Submitted by Woodshed Renewables
Principal Investigator: David Fiebelkorn

PARTICIPANTS

Sponsor	Cost Share
Woodshed Renewables (In-kind)	\$228,739
Woodshed Renewables (Cash)	<u>\$172,400</u>
Subtotal Cash Cost Share	\$401,139
North Dakota Industrial Commission	<u>\$237,093</u>
Total Project Cost	\$638,232
Project Schedule – 30 months	Project Deliverables:
Contract Date – December 16, 2014	Status Report: December 31, 2014 ✓
Start Date – July 1, 2014	Status Report: June 30, 2015 ✓
Completion Date – June 30, 2017*	Status Report: December 31, 2015 ✓
	Status Report: June 30, 2016 ✓
	Final Report: June 30, 2017*

OBJECTIVE/STATEMENT OF WORK:

Woodshed Renewables owns a currently idle manufacturing facility in Finley. The company would like to begin producing biomass/wood blend pellets at the facility. The primary objective of this project is to define the market opportunity, optimize the production of solid fuels using standard equipment, and estimate the costs and returns. This will be achieved by the following tasks:

- Identify price points and markets for new products
- Develop a regional urban wood waste and agricultural co-products supply schedule.
- Estimate revenue, costs, and returns to pellet production using North Dakota-based, renewable feedstocks.
- Characterization of agricultural processing byproducts in relation to energy applications.
 - The specific products are urban wood waste, soybean stover, bean splits, and sunflower screenings.
- Development of high energy density formulation for pellets and fire logs.

NDSU will be performing the market analysis, and optimizing the production of the pellets. If successful, this project will increase the economic activity in a rural area by adding jobs to the community, ramping up production in a currently idle facility, and providing payments for crop residues to are farmers.

STATUS:

NDSU has provided a Preliminary Feasibility Analysis dated December 30, 2014. (A copy of this Analysis is posted on the website.)

Summary report for the period December 31, 2014 through June 30, 2015 has been submitted. It states:

The project consists of feedstock supply estimation, cost estimation, product marketing, material characterization, and product formulation, testing and certification activities.

FEEDSTOCK SUPPLY: A geodatabase of feedstock supply locations has been assembled.

NEW PRODUCT MARKETING: A preliminary list of products and channels has been identified.

WASTE WOOD AND COPRODUCT SUPPLY SCHEDULE: An inventory of potential sources of agricultural co-products was conducted.

COST MODEL: A cost model was developed to determine the feasibility of solid biofuel production using biomass. The analysis shows that under current market conditions returns to the enterprise are positive.

MATERIAL CHARACTERIZATION: A recently hired graduate student has been conducting preliminary experiments to understand the relationship between material composition and the energy values of densified solid biofuels. Initial caloric values of various byproducts have been collected.

PRODUCT FORMULATION: A pellet mill has been ordered and is expected to arrive in late August or early September.

PRODUCT TESTING AND CERTIFICATION: Raw material samples are being prepared for composition and ash content analysis by a third party independent laboratory.

Summary report for the period July 1, 2015 through December 30, 2015 has been submitted. It states:

FEEDSTOCK SUPPLY: Locations of primary and secondary feedstocks and physical supplies have been identified.

NEW PRODUCT MARKETING: Targeted products and channels have been identified from the preliminary list assembled in the period period.

WASTE WOOD AND COPRODUCT SUPPLY SCHEDULE: Physical and economic supply schedule data sources have been identified. Data collection has begun.

COST MODEL: The cost model was updated with current and forecast values. Returns are currently (December 2015) small given a slow start to the winter heating season.

MATERIAL CHARACTERIZATION/PRODUCT FORMULATION: A graduate student Jamileh Shojaeiarani was hired to work on this project. In the past 6 months most of the work focused on the characterization of material and evaluating some of the physical properties. There were four experiments that were conducted in the laboratory. A new laboratory scale pellet mill was also purchased to conduct the future experiments.

The materials that were tested included: Sunflower Hulls, Soy Stover, Culled Beans and Wood Flour. The following four experiments were conducted. (Information on each experiment is available in the status report that is posted on the website.)

Experiment 1 - Effect of moisture content and temperature on particle size distribution

Experiment 2 - Effect of moisture content and temperature on bulk density

Experiment 3 - Effect of moisture content, temperature and different fraction of raw material in solid bio fuels ash content

Experiment 4 - Effect of moisture content, temperature and different fraction of raw material in solid bio fuels heat value

Next we will be making pellets by blending different materials in different formulations and evaluating the physical and thermal properties as per PFI standard.

The summary report for the period **January 1 to June 30, 2016** was submitted and it states in part:

Most of the work in this period focused on making pellets with different fraction of material and testing the mechanical durability for those pellets. There were two experiments that were conducted in the laboratory. A laboratory scale durability test machine was fabricated to conduct mechanical durability tests.

The materials that were tested included: Sunflower Hulls, Soy Stover, Culled Beans and Wood Flour. The two experiments were: (information on the results of these experiments are included in the summary report that is posted on the website)

Experiment 1 - To understand the effect of different fractions of raw material on solid biofuels durability.

Experiment 2 - Evaluate the effect of particle size on the moisture absorption rate in biofuels.

Results - The test results show 20-40% sunflower hulls, culled bean can be added to wood to maintain durability index of 90% or above. The particle size doesn't have substantial impact on the final moisture absorption of pellets made using 20% sunflower hulls and 80% wood.

Woodshed Renewables has requested a no-cost extension to file the final report -- extending the contract until June 30, 2017. This request has been granted and an amendment has been partially executed.

12/30/2016