COMPREHENSIVE RESEARCH ON RICE
ANNUAL REPORT

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PROJECT TITLE:

New Approaches and Energy Savings in Drying of California Smooth and Rough Hulled Rice Varieties

PROJECT LEADER AND PRINCIPAL UC INVESTIGATOR:

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LEVEL OF 1978 FUNDING: $22,984

OBJECTIVES AND EXPERIMENTS CONDUCTED BY LOCATION TO ACCOMPLISH OBJECTIVES:

Objective I. To increase the energy efficiency of rice dryers by: a) partial re-use of exit air, and b) the use of other drier configurations such as concurrent flow, counter-current flow, etc.

1. Experiments conducted with pilot-scale drier at UC Davis.

Objective II. To determine the optimum time in terms of moisture content of rice when it is most economical to transfer rice from a column drier to a deepbed drier.

1. Trials conducted at UC Davis, a basic study initiated on tempering times. Simulated some drying/tempering schedules as followed by a major rice drier in the state.

Objective III. To develop computer-aided simulations of rice driers for evaluating the drier performance in terms of energy efficiency, rice quality and increased capacity.

1. Determined several basic physical and thermal properties of medium grain M5 rice variety at UC Davis.
2. Developed a computer model to simulate the cross flow drying system on the main computer at UC Davis.

SUMMARY OF 1978 RESEARCH (MAJOR ACCOMPLISHMENTS) BY OBJECTIVE:

Objective I

APPLIED STUDIES:

1. Based on results obtained during 1977, the pilot scale drier was modified to get more information on moisture and temperature gradients in the rice column. A moisture sampling device was constructed that allowed obtaining samples for moisture from any

desired location of the column. The drier was operated at 120°F temperature. Different air flow rates (30, 70 and 85 cfm/ft^2) and absolute humidity (.005 to .02 lb water/lb dry air) were tried along with different passes. Preliminary analysis confirms the existence of a significant moisture gradient inside the column which results in overdrying of rice with lower quality. The rice appears to move in a non-plug flow manner inside the column, which if confirmed from field scale tests, may be another cause of deterioration of milling quality.

2. Research on the counter-flow rice drier located in Escalon (courtesy of Mr. Fred Paulus) funded separately by Shivvers Enterprises, Corydon, Iowa, was completed. A final report is available for anyone interested.

Objective II

APPLIED STUDIES:

1. An extensive study conducted to examine different tempering times and cooling grain after drying revealed the following:
   a) In reducing the water in high moisture rice (initial moisture 24% wb) by 3 to 4% per pass when using 100°F air and 20 minute drying periods, a 35 minute tempering time is sufficient. In using a 35-min drying period at 122°F, or 20 minute drying period at 122°F, tempering times of three hours are satisfactory and shorter time may be adequate.
   b) Cooling rice immediately after a drying pass may reduce the total and head yield of the grain. This practice should be avoided.
   c) The Motomco moisture meter gives an erroneous moisture value if the measurement is taken immediately at the end of a drying pass. The moisture meter may indicate a value of 2 to 3% less than the true moisture content. The moisture meter gives correct reading if sufficient time is allowed for the moisture gradient inside the rice kernels to equilibrate.

BASIC STUDIES:

The mass diffusivity of the rough rice components (starchy endosperm, bran and hull) have been determined for a wide range of temperatures. This information has been used to develop a mathematical model which describes the movement of moisture inside a kernal of rice during drying and tempering. The model has been verified by comparing experimental data to theoretically predicted values.

The moisture diffusion model of rough rice is being used to determine the length of time rice should be held between passes in a multi-pass drying system. Moisture migration inside a kernal during tempering reduces the moisture gradient caused by drying. This is an important part of rice processing because internal moisture gradients may cause rice cracking and reduce the energy efficiency during drying. The rough rice model is being used to develop a simple equation to predict tempering time given the moisture content of the grain before drying, the drying conditions (air temperature and relative humidity), and the drying time or amount of moisture removed by drying.

Objective III

APPLIED STUDIES:

1. A computer aided simulation of a cross flow rice drier has been developed and tested in the laboratory. The results are promising. With future refinement, this computer model would provide an easy tool for the rice drier operator to select operating variables for reduced energy consumption and better quality.

BASIC STUDIES:

1. Several basic drying related properties of California medium grain M5 were determined. These include equilibrium moisture content of rough rice between 50°F and 90°F, convective heat transfer coefficient of rough rice, latent heat of vaporization of rough rice, thin layer drying rates of rough rice between 50°F and 130°F. Detailed information is available in the list of publications written on these studies during 1978.

PUBLICATIONS OR REPORTS:

1. Wang, C. Y., and R. P. Singh. 1978. A single layer drying equation for rough rice. ASAE Paper 78-3001.
2. Bakshi, A. S., R. P. Singh, C. Y. Wang, and J. F. Steffe. 1978. Energy costs of a conventional and air recycling cross flow rice drier. ASAE Paper 78-3011.
3. Steffe, J. F., R. P. Singh, and A. S. Bakshi. 1978. Influence of tempering time on rice milling yields and moisture removal. ASAE Paper 78-3055.
4. Zuritz, C. A., and R. P. Singh. 1978. Desorption isotherms of rice from 10°C to 40°C. ASAE Paper 78-6006.
5. Singh, R. P., C. Y. Wang, and C. A. Zuritz. 1978. A numerical approach to simulate rice drying. Paper presented at First International Symposium on Drying, Montreal, Canada.
6. Wang, C. Y., and R. P. Singh. 1978. Computer aided simulation of rice drying. Paper presented at American Institute of Chemical Engineers Meeting, Miami Beach, Florida.
7. Chhinnan, M. S., and R. P. Singh. 1978. Performance evaluation of a semi-continuous counter flow dryer for rice. Dept. of Agric. Engr., Univ. of Calif., Davis, CA 95616.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

Experiments were conducted and data analyzed to develop computer-aided simulation model of rice drying. The computer model was tested for several pilot-scale trials. Basic studies were initiated to study moisture movement inside rice kernals. These experimental studies are designed to develop new drying systems to conserve energy and improve milling quality of rice.