COMPREHENSIVE RESEARCH ON RICE ANNUAL REPORT

January 1, 1982 - December 31, 1982

PROJECT TITLE :

Genetic and Environmental Influence on Head Rice in California - An Epidemiological Approach.

PROJECT LEADER :

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LEVEL OF 1982 FUNDING : $6,500.

OBJECTIVE AND EXPERIMENTS CONDUCTED BY LOCATION TO ACCOMPLISH OBJECTIVES :

General Objective

To determine by analysis of statewide records available from California rice mills, some factors associated with head yield. Factor such as variety, rice growing location, time of harvest, grain moisture content and effects of local climatic factors affecting plant growth, crop yields and head rice will be investigated.

Working Objectives

1. Collect and computerize California rice information from records of Rice Growers Association in Sacramento and Butte County Rice Growers Association. Collect climatic data from

weather stations in Sacramento Valley to evaluate the phenological aspect of rice quality.

2. Identify and quantify major genetic and environmental factors that may affect head rice under current cultural practice and milling techniques in California.

SUMMARY OF 1982 RESEARCH (MAJOR ACCOMPLISHMENTS) BY OBJECTIVE:

1. Three years information (1979-1981) on rice varieties, location, head yield, broken rice, moisture at harvest and harvesting date for individual lots of the Rice Growers' Association were processed into a departmental micro-computer system on the UC Davis Campus. Yield data in the same period were also computerized from Butte County Rice Growers' Association. Weather data were obtained from UCD Integrated Pest Management Office and contains daily high and low temperatures from nine weather stations located throughout the rice growing area. Computer programs were developed to calculate degree days (the area of the temperature curve between 65 F and 95 F), cold units (between daily minimum and 65 F), and heat units (between 95 F and the daily maximum) for each variety, location and year.

   Data from these sources were combined for statistical analysis. Various summary tables, character distributions, bivariable plots, and stem-and-leaf figures can now be easily produced if requested by California growers or researchers.

2. Several genetic, environmental and cultural factors are identified as having an important effect on California head rice. They are described below.

   Genetic or Cultivar Related Factors

   Plant height is not an important factor in influencing head rice. Both high and low head rice were observed for both short and tall plants. The substitution of tall stature rice by short does not affect the overall head yield in California. In most cases short grain cultivars had higher head yields than medium grain cultivars. But the contrary is also found in Butte, Davis areas and Willows in 1981. Therefore the interaction between grain size and the mechanical aspects of harvesting and milling could be a critical factor to maximize the head rice.

The most outstanding difference between head rice were found between maturity groups (Table 1). Late maturity cultivars on the average, had about 10% higher rice head than very early cultivars and about 5% greater than early cultivars. All cultivars were planted in several areas, the difference between maturity groups were repeatedly observed all environments. Further analysis of the distribution of harvesting dates for each cultivar, and the temperature at harvesting time, indicates that only 3% of the very early cultivars were harvested at temperatures above 95 F. Similar distributions were also found for late maturing cultivars (Table 2). Thus the difference in head rice between maturity groups is likely a genetic character which may be closely linked with maturity.

Since each cultivar was planted in several areas and years, the stability of head rice is also examined for each cultivar. From the ranges in head rice a cultivar was classified into stable, unstable, or highly unstable classes if the range of head rice was less than 2%, between 5 to 9% or above 9% respectively (Table 3). Based on this criterion, M-7 and Calrose 76 were the most stable cultivars with uniformly high head yield. S201, Colusa, and Earlirose, on the other hand, are highly unstable and were location specific. M-101 was unstable and had uniformly poor head yield at all environments. Other cultivars in the unstable group had reasonably good head rice. This result suggests that in addition to maturity, there is diverse genetic background in the head rice of these cultivars in responding to environments. Thus location specific cultivars may be selected to maximize the head yield, if no one cultivar can be found with all the desirable traits in all environments.

Analysis of BUCRA data showed that grain yield is positively correlated with head rice (That is, when grain yield increases head yield increases). This result is extremely encouraging because it implies that selection of cultivars with both high grain yield and head rice is possible.

Environmental Factors

Heat units and temperature above 95 F during the period of maturation did show an adverse effect on head rice. Cold units (below 65 F) at the 10 day period prior to flowering had little effect on head rice but a significant reduction of grain yield was found in the BUCRA data. Degree days (total temperature between 65 F and 95 F in the grain filling period) were found positively correlated with head

yield for most cultivars. But the exact range of temperatures optimal to rice growth and development need to be further defined for various physiological stages.

Cultural Factors

Most cultivars were harvested within 10 days between the middle of September and the end of October (Table 2). The temperature was above 95 F for only a few days in this period. Thus, no significant relationship between harvesting days and head rice was detected in our analysis. (For lack of information, the effect of wind was not evaluated, though the speed and direction of wind may have a detrimental effect on the head rice).

Average moisture content at harvest ranged from a low of 19±2.7% in 1979 at Modesto to a high of 23±2.2% in 1981 at Orland. The variability in head rice was increased when rice was harvested at lower moisture levels. This result documents that grain harvested at higher moisture levels (above 23%) will be more robust in resisting possible injuries or cracking during the harvesting and milling process. Moisture curves were developed for 10 commonly planted cultivars in California from 1979 to 1981 (Figure 1). The predicted upper limit of optimal harvesting moisture ranged from 23.6% for Colusa to a high of 34% for M-9. However, very little change in head rice is predicted for M-9 in the 20-30% moisture range. All other optimums fall in the range of 24 to 30 %. The predicted maximum head rice increased from early to late maturing cultivars. But the required moisture to produce maximal head rice decreased from early to late maturing cultivars. The optimal moisture levels at harvest are 29%,27% and 25% for very early , early and late maturing cultivars respectively.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS :

California rice data of 1979 to 1981 were obtained from the Rice Growers Association in Sacramento and Butte County Rice Growers Association. These data were analyzed together with climatological data obtained from the Office of the Integrated Pest Management Program at UCD. Important Genetic, environmental and cultural factors that affect California rice head yield were evaluated, and their effects were quantified.

Plant height was found not to be an important factor, hence, the substitution of tall stature rices by short stature rices should not affect the overall head rice in California. The difference of head rice between short and medium grain cultivars

depends on location. Therefore the interaction between grain size and the mechanical aspects of harvesting and milling can be a critical factor to maximize the head yield.

The most outstanding difference in head rice were found between maturity groups. Detailed analysis of the distributions of temperatures and locations suggests that the head rice difference between maturity groups is a genetic and not an environmentally related character. It was also shown that cultivars are different in respect to the stablility of head rice when evaluated across environments.

In the past three years, California head rice was decreased from 55.1 to 53.8%. In the same period ,there was an increase of planting early maturing cultivars by growers. The analysis of cultivars, however, showed a general increase in head rice over years, which reflects an improvement either made by growers in cultural methods and/or by dryers and mills. Thus the decrease in head rice has to be accounted for by the general replacement of late to early maturing cultivars.

Our preliminary analysis of BUCRA data, however, indicated a positive relationship between head rice and grain yield. This result is extremely encouraging since it implies that selection of cultivars with both high grain yield and head rice is possible.

Average moisture content at harvest ranged from 19% to 23% in the areas around the 9 weather stations from Orland to Modesto. Higher moisture content at harvest could help reduce the risk of rice grain broken by harvesting and milling. Moisture curves were developed for each cultivar. The optimal moisture content at harvest were 29%, 27% and 25% for very early, early, and late maturing cultvars,respectively.

Table 1. Percent head yields of major rice varieties planted in major areas of in California (RGA data).

	Very Early Varieties		Early Varieties				Intermediate	Late Varieties		
	Earlirose	M101	Colusa	S6	S201	M9	M5	Calrose	Calrose 76	M7
(Grain size)	(M)	(M)	(S)	(S)	(S)	(M)	(M)	(M)	(M)	(M)
Total lots	582	167	59	1105	408	1522	60	89	237	336
(Average head yield in areas around the 9 weather stations with proportion of plantings in parantheses)										
Orland	54.5^{M} 1/ (1.4%)	48.0 (1.8%)	--	55.3 (1.3%)	54.2 (0.2%)	56.5^{M} (1.4%)	52.7^{m} (1.7%)	--	--	59.3 (9.5%)
Chico	53.2 (1.2%)	47.6 (2.4%)	51.5 (8.5%)	56.1 (4.8%)	47.4 (12.7%)	54.6 (4.8%)	53.0 (5%)	--	59.9^{M} (1.3%)	59.2 (5.7%)
Willows	50.0 (2.1%)	44.9 (5.4%)	47.1^{m} (27.1%)	53.5^{m} (21.6%)	51.4 (23%)	50.2^{m} (21.2%)	54.9 (6.7%)	58.7^{M} (22.5%)	59.4 (45%)	59.9 (36.3%)
Colusa	48.2 (1.5%)	42.5 (7.8%)	49.2 (10.0%)	54.6 (13.9%)	54.8^{M} (14.5%)	55.0 (13.6%)	54.8 (26.7%)	58.4 (10.1%)	57.7^{m} (19.8%)	60.3^{M} (34.2%)
Marsyville	52.4 (7.2%)	46.7 (13.2%)	57.0 (32.2%)	55.2 (14.2%)	48.6 (18.9%)	55.8 (25.5%)	55.3 (18.3%)	57.2 (20.2%)	57.9 (17.7%)	60.2 (7.1%)
Sacramento	49.1 (39.3%)	48.6^{M} (61.1%)	58.9^{M} (11.9%)	58.2 (16.7%)	45.3^{m} (18.9%)	55.8 (27.2%)	57.8 (10%)	53.4^{m} (23.6%)	58.9 (8.9%)	59.2 (3.9%)
Davis	54.4 (0.9%)	46.1 (1.8%)	53.8 (10%)	55.2 (4.8%)	52.5 (4.9%)	54.3 (5.8%)	60.7 (10%)	56.8 (4.5%)	58.7 (4.6%)	58.8^{m} (3.2%)
Stockton	51.8 (1.9%)	--	--	61.4^{M} (0.4%)	--	54.5 (0.1%)	--	--	--	--
Modesto	46.5^{m} 2/ (44.5%)	42.0^{m} (6.6%)	--	55.8 (22.6%)	52.2 (6.9%)	55.4 (0.3%)	60.9^{M} (21.7%)	57.1 (19.1%)	59.7 (2.5%)	--
Ave.	48.4	47.0	53.0	55.5	51.9	55.4	57.0	57.0	59.0	60.0

1/ Maximal average head yield.

2/ Minimal average head yield.

Table 2. Distribution of harvesting dates, percent lot harvested at temperature less than 95 F, and the major production areas for each variety.

Variety	% harvest in months Sept	Oct	Nov	Dec	Harvest date at 1st day	90%	99%	% harvest less 95 F	Area of 20% more production
Earlirose	15	65	17	3	Sept 10	Nov 10	Dec 9	98%	Sac., Modesto
M-101	11	54	28	7	Sept 14	Nov 2	Dec 15	96%	Sac.
Calrose	39	54	7	0	Sept 13	Oct 23	Nov 20	95%	Willows, Marysville
S6	27	65	7	1	Sept 13	Oct 31	Nov 17	86%	Willows, Modesto
S-201	30	59	10	1	Sept 10	Oct 31	Nov 23	99%	Willows
M9	25	61	12	2	Sept 10	Nov 6	Dec 2	91%	Willows, Marsyville, Sac.
M5	28	65	7	0	Sept 18	Oct 28	Nov 7	98%	Colusa, Modesto
Calrose	3	85	12	0	Sept 28	Oct 31	Nov 6	100%	Willows, Marysville, Sac.
Calrose 76	3	84	14	0	Sept 24	Nov 1	Nov 10	93%	Willows, Colusa
M7	3	88	9	0	Sept 22	Oct 31	Nov 20	97%	Willows, Colusa

Table 3. Stability of rice head yields.

Variety	Range of ave. head yield	Stability over environments
M7	58.8 ~ 60.3	Stable and uniformly high
Calrose	57.7 ~ 59.9	Stable and uniformly high
Calrose	53.4 ~ 58.7	Unstable and good head yield
M5	52.7 ~ 60.9	Unstable and good head yield
M9	50.2 ~ 56.5	Unstable and good head yield
S6	53.5 ~ 61.4	Unstable and good head yield
M101	42.0 ~ 48.6	Unstable and poor head yield
S201	45.3 ~ 54.8	Highly unstable, location specific
Colusa	47.1 ~ 58.9	Highly unstable, location specific
Earlirose	46.5 ~ 54.5	Highly unstable, location specific

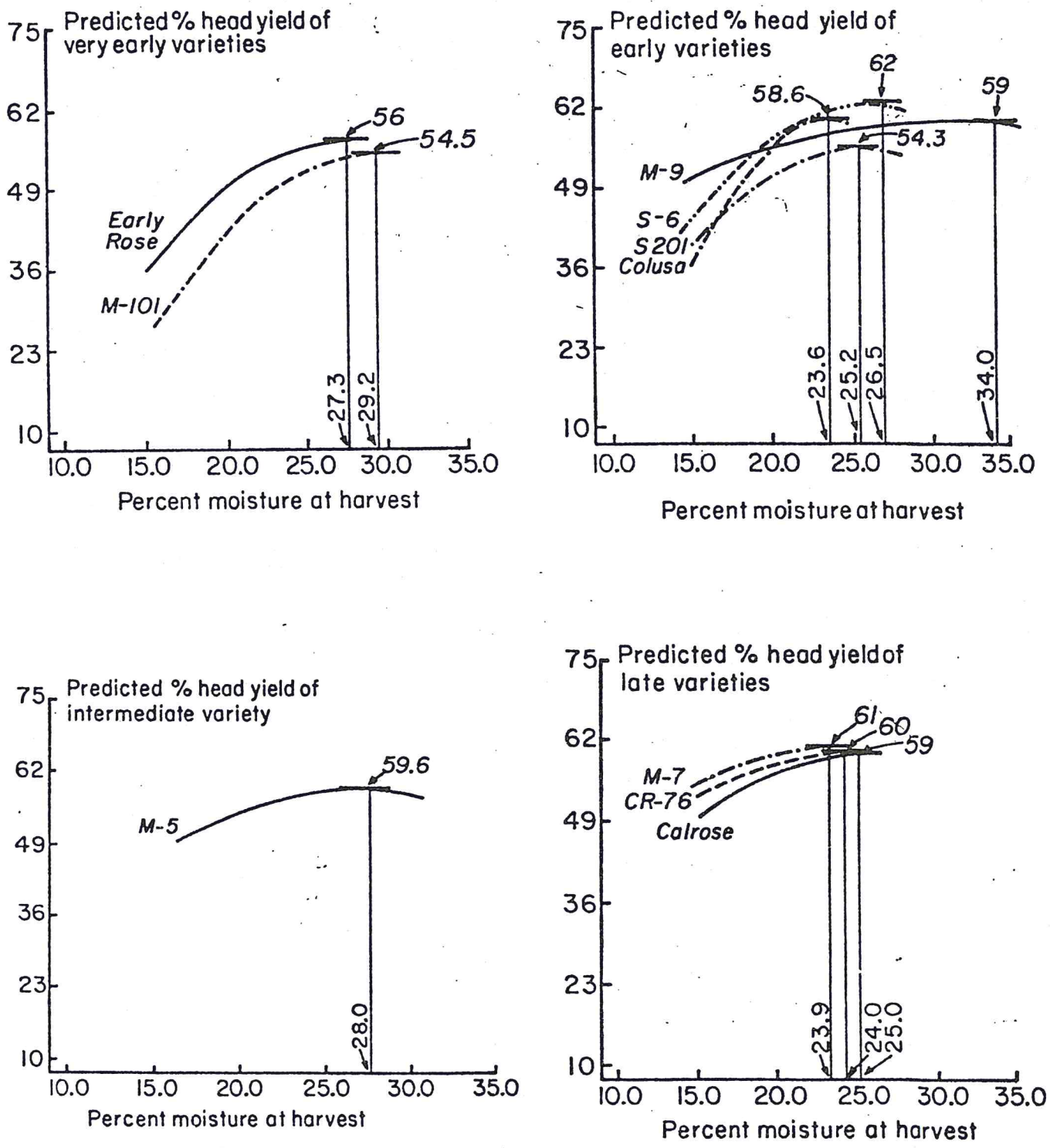

Figure 1. Predicted head yields for California commercial cultivars harvested at various levels of moisture.