Comprehensive Research on Rice
Annual Report
January 1, 1988 - December 31, 1988

PROJECT TITLE:

Cultivar and Environmental Influences on Head Rice in California

PROJECT LEADER:

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PRINCIPAL INVESTIGATORS:

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OBJECTIVES AND EXPERIMENTS CONDUCTED TO ACCOMPLISH OBJECTIVES:

1. Develop and implement computer programs for rice farm management.

   In this project, a computer expert decision system, CALEX, which was developed for California cotton farm management by Dr. R. Plant, was adapted for rice farm management applications.

2. Design, construct, and evaluate a system for the automatic measurement and recording of the individual weight, length, width, and thickness of large numbers of rice kernels.

   Toward this goal a prototype unit has been assembled at the instrumentation facility of the Agronomy and Range Science Department on the Davis campus, and is currently undergoing testing and continued software development.

SUMMARY -- MAJOR ACCOMPLISHMENTS OF 1988 RESEARCH:

OBJECTIVE 1

An expert system is a computer program which integrates expert opinions and is operated by a set of knowledge rules to interface users with a computer system to help users make decisions for certain application purposes. Typically, an expert system consists of three components: a knowledge base; an inference engine which is an expert system shell written in a computer programming language; and a user interface program. Expert systems provide a powerful tool which allows users to interact with or to incorporate all existing relevant information, whether from the literature or from an expert's knowledge and experience, in their decision making process.

Farming is becoming an increasingly sophisticated and complex business. Farmers must consider social, economic, and environmental policies in addition to production issues in managing their farms. Expert systems can help farmers handle large amounts of information, perform complex analyses on all kinds of data, and make timely decisions on cultural practices. The only expert system available for farming operations in California is CALEX which was developed for cotton. This year we have adapted the CALEX shell and developed a knowledge base on agronomic management, weed management, and economic analysis as the first step toward the development of an expert system for California rice production.

The weed management section contains the following information: weed general information, weed monitoring and identification, weed cultural control methods, weed herbicide susceptibility table, and weed herbicide control methods. The information in the weed control section were obtained from the California IPM manual for rice, the Grower's Weed Identification Handbook, and Dr. J. Hill's experience.

Agronomic management includes three options: seeding rate determination, water management and fertilization recommendations. Fertilization recommendations are based on soil and leaf tissue analyses techniques developed by Dr. D. Mikkelsen.

The economic analysis is based on functional relationships established in our previous experiments between the milling quality, the harvesting moisture and the applied nitrogen levels.

This system is very general and flexible and is readily expandable as new information becomes available. One way in which the program can be further improved is to add a growth model so that rice developmental stages can be better predicted given certain weather conditions. In this way, management options can be planned and anticipated before the actual occurrence of an event.

OBJECTIVE 2

At the beginning of the year, a tentative overall design approach had been identified and an early prototype constructed for further evaluation (see Fig. 1). This consists of (1) an IBM-PC compatible computer, (2) a standard vibrating bowl fitted with a photocell-operated pneumatic diverter mechanism which selects single grains spaced at the interval required by the measurement system, (3) an imaging device which sends a digitized top view and a mirror-produced side view of the kernels to the computer, (4) a high-speed weighing device based on a time-of-flight principle which sends weight data to the computer, and (5) a moving belt which presents the kernels to the imaging device, freezes the motion during image capture, and then transports the kernels to the weighing device.

Evaluation of this prototype revealed two problems with the inexpensive, rudimentary imaging device. First, it was unable to distinguish different levels of light intensity and therefore required constant adjustment of illumination for uniformity, variation in grain color, and lamp aging. Secondly, the imaging package was difficult to access from a software standpoint. Therefore, a more conventional, but still relatively inexpensive, video-based imaging system was purchased, along with a library of operational subroutines.

The new imaging device has proven to function very well in this application. Illumination intensity is no longer critical, and the library of subroutines has allowed software control of all video parameters. The operating program has been developed to the point of automatically acquiring weights and images, and contains subsections for calibration, adjustment of video parameters, saving data to disk or printer, and on-line assistance for new users.

As soon as the new subroutines are installed the system should be operational for acquiring data on batches of rice kernels manually placed in the vibrating bowl. Upon successful operation of the present prototype, development of an automatic carousel for processing of successive samples will proceed, and an optimized version of the system will be constructed.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS

1. A computer expert system is being developed for rice farm management. This system includes some agronomic management considerations, weed management options and economic analysis based on grain and head rice yields.

2. A prototype of a computer-based measuring device has been constructed. This mechanism can weigh and measure kernel size and dimensions automatically. Software has also been developed to analyze the image data for breeding selection purposes.

CAPTIONS FOR FIGURE 1

1a. An overall system view showing the computer and its monitor, the video monitor, the vibrating bowl, and the processing unit.

1b. View of the vibrating bowl and the processing unit with video camera mounted on top.

1c. The image of a kernel as displayed on the video monitor. Note that a single image consists of a top view of the kernel as well as a mirror produced side view.

1d. The digitized image displayed on the computer monitor. The distortion is caused by the aspect ratio of the monitor, and is easily compensated for during calibration.

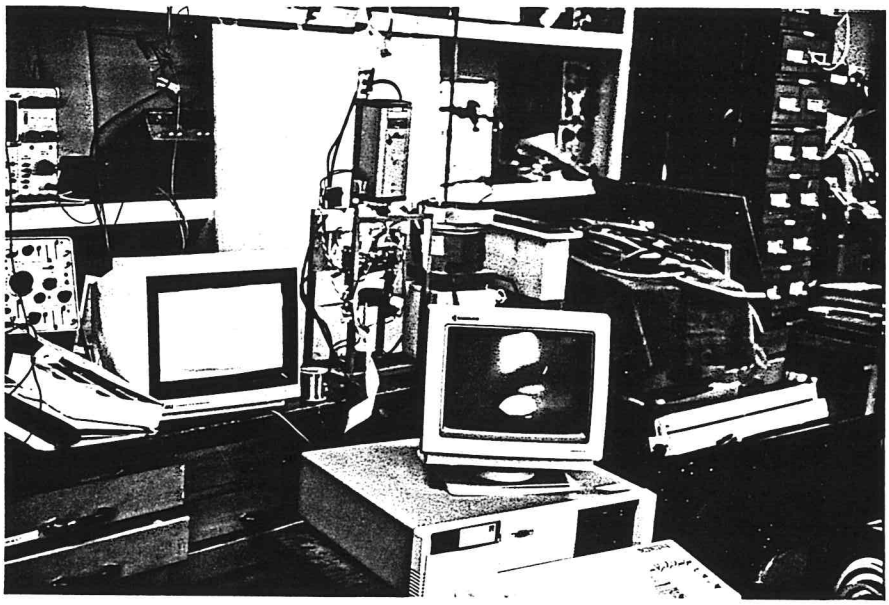

Fig. 1a

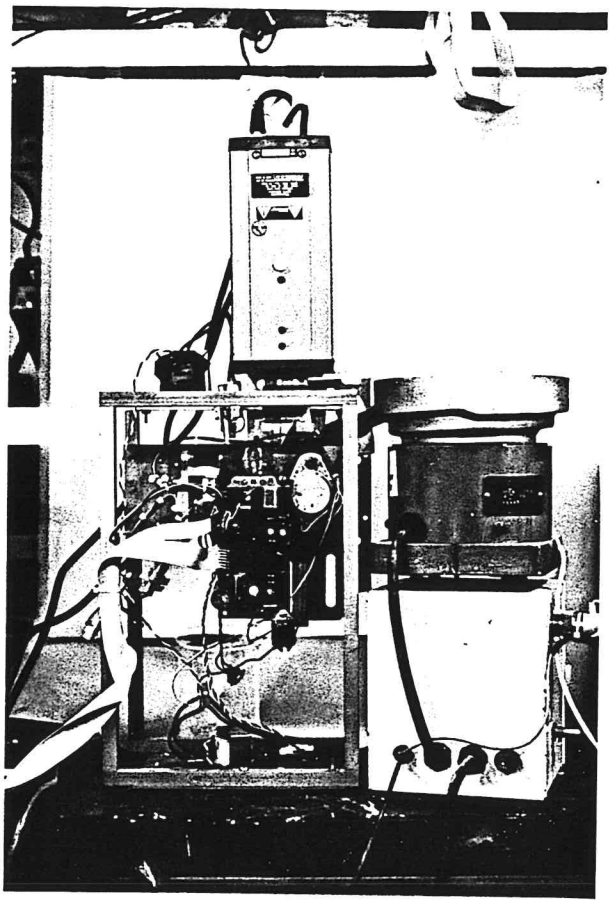

Fig. 1b

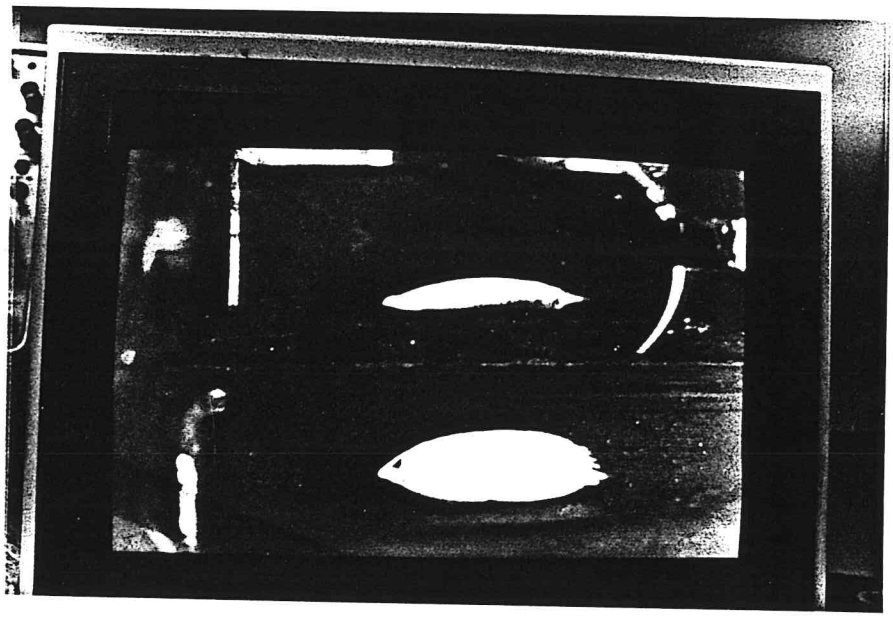

Fig. 1c

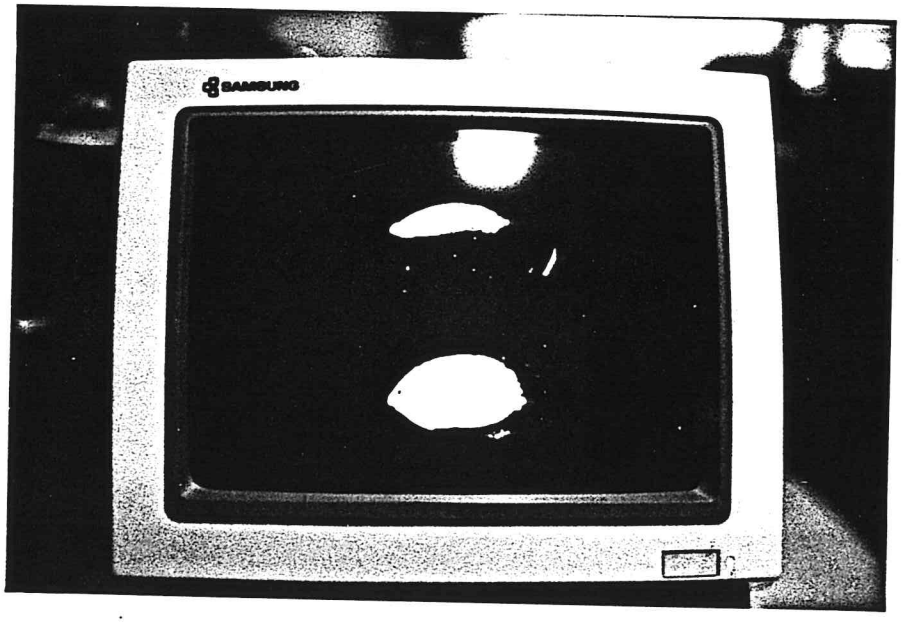

Fig. 1d