Semi Annual Project Report - 3
NDIC Grant Project: Commercial Application of Soybean Stalk as a New Alternative Fiber in Particle Boards

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This is a third report which summarizes the project activities between June 2015 and October 2015. The research funds for this project are provided by NDIC and Masonite PrimeBoard Company located in Wahpeton, ND. The overall goal of this project is to explore and demonstrate the feasibility of using soybean stalks as an alternate material for manufacturing particle boards. The specific tasks set to achieve the project goal include (1) understanding the material collection and transportation logistics, (2) equipment and machinery changes required to efficiently process soybean stalks, and (3) optimization of the formulations for manufacturing soy stalk based variable density particle boards.

The investigator from NDSU (Dilpreet Bajwa) met with their collaborators from Masonite PrimeBoard (John Robinson and Andrew Sutherland) on July 15, 2015 along with graduate student Evan Sitz to discuss project progress and share the results of the work that has been going on at NDSU. The project team revisited the comprehensive research plan to ensure project tasks are progressing satisfactorily. It was again decide that communication between all collaborators, students and funding agency be conducted seamlessly via emails or visit to Masonite PrimeBoard plant in Wahpeton, ND. The company also gave an update on the current material use and discussed various issues related to the use of wheat straw as well as incorporating Soy Stover into their production lines. It was decided that communicating on a bimonthly basis should help to meet all the deadlines.

Described below are some of the major highlights of the last six months (June 2015 – October 2015) work on the project followed by additional detail specifically discussing the contributions made by each party.

Project Update

NDSU (D. Bajwa, S. Bajwa, E. Sitz)

In the last six months material processing and characterization was the main focus. The hammer mill purchased through the funding from NDIC was extensively used to process wheat and soy stover. The primary objective of this work was to identify the impact of processing variables on the particle size and production of fines. This task will help the research team in optimizing the processing variables for the production of good quality uniform size particles with minimal fines. The processed material was used for wheat and soybean fiberboard production. In this testing we varied the straw moisture content, milling speed, and screen size used in the fiber milling process to reduce the fines produced from the process; larger fines content have been shown to reduce fiberboard performance and generally reduce processing efficiency. Wheat and soybean straw fibers were milled, with the processing conditions of the straw as follows: fiber moisture content of the total straw weight set at 5 wt.%, 15 wt.%, and 25 wt.%; hammer tip speed set at 88.2 ft./s, 117.8 ft./s, and 147.3 ft./s; and screen sizes of 3/8" and 1" round holes. Currently all 36 unique runs of the wheat and soybean straw fibers have been milled using the Shcutte-Buffalo hammer mill. Approximately 60% of these runs have been sieved to date using a Humboldt vertically oscillating sieve shaker. Three samples of ~50 grams each were taken from each run using ASTM C702 as the standard sampling method to create homogeneous sample distributions. Each sample was run in the sieve shaker for 10 minutes using 20 mesh, 40 mesh, 60 mesh, and 80 mesh screens, with the fibers passing through the 80 mesh screens accounting for the fines content. The measured fines content produced from hammer milling for each condition can be seen in Tables 1-4 (see appendix). The results thus far show that soybean fines content has a low dependence on the hammer tip speed in comparison to wheat. The results also indicate that screen size has a significant effect on reducing fines in wheat straw but does not affect soybean fines content as significantly. The common factor that does affect fines generation is the moisture content of the fibers, which has the general effect of reducing produced fines. Interestingly, the soybean fibers appear to be more responsive to the hammer tip speed at higher moisture content levels, as evidenced by the results in Table 3.

Masonite PrimeBoard (J. Robinson, A. Sutherland and E. Sitz)

There were numerous material processing related experiments conducted at the industrial partners facility. Several processing parameters for reducing fines were identified from experimental trial runs at the PrimeBoard location in Wahpeton, ND. The most significant factor in reducing fines content in milled fibers is close control of blinding in the screening process. Blinding is a process that occurs when fibers that are passing through a screen are the same size as the holes in that screen. This process was shown to significantly affect screens of 60 mesh or finer, which is the level at which fibers begin to reduce fiberboard properties. Trials specifically showed that regular clearing of the screening in the fiber conveying process reduced the average fines content used in the press from 14% to 3-4%, resulting in a significant reduction of board failures, reducing resin consumption, and improving the overall consistency of the board properties. Investigation of the fiber refining process for wheat also showed that using a variable drive to vary hammer tip speed with changing moisture content allowed for an optimization of the fines content that was being sent to be screened, allowing for optimization of fines production depending on the incoming fiber moisture content.

Appendix

Table 1 – Fine Content by Weight Post-Hammer Milling for As-Received Moisture Content					
Soybean – 88.2 ft./s, 3/8" Screen, 4.62% Moist			**Wheat – 88.2 ft./s, 3/8" Screen, 3.86% Moist**		
Mesh Size	Average	Std. Dev	Mesh Size	Average	Std. Dev
> 80 mesh	1.53%	0.0047	> 80 mesh	1.21%	0.0034
Soybean – 117.8 ft./s, 3/8" Screen, 4.62% Moist			**Wheat – 117.8 ft./s, 3/8" Screen, 3.86% Moist**		
Mesh Size	Average	Std. Dev	Mesh Size	Average	Std. Dev
> 80 mesh	2.25%	0.0043	> 80 mesh	1.80%	0.0018
Soybean – 147.3 ft./s, 3/8" Screen, 4.62% Moist			**Wheat – 147.3 ft./s, 3/8" Screen, 4.62% Moist**		
Mesh Size	Average	Std. Dev	Mesh Size	Average	Std. Dev
> 80 mesh	1.78%	0.0059	> 80 mesh	2.32%	0.0017

Table 2 – Fine Content by Weight Post-Hammer Milling for As-Received Moisture Content					
Soybean – 88.2 ft./s, 1" Screen, 4.83% Moist			**Wheat – 88.2 ft./s, 1" Screen, 4.86% Moist**		
Mesh Size	Average	Std. Dev	Mesh Size	Average	Std. Dev
> 80 mesh	0.96%	0.0046	> 80 mesh	0.56%	0.0034
Soybean – 117.8 ft./s, 1" Screen, 4.83% Moist			**Wheat – 117.8 ft./s, 1" Screen, 4.86% Moist**		
Mesh Size	Average	Std. Dev	Mesh Size	Average	Std. Dev
> 80 mesh	1.27%	0.0014	> 80 mesh	0.40%	0.0039
Soybean – 147.3 ft./s, 1" Screen, 4.83% Moist			**Wheat – 147.3 ft./s, 1" Screen, 4.86% Moist**		
Mesh Size	Average	Std. Dev	Mesh Size	Average	Std. Dev
> 80 mesh	0.72%	0.0010	> 80 mesh	0.36%	0.0014

Table 3 – Fine Content by Weight Post-Hammer Milling for 15% Moisture Content					
Soybean – 88.2 ft./s, 3/8" Screen, 16.35% Moist			**Wheat – 88.2 ft./s, 3/8" Screen, 16.42% Moist**		
Mesh Size	Average	Std. Dev	Mesh Size	Average	Std. Dev
> 80 mesh	0.66%	0.0030	> 80 mesh	0.65%	0.0013
Soybean – 117.8 ft./s, 3/8" Screen, 16.35% Moist			**Wheat – 117.8 ft./s, 3/8" Screen, 16.42% Moist**		
Mesh Size	Average	Std. Dev	Mesh Size	Average	Std. Dev
> 80 mesh	1.31%	0.0022	> 80 mesh	0.75%	0.0017
Soybean – 147.3 ft./s, 3/8" Screen, 16.35% Moist			**Wheat – 147.3 ft./s, 3/8" Screen, 16.42% Moist**		
Mesh Size	Average	Std. Dev	Mesh Size	Average	Std. Dev
> 80 mesh	2.022%	0.0102	> 80 mesh	0.89%	0.0015

Table 4 – Fine Content by Weight Post-Hammer Milling for 15% Moisture Content					
Soybean – 88.2 ft./s, 1" Screen, 16.20% Moist			**Wheat – 88.2 ft./s, 1" Screen, 16.51% Moist**		
Mesh Size	Average	Std. Dev	Mesh Size	Average	Std. Dev
> 80 mesh	-	-	> 80 mesh	0.30%	0.0012
Soybean – 117.8 ft./s, 1" Screen, 16.20% Moist			**Wheat – 117.8 ft./s, 1" Screen, 16.51% Moist**		
Mesh Size	Average	Std. Dev	Mesh Size	Average	Std. Dev
> 80 mesh	-	-	> 80 mesh	0.77%	0.0029
Soybean – 147.3 ft./s, 1" Screen, 16.20% Moist			**Wheat – 147.3 ft./s, 1" Screen, 16.51% Moist**		
Mesh Size	Average	Std. Dev	Mesh Size	Average	Std. Dev
> 80 mesh	-	-	> 80 mesh	1.27%	0.0062