

PROJECT NO. RU-07

ANNUAL REPORT COMPREHENSIVE
RESEARCH ON RICE January 1, 2013 -
December 31, 2013

PROJECT TITLE: Rice Board Development with Biodegradable Plastics

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PRINCIPAL UC INVESTIGATORS (include departmental affiliation):

COOPERATORS:

LEVEL OF 2013 FUNDING:\$10,000

OBJECTIVES AND EXPERIMENTS CONDUCTED, BY LOCATION, TO
ACCOMPLISH OBJECTIVES:

Objectives for the project are as follows:

1. Mix rice straw and plastic to produce a rice board.
2. Build a compression mold to produce rice boards.
3. Develop process to produce rice boards.
4. Test the rice boards for mechanical and physical properties.

Experiments were conducted at the CSU, Chico Plastics Laboratory in Chico, CA.

SUMMARY OF 2013 RESEARCH (major accomplishments), BY OBJECTIVE:

(Objective 1) Rice straw boards were produced with LDPE and PHA biodegradable plastic powders on a prototype machine. A 5" x 8" x 3/8" die was built with a shear edge design. The machine consists of a chopper and a compressions press. Rice straw was placed in the table top chopper and then chopped for 5 minutes. The rice pulp was mixed with LDPE powder at concentrations of 60%/40% rice/LDPE and 80%/20% rice/LDPE. The rice pulp was mixed with PHA plastic powder at concentrations of 50%/50% rice/PHA plastic.

(Objective 2) The mixed materials were heated to 550°F and then compressed in a press at 50 psi with a shear edge compression die.

(Objective 3) The rice/LDPE mixture was held at 550°F for 3 minutes and then the press was opened and the rice board was air cooled. RiceBoards were produced.

(Objective 4) The LDPE/rice board was tested for tensile, impact, density, and moisture absorption properties. The results are listed below.

The test pieces were tested with a MTS tensile machine at a rate of 1 in per minute. The tensile machine has a load limit of 10,000 pounds. The tensile properties of the rice board with 70% rice and 30% LDPE were similar to plywood. The mechanical properties are listed in Table 1 below

Material	Peak load, lbs	Strain at Break	Modulus, psi
Rice/LDPE Ave	534.157	0.044	658,422.983
Rice/LDPE St Dev	245.790	0.003	89,126.172
Plywood Ave	784.794	0.035	898,025.326
Plywood St Dev	208.992	0.017	45,465.417

Table 1. Mechanical properties of rice straw board and plywood.

The impact, density, and moisture absorption for rice straw/LDPE and plywood are listed in Table 2. The impact was tested with a Izod impact tester the rice/LDPE board had equivalent impact as the particle board but had higher density and higher moisture absorption.

Material	Impact strength, ft-lbs	Density, g/cc	Moisture % after 24 hours
Rice/LDPE Ave	534.157	0.044	53.51
Rice/LDPE St Dev	245.790	0.003	9.86
Plywood Ave	784.794	0.035	56.15
Plywood St Dev	208.992	0.017	8.96

Table 2. Mechanical properties of rice straw board and plywood.

PUBLICATIONS OR REPORTS:

The research will be published in an Agricultural Research Initiative (ARI) report in 2014.

CONCISE GENERAL SUMMARY OF CURRENT YEAR ' S RESULTS:

This project developed biobased rice boards based on rice straw and biobased plastic binder. The biobased particle board can replace conventional particle board without toxic VOCs. The biobased composite board will be made from the rice straw and a biopolymer made from PHA biodegradable plastic.

This research project includes a laboratory-scale feasibility study. The first phase of the project developed rice straw boards made with LDPE. The rice straw was obtained from a local rice farmer. The rice straw was chopped with a device made from spinning blades. The chopped rice straw was mixed with powdered LDPE and placed in the mold. A 7" x 7" shear edge mold was built with aluminum with 1° draft and a knock-out pin at the base of the mold. The mold was heated to 450°F. Several parts were made with 50% LDPE/50% LDPE and 30% LDPE/70% rice straw. The cycle time was 10 minutes.

The rice/LDPE part was tested for mechanical and physical properties. The tensile and impact properties of the 70% rice straw/30% LDPE were comparable to tensile and impact properties of plywood. The density of the rice straw board was significantly higher than plywood. The moisture absorption of the rice board was slightly higher than plywood.

The research project developed a rice straw chopping process with a plastic grinder that produced consistent rice straw particles. The rice straw fragments were combined with PHA biodegradable powder in a twin screw extruder and produced plastic pellets of rice straw and PHA plastic. The rice straw caused problems with the twin screw and caused it to prematurely shut down. The pellets were heated in an extruder and then placed in a compression mold for 5 minutes to produce parts. The cycle time of the process was reduced to 5 minutes.

Future work will include the following list:

1. Test the mechanical and physical properties of the RiceBoards made from PHA.
2. Develop the process to reduce the cycle time from 5 minutes.
3. Develop a process to reduce the tendency of the rice straw to block the vents in the twin extruder and cause a shut down of the process.
4. Develop the rice straw material and process to create a continuous production of rice straw/plastic pellets with the twin screw.
5. Injection mold rice/PHA and rice/LDPE plastics with tensile bar mold.
6. Build a new injection mold for clay pigeons.
7. Injection mold rice/PHA and rice/LDPE plastics with clay pigeon mold
8. Develop a technical feasibility study.
9. Develop an economic feasibility study.
10. Develop a sustainability feasibility study.