Project No. RM-5

FINAL REPORT
COMPREHENSIVE RESEARCH ON RICE
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Project Title: Analysis of Variability in Rice Milling Appraisals

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Objectives:

Determine the effect of the following factors on rice quality as measured by head and total rice milling appraisal values:

a) Moisture content of appraisal sample
b) Rice cultivar
c) Length of time sample is stored (tempering)
d) Appraisal test error of the California Department of Food Agriculture laboratory.

Also, investigate how appraisal quality might be affected by 1) low head rice, 2) method of sample collection, 3) operating conditions of the sample milling equipment, and 4) sample drying technique.

Summary of 1987 Research

I. Effect of Rice Cultivar, Sample Moisture, and Storage Time on Appraisal Quality.

Procedure:

Samples for this test were prepared by collecting about 300 lbs each of L-202, M-202, and S-201 paddy at a dryer. The rice was obtained directly from trucks as they were unloading. We selected rice that was harvested at a high enough field moisture to ensure that it was of high quality. Each 300 lb lot was then thoroughly mixed and placed on a laboratory dryer. One quarter portions of each cultivar were dried to approximately 13.5%, 12.0%, 10.5%, and 9.0% moisture using the California Warehouse Association (CWA) sample drying procedure. This method subjects the rice to drying air of less than $110^{0}F$ for 30 min., followed by a 4 hour tempering period. The drying and tempering cycle is repeated until the rice reaches the desired moisture. The quarter portions were then thoroughly mixed and split, using a standard grain splitter, into 16 -1250 gram samples. The 1250 gram samples were stored in sealed glass jars. The jars were weighed just after filling and prior to analysis to insure that there was no moisture loss during storage. After 10 days, 31 days, 60 days, and 118 days of storage, four samples at each moisture for each cultivar were analyzed for milling quality and moisture content at the California Department of Food and Agriculture (CDFA) laboratory in West Sacramento, CA using standard USDA-FGIS procedures. Air temperature in the lab was held between 68°F and 74°F and the relative humidity between 46% and 54%.

We also evaluated the effect of storage time and appraisal moisture on rice with a low appraisal quality. We collected some long and medium grain rice that was harvested at a low moisture and had a low overall quality. Samples were prepared in the same manner as high quality rice samples.

Results:

The appraisal quality data showed that there was no significant effect of storage time on head and total results for any of the three cultivars. This allowed us to combine the data obtained for each storage time into one data set.

The combined data showed that moisture content of the appraisal sample and cultivar had significant effects on the head (milled whole kernels) and total (milled whole and broken kernels) results. Figures 1, 2, and 3 show that as moisture content of the appraisal sample decreases both head and total values increase. For high quality L-202 rice, head rice increased by 14.4 percentage points comparing rice at 13.5% moisture with rice at 8.5% moisture. Over the same range of moisture, the total rice increased by 5.1 percentage points. The effect was less but still significant for the high quality M-202 rice. For S-201 rice, appraisal moisture had the smallest effect. Over a range of moisture from 14% to 8.5%, the head rice increased by only 2.8 percentage points and the total rice increased by only 2.7 percentage points.

Most millers in the state believe that it is not feasible to mill rice at moistures lower than 12%. Table 1 summarizes the effect of moisture content of the sample on milling appraisal by comparing the difference in head and total for rice appraised at 13.5% with rice appraised at 12% moisture. Even over this smaller range of moisture, there is still a significant effect of milling moisture on head and total values.

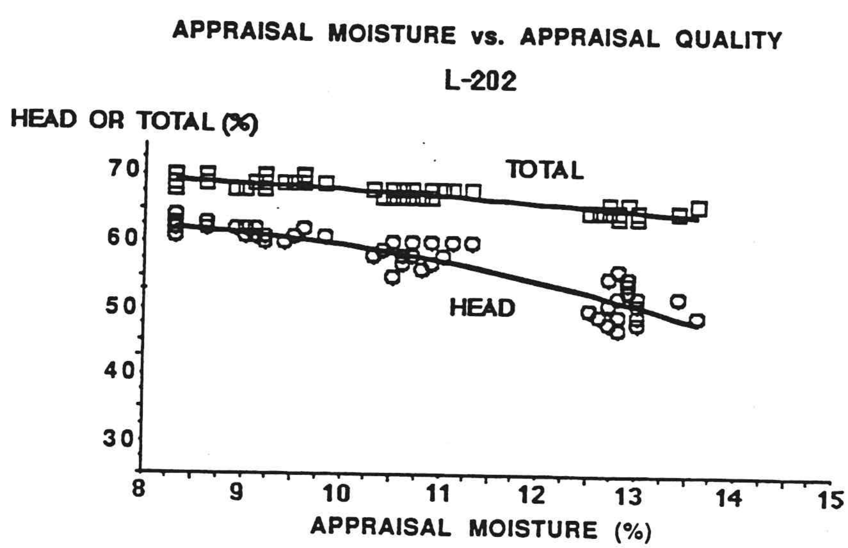

Figure 1. L-202 head rice and total rice data for a single lot of high quality rice split into 64 sub-samples appraised at differing moisture levels and after different storage periods. (Head rice equation-R squared=88, overall F=221, probability=0.0001, Total rice equation R squared=86, overall F=189, probability=0.0001)

APPRAISAL MOISTURE vs. APPRAISAL QUALITY
M-202

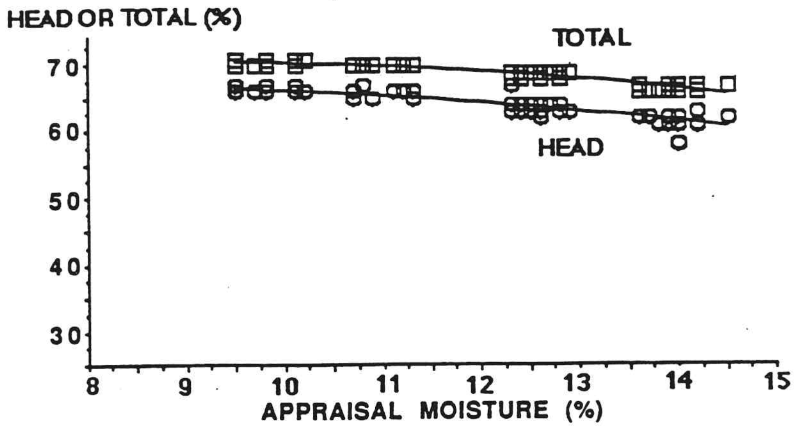

Figure 2. M-202 head rice and total rice data for a single lot of high quality rice split into 64 sub-samples and appraised at differing moisture levels and after different storage periods. (Head rice equation-R squared=81, overall F=267, probability=0.0001, Total rice equation R squared=89, overall F=257, probability=0.0001)

APPRAISAL MOISTURE vs. APPRAISAL QUALITY
2-201

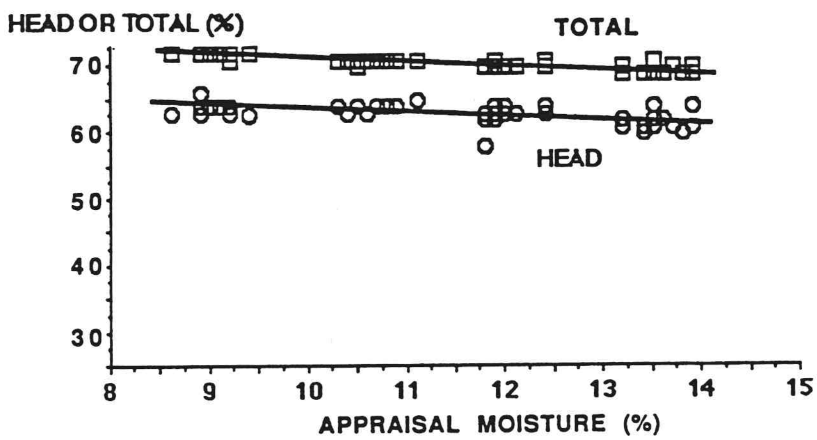

Figure 3. S-201 head rice and total rice data for a single lot of high quality rice split into 64 sub-samples and appraised at differing moisture levels and after different storage periods. (Head rice equation-R squared=35, overall F=33, probability=0.0001)

Table 1. Loss in head and total rice caused by milling appraising high quality rice at at 13.5% versus 12% moisture.

	Points of Appraisal Quality Loss	
	Head	Total
Long grain	6.3	1.8
Medium grain	1.8	1.9
Short grain	0.7	0.7

The financial effect of appraising a high quality sample at a lower moisture is shown in Table 2. The value of the rice is based on 1987 loan rates and the decrease in value caused by selling at lower moisture content is accounted for. The value of long grain rice is increased by $0.35 per cwt. when it is appraised at 12% moisture content compared with appraisal at 13.5%. Medium grain rice gains $0.10 per cwt. when appraised at 12% moisture. The value of short grain rice is slightly reduced at 12% moisture because the loss in value caused by the weight loss is greater than the increase in value caused by the higher appraisal results.

Table 2. Financial effect* of drying appraisal samples to 12% versus 13.5% moisture.

	L-202	M-202	S-201
Head/Total @12%	54/66	64/69	63/70
Head/Total@13.5%	48/64	62/67	62/69
Difference	6/2	2/2	1/1
Value @13.5% ($/cwt)	6.36	6.71	6.88
Value @12% ($/cwt)	6.82	6.91	6.92
Value of Wt Loss @12% ($/cwt)	.11	.10	.10
Net Value @12% ($/cwt)	6.71	6.81	6.82
% Increase in Value @12%	5.5	1.5	-0.9

*Based on 1987 loan value.

If an actual lot of rice were dried to a lower moisture to improve its appraisal quality, the cost of the extra drying would have to be included in a financial analysis. Dryer operators indicate that the cost of extra drying in a column dryer would be in the range of $0.10-$0.20 per hundred weight. If dried during long term storage, the cost would be less than this. In fact, rice often dries to 12% or lower in storage because of normal aeration and storage practice and it may be reasonable to assign no cost to extra drying if the rice will be stored for several months before it is milled.

The effect of moisture content on appraisal results of low quality L-202 rice is shown in Figure 4. It shows that there is a smaller effect of appraisal moisture on head and total rice compared with high quality L-202. A medium grain test showed no significant difference in the effect of appraisal moisture on head yields, although the low quality medium grain rice we worked with did not have as low a head yield as the long grain rice did. This indicates that the results we obtained for the high quality rice present the maximum potential effect of appraisal moisture on appraisal results. Particularly for long grain rice, the effect of appraisal moisture on appraisal quality is reduced as the overall quality of the rice decreases.

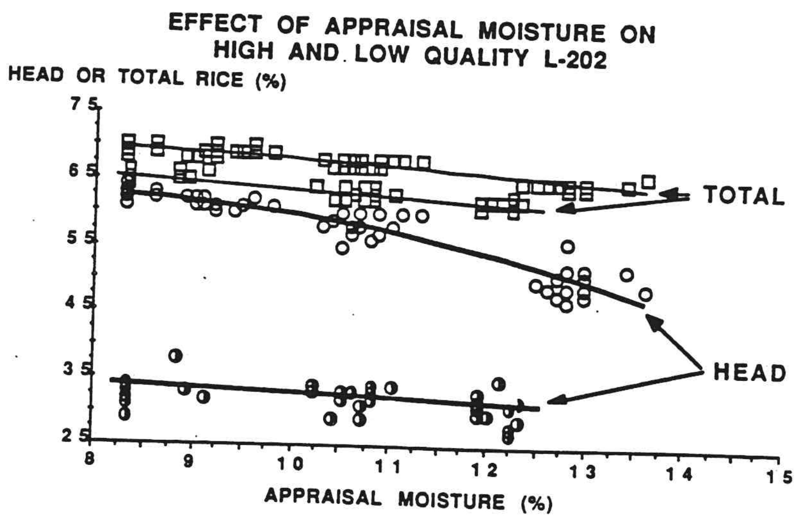

Figure 4. Comparison of the effect of appraisal moisture on high quality and low quality L-202.

We noticed that the milled long grain rice was not consistent in color. The lower moisture samples were significantly darker than the higher moisture samples, although all of the samples were light enough to be classified as well milled according to USDA-FGIS standards. The darker samples may have been less well milled, which would result in higher head and total results compared with the lighter, high moisture samples.

Milled appraisal samples of short, medium, and long grain rice were analyzed for oil content. This is a standard method of determining the level of milling. The data in Figure 5 show that low moisture content samples tend to have a higher oil content than the high moisture samples and this is particularly evident with long grain rice. However, the oil content of the milled samples does not begin to increase significantly until the moisture drops below 11.5%, yet head and total values increase at their greatest rates between 11.5% and 13.5% moisture. Therefore, over the full range of moisture content, low appraisal moisture results in low levels of appraisal milling. However, at commercially important moistures, between 11.5% and 13.5%, the level of milling is fairly constant and does not appear to be a cause of variation in head and total results.

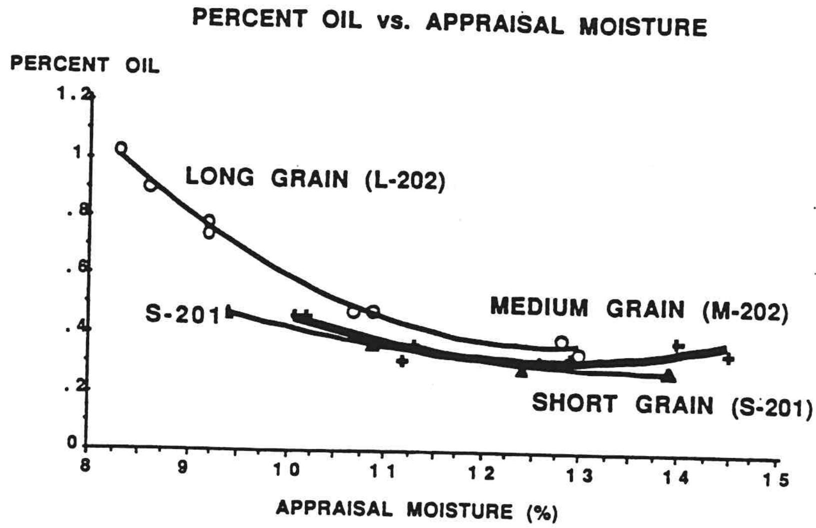

Figure 5. Percent oil in samples appraised by the CDFA appraisal test versus the moisture of the sample at the time the appraisal was performed.

II. Variability Caused by the CDFA Laboratory.

Procedure:

One hundred twenty-four samples of short, medium, and long grain rice were analyzed to determine the typical level of variability in appraisal results for the CDFA lab in West Sacramento. One year old samples of each cultivar were collected from local warehouses. Each sample was mixed and split with a standard grain splitter and separated into 1500g samples that were held in polyethylene bags. Each sample was then given to three warehouses in the Sacramento Valley for each to submit using their own labeling system. This insured that the CDFA lab personnel did not know that these samples were a part of the test. Some of the samples were retained and analyzed with UCD personnel present at the lab.

Results:

Table 3 is a summary of the results. The data in the table are a 95% confidence interval based on the variability in the appraisal results for each cultivar. A 95% confidence interval means that 95% of the appraisal results are expected to fall within the tolerance listed. The table shows that the CDFA lab has a tolerance of less than or equal to ± 2.6 points of head and ± 1.3 points of total for the three cultivars tested. There is very little difference in the variability between the three cultivars.

Table 3. **Variability in appraisal results from the CDFA laboratory.**

	Variability* (± points of head or total)	
	Head	Total
Long grain	±2.6	±1.3
Medium grain	±2.4	±1.2
Short grain	±2.4	±1.3

*variability is measured by a 95% confidence interval

III. Variability Caused by Truck Sampling.

Procedure:

We conducted a preliminary evaluation of the potential variability in appraisal results caused by sample collection. Four trailer loads of rice, 3 medium grain and 1 short grain, were sampled using either an open-ended vacuum probe or multi-chambered vacuum probe. For each truck we also collected 16 to 20 appraisal samples by placing a can in the stream of rice as the trailer was being unloaded.

Results:

The four probe tests showed a tolerance due to the sampling system (as measured by a 95% confidence interval) of ±1.8 points of head and ±1.7 points of total. This tolerance is about as large as the tolerance of the CDFA appraisal analysis.

The tolerance of samples taken with a catch can was ±4.1 points of head and ±2.2 points of total. This verifies that an individual can sample has a significantly higher variability in appraisal data compared with sampling with a probe. All samples should be collected with a probe. If a catch can must be used, take at least three to four samples throughout the load of a truck and then mix and split the sample.

IV. Variability Caused by Sample Drying.

Procedure:

Five batches of medium grain rice of 4 replications each were dried with unheated air, using a standard recommended by the CWA. The standard requires that the rice be dried with air heated to less than 110°F and that rice temperature not exceed 95°F. Heated air is applied for 30 min., followed by a 4 hr. tempering period. The heating and tempering cycle is repeated until the rice reaches the prescribed moisture. Unheated air drying was done with a continuous flow of air at temperatures between 65°F and 74°F until the samples reached final moisture.

Results:

As seen in Table 4, the CWA standard method reduced head rice by an average of 2.4 points. The CWA method did not have a significant effect on reducing total rice, but there was a trend in this direction. Warehouse operators attempt to achieve quality reductions of about two points in head rice and one point in total to simulate the typical quality loss in their drying and handling operations.

Table 4. Effect of sample drying method on appraisal quality.

Sample	Unheated Air Head/Total	CWA Method Head/Total
1	58.8/66.2	56.5/66.0
2	55.8/65.2	53.0/66.3
3	55.5/64.2	54.0/63.8
4	54.0/67.0	51.0/65.5
Average*	56.0/65.7	53.6/65.4

*Difference in head rice between drying methods is significant at 95% level. Total rice data is not significantly different.

V. Discussion of Results.

Moisture content of the sample at appraisal has a large enough effect on the appraisal results to effect the value of long and medium grain rice. Because of this we recommend that all appraisal statements list the moisture of the sample. This will help the industry identify one of the major sources of variability in results.

However, the effect of appraisal moisture on appraisal results is most obvious when comparing data from rice of the same lot. When comparing data from different lots of rice the effect of moisture will usually not appear as great as our data indicate. For example, Figure 6 is a plot of head and total results for 51 lots of long grain rice received at a local warehouse. There is a significant effect of moisture on appraisal

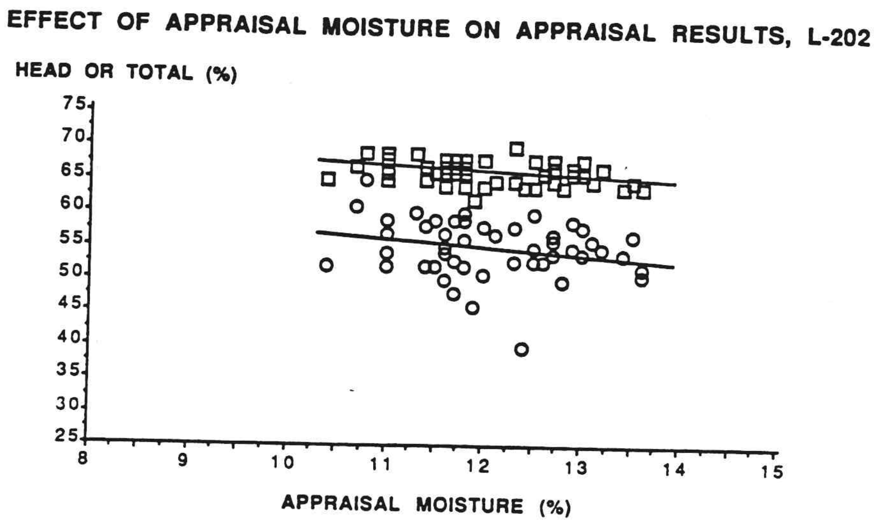

Figure 6. Data from a warehouse in the Sacramento Valley of mixed lots of L-202 showing the effect of appraisal moisture on head and total rice.

results, but the effect is not as great as we observed in Figure 1. This is because head and total quality are also affected by harvest moisture, sample drying method, type of harvester, harvester operation, cultural practices such as fertilizer level, and weather conditions just prior to harvest. All of these factors differ between fields and contribute to the difference in results between the 51 lots in the figure. These other sources of variability reduce the apparent effect of appraisal moisture on head and total results. But if all these other factors which affect rice quality could be held constant, sample moisture would prove to be as large a factor as our data indicate.

It might be convenient to determine a set of simple conversion factors to correct for the effect of appraisal moisture on appraisal results. For example, for long grain rice, each point decrease in appraisal moisture below 13.5% moisture will increase head and the total by certain constant values. Our data show that corrections like this will not be easy to develop. First, the effect of appraisal moisture on appraisal results is not linear for long grain rice. The correction factor would vary with appraisal moisture. But most importantly, the data for low quality long grain, dictates that the correction factor varies with the overall quality of the rice. Appraisal results of low quality rice are not as much affected by appraisal moisture as they are with high quality rice. Any system of correction factors would have to account for rice cultivar, appraisal moisture, and overall quality level of sample. A complicated system like this would be time consuming and difficult to verify.

The truck sampling test showed clearly that there is some variability caused by this procedure. Vacuum probes should be used instead of a catch-can system, to hold variability to a minimum.

Variability caused by the CDFA lab and truck sampling is random in nature. This means that if enough samples of a given lot of rice are taken, the average of the samples will be close to the average quality of the lot. However, the effects of sample moisture and sample drying method are not random and can cause the appraisal results to be very different from the actual quality of a lot of rice. Probably the best way for the industry to deal with this potential problem is to insure that appraisal samples are properly dried and dried to an industry agreed upon standard moisture.

General Summary:

Price quality appraisal results are significantly affected by the moisture content of the appraisal sample. For example, long grain rice analyzed at 12% moisture can have 6.3 points of head and 1.8 points of total higher quality compared with the same sample dried to only 13.5% moisture. The effect of moisture is less with medium grain rice and much less with short grain rice. Length of time between sample drying and appraisal does not have a significant effect on appraisal results. The sample drying method recommended by the California Warehouse Association reduces medium grain appraisal results by 2.4 points of head but has no significant effect on total rice. Variability caused by vacuum probe truck sampling is ± 1.8 points of head and ± 1.7 points of total. A vacuum probe sample has about one half as much variability compared with a grab sample taken as the trailer is emptying. Variability in appraisal results caused by the CDFA lab is less than or equal to ±2.6 points of head and ±1.3 points of total. This error and truck sampling are random. The effect of random error can be minimized by taking many appraisal samples of a lot and averaging the results.