ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE
January 1, 2002 - December 31, 2002

PROJECT TITLE: Measuring the Effect of Low Water Temperature on Blanking and Grain Yield

STATUS OF PROPOSAL: Continuing

PROJECT LEADERS:
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LEVEL OF 2002 FUNDING: $28,140

OBJECTIVES AND EXPERIMENTS CONDUCTED BY LOCATION TO ACCOMPLISH OBJECTIVES:

The overall objective of this proposal is to quantify the effect of low water temperature on yield loss due to blanking and reduced plant productivity. The initial objectives of the proposal were:

1. Quantify the effect of low water temperature on the within field variability in rice yield loss. Determine what portion of this yield loss is due to blanking and what portion is due to other causes. Yield components analysis will be used to assess the precise nature of those causes.
2. Determine whether water temperature distribution and absolute water temperature can be estimated based on thermal infrared remote sensing. Develop an inexpensive means of determining those parts of a field that are subject to yield reducing stress due to low water temperature.

During the course of the project we recognized that a third fourth objectives were important and achievable, and we therefore added these to our list. These objectives are the following

3. Quantify the change in water temperature with distance from the source along a distribution canal.
4. Using the results of Objectives 1, 2, and 3, evaluate remote sensing technology as a means of estimating yield variability associated with water temperature on a regional scale.

In 2001 two rice fields, one near Thermalito Afterbay and another near Richvale, CA with cold water inlets from adjacent irrigation district canals were fitted with a grid or transect pattern of "Hobo" temperature sensors (Figure 1a and b). In 2002 a third field, located west of the two studied in 2001, was added to the study (Figure 2). At sampled location water and canopy temperature were measured. As the rice grew, the canopy sensors were moved upward so that they were always near the top of the canopy. Hourly temperatures were recorded from both sensors throughout the growing season. At harvest, yield components and percent blanking were recorded in the vicinity of each sensor. Sensors were removed prior to harvesting and yield maps were created of the field. In addition, thermal infrared remote sensing was used to record thermal images of the field.

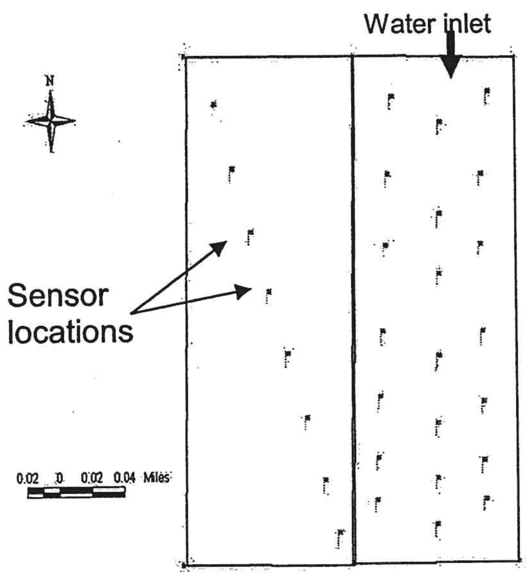

Figure 1a: Thermalito Afterbay field study

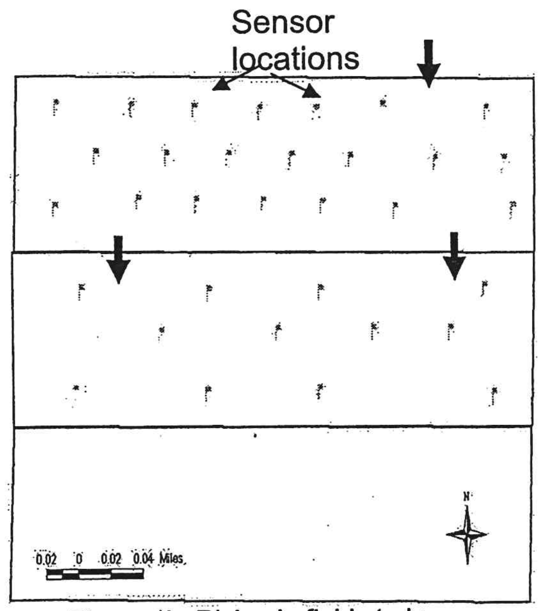

Figure 1b: Richvale field study. Sensor locations deployment

Thermal infrared images made from an airplane of the same rice check where the temperature sensor were located showed the same temperature distribution. This provides preliminary evidence that early morning temperature distribution, or at least the location of cold areas of the check, can be detected using remote sensing from an aircraft

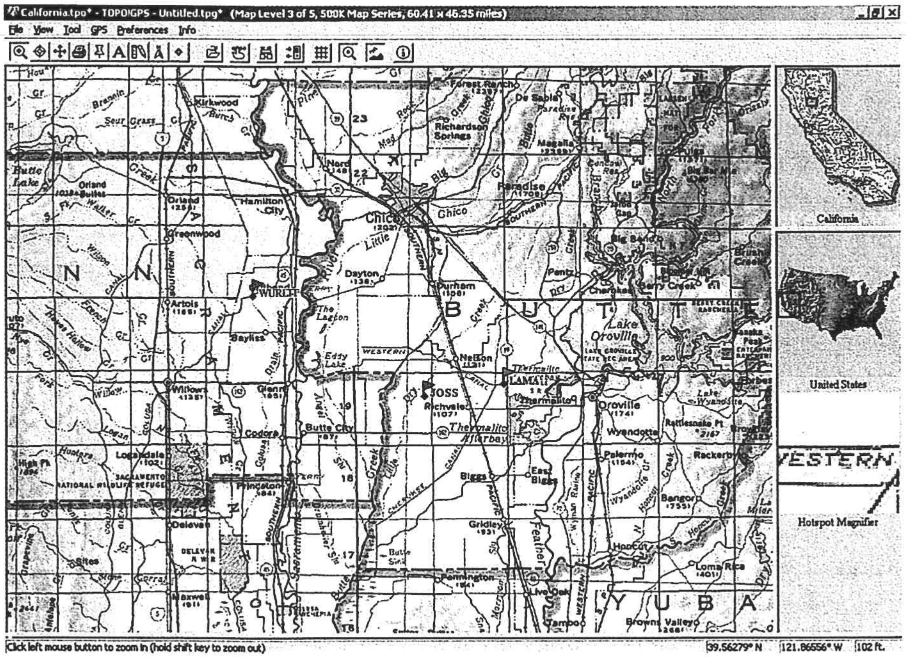

Figure 2: Flags indicate the locations of the field scale level studies.

SUMMARY OF 2002 RESEARCH (MAJOR ACCOMPLISHMENTS) BY OBJECTIVE:

Based on the results of the 2001 experiment, the probability of determining a significant relationship between water temperature and yield loss due to both blanking and other causes is very high. Results in 2002 tended to confirm those obtained in 2001. A final analysis is not yet complete but preliminary data are available.

Fig.3 shows the relationship between yield and hours of exposure to water below 60°F during the early, mid, and late seasons. Similar data are available for hours of exposure to water below 55°F and water below 65°F. The general conclusion is that the rice crop is most susceptible during the early to mid season and that susceptibility begins at temperatures around 65°F.

Figure 4 shows a thermal image made from an airplane of the same rice check represented in Figure 3. The cooler areas of the field (dark blue) correspond to areas in Figure 3 where low in temperature and yield were observed.

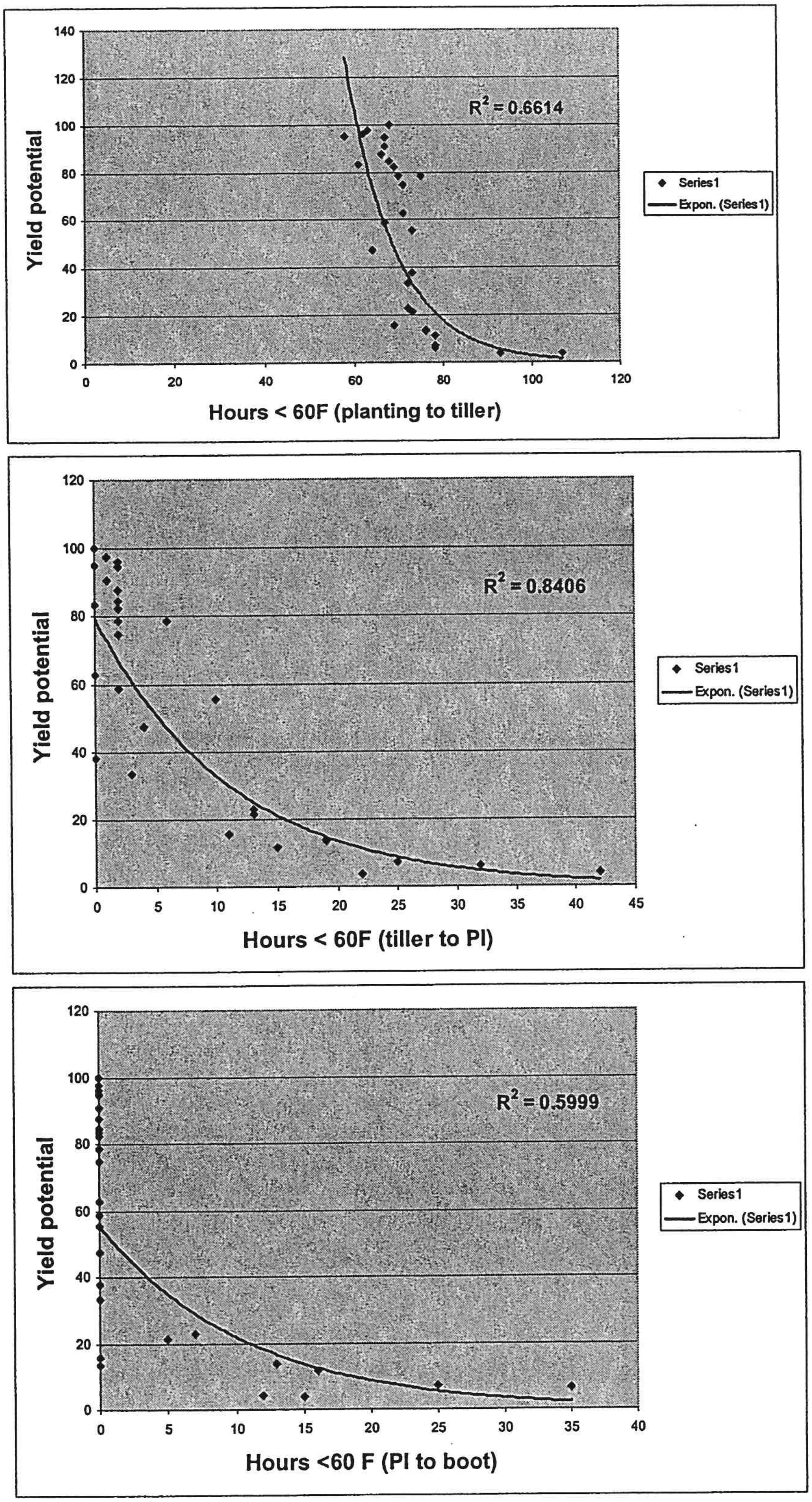

Figure 3. Plots of yield (as a fraction of potential yield) vs. hours of exposure to water below 60°F during the early, mid, and late seasons.

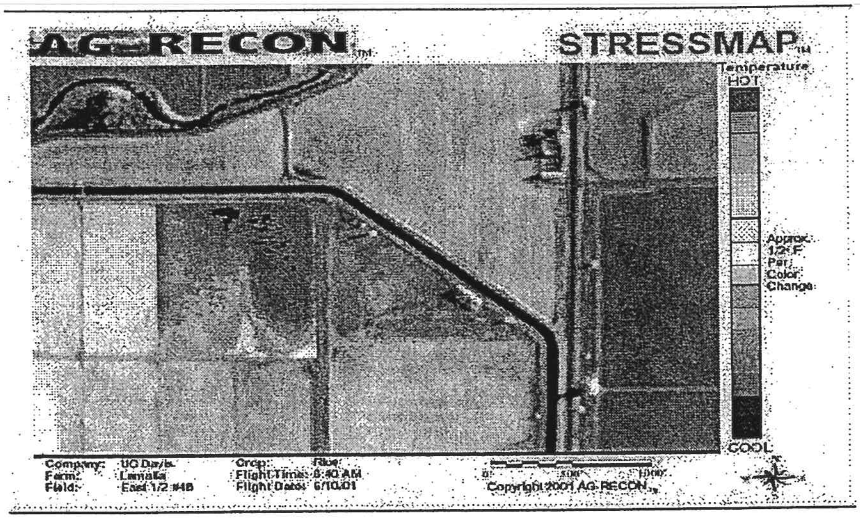

Figure 4 Temperature distribution at Thermalito Afterbay study measured using remote sensing from an aircraft. Ag-Recon, Davis, CA.

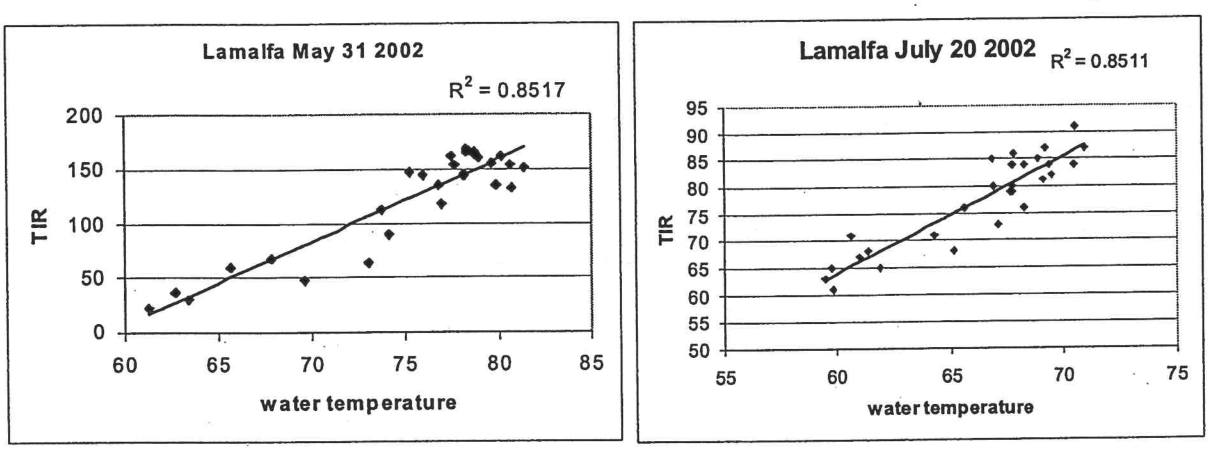

Figure 5. Relationship between thermal infrared value and water temperature on May 31 and July 20, 2002.

Figure 5 shows the relationship between water temperature and thermal infrared image value for the Lamalfa field during the early and mid season. These plots indicate that during this time thermal infrared imagery can provide a useful and relatively inexpensive way to measure the distribution of water temperature.

PUBLICATIONS OR REPORTS:

Alvaro Roel, R.G. Mutters, James Eckert and R.E. Plant. Water temperature Impact on California Rice Production. Rice Field Day (2002)

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

Water temperature has increasingly become a matter of concern for California rice farmers due to the desire of regulatory agencies to improve habitat quality for fish. Based on these project preliminary results, we were able to precisely quantify the impact of water temperature in yield losses in two different fields, as well as, starting to develop the dimension of the impacts at the regional level.

The data show that these two fields present a high spatial and temporal variability in water and canopy temperature as well as very significant relationship between these behaviors and yield (Figure 3).

In summary the project allowed the quantification of the spatial and temporal variability of water and canopy temperature and their effects in final yield. Significant effect of the hours that the crop is under a threshold water temperature in yield was found (Figure 3).

The good agreement between the temperature measured with the sensor and the thermal aerial image (Figure 5) provides evidence that early morning temperature distribution, or at least the location of cold areas of the check, can be detected using remote sensing from an aircraft. At least one commercial company in the Sacramento Valley offers thermal remote sensing at a moderate cost per acre, and other companies have the capacity to make this service available if a market exists.

Previous studies have shown that cool air temperatures during the period of panicle development may lead to pollen sterility and hence to blanking and yield reduction. This project preliminary analysis indicates that even in "normal" growing season, with no problem of cool air temperature, there can be significant reduction of yield due to water rather than air temperature effects. Farmers will need to quantify and separate the effects in yield due to cool air temperature from the effects due to low water temperature to illustrate to water agencies that changes of water delivery mechanism that would substantially reduce water temperature may adversely impact crop productivity. A precise quantification of the yield loss due to temperature effects will provide the grower with the capacity to determine whether the economic gains associated with improving temperature distribution are worth the costs to make the improvement