ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE
January 1, 2006 - December 31, 2006

PROJECT TITLE: Enhancement of Forage Quality of Rice Hay

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OBJECTIVES OF RESEARCH:

Objective 1 – Improvement of physical qualities of rice hay forage

A. Treat hay at one location.
B. Collect samples from treated and untreated rice hay.
C. Wet chemistry and biological analysis were conducted to determine forage quality.
D. Evaluate the impact of the treatment on forage quality by feeding 40 head of cattle.

Objective 2 – Improvement of chemical qualities of rice hay forage

A. Coordinate with USDA Ag. Research Service researchers.

SUMMARY OF RESEARCH:

OBJECTIVE 1. *Improvement of physical qualities of rice hay forage*

2005 Research Methods
Three different treatments were applied in a split rice plot design and replicated in four rice checks:

Control or unmacerated
Regular macerator
Rice designed macerator

The rice macerator was specially designed with two steel roller that had double the surface area of control of the regular macerator. This design was based on the 2004 study results that physically did not achieve enough treatment and provided no improved animal performance. Each check was divided into three sections and the straw rows were treated. Core samples were taken from eighteen bales of each treatment in the check. This process was repeated in four checks. Samples were submitted to the laboratory and analyzed for forage quality differences using wet chemistry.

Learning from the 2004 animal research feeding study, the 2005 study design was altered to improve confidence in the results that maceration did not significantly improve the intake or digestibility of rice hay. The research design was increased to 8 groups of 10 steers – four groups being fed rice designed macerated and four unmacerated. The steers were weighed on Day 0 and assigned to blocks by weight and then randomly assigned to one of the eight groups. Each group was fed a 60 % alfalfa, rice bran, cottonseed and 40% rice hay diet by weight at the start of the study period. Then the each pen is fed rice hay adjusted to their consumption refusal (or waste) rate of no more than 3% Another change in the study design is that alfalfa, rice bran, cottonseed, and oyster shell are fed in the morning at 8 am. The animals were allowed to completely consume all contents in the cement feeding bunk and then rice hay is fed in the long stem form, straight from the 3 twine bales. This will allow for all the refusal to be rice hay. The previous work had combined alfalfa and rice hay in the refusal. The steers will be fed to minimize waste of the hay out of the bunk to no more than 3%. Pounds of waste will be estimated or weighed and the daily consumption is being recorded. The feeding period started in October and conclude in late December. Weights of the animals are being taken on Day 0, 14, 28, 42, and 56. At each weight, fecal samples will be collected from a subset of 4 animals per treatment and combined in one zip lock bag. The feces will be analyzed for digestiblity differences.

2005 Results

Results in Table 1 (Laboratory wet chemistry forage values for each of the treatments) indicate the rice designed maceration significantly lowered the acid detergent fiber, which should predict that the rice hay would have a higher digestibility in the animal. These results did not repeat in the rice hay sampled in the animal feeding study.

Table 1. Laboratory wet chemistry forage values for each of the treatments.

Description	DM	OM %DM	FAT %DM	CP %DM	ADICP %CP	NDF %DM	dNDF30 %NDF	ADF %DM	TDN %DM	ME Mcal/kgDM
1 Rice designed macerator 1	92.32	83.40	1.92	5.06	23.95	73.21	43.73	54.02	40.68	1.36
2 Rice designed macerator 2	91.69	83.24	1.96	3.80	36.05	73.87	41.05	54.82	38.18	1.25
3 Rice designed macerator 3	92.02	83.32	1.94	3.73	30.94	74.69	41.58	55.75	38.38	1.26
4 Rice designed macerator 4	92.14	82.99	2.03	3.34	39.02	75.01	41.49	55.81	37.80	1.23
5 Regular macerator 1	92.23	82.76	1.87	3.96	41.63	75.11	40.91	56.14	36.52	1.18
6 Regular macerator 2	92.00	82.62	1.98	3.70	40.81	75.07	42.13	56.64	37.61	1.23
7 Regular macerator 3	92.27	82.73	1.67	3.59	33.72	76.97	41.83	57.04	36.32	1.17
8 Regular macerator 4	91.88	83.29	1.74	3.75	31.19	76.67	40.27	56.84	35.95	1.15
9 CONTROL-1	91.88	82.98	1.68	3.62	30.66	74.32	37.75	55.81	35.13	1.11
10 CONTROL-2	92.05	82.96	1.66	3.35	37.80	74.84	40.14	55.77	36.43	1.17
11 CONTROL-3	92.16	82.41	1.46	3.41	36.21	76.11	37.40	56.19	32.85	1.01
12 CONTROL-4	92.22	82.51	1.99	3.61	35.28	75.44	40.79	56.27	36.52	1.18
Means										
Control	92.08	82.71	1.70	3.50	34.99	75.18	39.02	56.01	35.23	1.12
Ma - Regular	92.09	82.85	1.81	3.75	36.84	75.96	41.29	56.66	36.60	1.18
Ma - High	92.04	83.24	1.96	3.98	32.49	74.20	41.96	55.10	38.76	1.28
SEM	0.146	0.187	0.107	0.316	3.650	0.615	0.917	0.400	0.925	0.042
Linear 'P'	0.82	0.02	0.04	0.16	0.51	0.14	0.01	0.05	<0.01	<0.01
Quadratic 'P'	0.79	0.46	0.88	0.97	0.35	0.04	0.34	0.01	0.63	0.71

Below are the results of the animal rice hay feeding study.

<u>Table 2.</u> Composition of alfalfa hay and rice hays fed to the heifers

	Alfalfa Hay	Rice Hay			P	
		Control	Macerated	SEM	AH vs. RS	C vs. M
Dry matter, %	88.8	91.0	90.8	0.72	<0.01	0.72
Organic matter, % DM	90.9	84.0	83.9	0.29	<0.01	0.83
Fat, % DM	2.4	1.8	1.8	0.07	<0.01	0.58
ND fiber, % DM	35.4	70.6	71.9	0.58	<0.01	0.03
digestible NDF, % NDF	39.0	40.3	42.7	1.23	0.04	0.05
AD fiber, % DM	28.5	50.4	52.0	0.75	<0.01	0.04
Lignin, % DM	6.2	5.1	5.2	0.12	<0.01	0.87
Crude protein, % DM	24.2	4.6	5.2	0.23	<0.01	0.03
soluble CP, % CP	32.8	17.0	20.7	1.30	<0.01	<0.01
AD insoluble CP, % CP	4.3	25.6	23.3	1.52	<0.01	0.11
ND insoluble CP, % CP	10.2	39.8	40.6	1.53	<0.01	0.57
Calcium, % DM	1.27	0.43	0.42	0.019	<0.01	0.58
Phosphorus, % DM	0.33	0.09	0.09	0.005	<0.01	0.41
Potassium, % DM	2.18	2.18	2.25	0.032	0.22	0.05
Magnesium, % DM	0.43	0.17	0.18	0.006	<0.01	0.18
Sodium, % DM	0.29	0.02	0.02	0.005	<0.01	0.85
Iron, ppm DM	217	193	190	13.8	0.05	0.79
Manganese, ppm DM	35	1605	1700	37.4	<0.01	0.02
Zinc, ppm DM	33	38	39	2.1	<0.01	0.52
Copper, ppm DM	11	18	18	2.0	<0.01	0.66
Selenium, ppm DM	0.09	0.06	0.06	0.004	<0.01	0.33
ME, MJ/kg DM	10.47	5.59	5.75	0.203	<0.01	0.38
TDN, % DM	66.3	40.1	41.0	1.08	<0.01	0.37

<u>Table 3.</u> Composition of feces, and whole tract digestibility of NDF, in the heifers as affected by maceration of the rice hay.

	Diet			
	Control	Macerated	SEM	P
<u>Fecal composition</u>				
Organic matter, % fecal DM	77.5	76.9	0.65	0.22
ND fiber, % fecal DM	58.6	58.7	1.24	0.86

digestible NDF, % fecal NDF	8.9	6.2	0.86	<0.01
AD fiber, % fecal DM	46.6	46.9	0.97	0.64
AD lignin, % fecal DM	13.5	13.5	0.37	0.84
Crude protein, % fecal DM	11.5	11.2	0.23	0.44
Digestion of NDF				
Whole tract, % of consumed NDF	48.4	48.4	0.46	0.88

Table 4. Intake, body weight gains and efficiency of body weight gains of the heifers as affected by maceration of the rice hay.

	Diet			
	Control	Macerated	SEM	P
Dry matter intake				
Alfalfa hay intake, lb/d	8.65	8.58	0.473	0.89
Rice hay intake, lb/d	5.26	5.13	0.306	0.58
Total intake, lb/d	13.91	13.71	0.767	0.80
Body condition score (BCS) and body weight change				
BCS change, units/mo	0.00	0.02	0.061	0.56
Body weight gain, lb/d	0.99	0.78	0.140	0.20
Efficiency of body weight change				
Feed/gain, lb/lb	14.2	18.7	2.17	0.10
Gain/feed, lb/100 lb	7.06	5.59	0.707	0.09

Although there were significant differences in the the macerated having a higher soluble crude protein and a lower fecal neutral detergent fiber (NDF), no change in animal performance occurred. Based on this study the researchers have concluded that the maceration process is not providing enough physical alteration of the rice hay to change animal performance.

In 2006, forage from rotary harvesters was compared to straw walker design harvesters for their impact on hay physical conditions. The study was conducted using a split check design to produce 60 tons of rice hay treated with a Caterpillar Lexion 500 series rotary harvester that was also flail chopped and then raked into windrows and baled to rice hay from a conventional design harvester that was baled in the windrow. The combination of the rotary harvester and chopping provided the most physical alteration of the forage by in field processes. Both treatments were tested for wet chemistry analysis and fed in a cattle feeding study. Results from that research are pending and will be reported next year.

Physical Alteration

Conventional

Rotary + Chopped

Rice Grower meeting
A rice hay educational meeting was held for rice producers and hay brokers in Maxwell, Ca. on June 27, 2006. The concept of the meeting was to educate both parities and bring them together for potential business in the upcoming season.

Dairy Demonstrations
To extend information on the use of rice hay in dairy replacement heifer rations, an article was written and submitted to California Dairy Magazine, which is sent to most of the dairies in California. The article was published in the June 2006 edition and is attached as a PDF file to this report.

A demonstrational project was conducted at two commercial dairies in the Madera and Kermin areas to illustrate the effectiveness of two different "in field" processes on direct use of rice hay in a TMR feed wagon. The following are the baled rice hay (with the nutritional lab values) that will be compared for ease of ration mixing:

	% Moisture	**Crude Protein**	**ADF**
Caterpillar Lexion 500 series rotary harvester and flail chopped in the windrow	17.7	6.9	42.8
Baler with a slicer that can cut it in 5" length	5.8	4.68	49.6

The first step to make sure that rice hay is utilized in dairy rations is to make sure that it can be fed without any additional processing at the dairy. With any bad experiences, the dairies do not tend to share information on the problems to the grower. They tend to just never use the product again. The concept of the demonstration is to make sure that in field treatments allow the product to mixes well in the ration. Then a product can be directed to the dairies that will have a guaranteed success. Air resources regulation on dust in the San Joaquin valley makes chopping rice hay at the dairy not realistic. Without reduction of the fiber length, direct addition of rice hay into Total Mix Ration (TMR) mixers at dairies will result in the forage wrapping around shafts and limit use of the product due to bad experiences. Two truck loads of rice hay from rotary harvesters and flail chopped were sent to two different diaries. Each dairy had a different types of TMRs: Vertical and Horizontal (more traditional in use). The goal of the ration mixer is to assure that every bite that the animal takes of the feed is the same nutritional quality. This assures that each animal is receiving the same nutrition level during the feeding period. The horizontal mixer dairy fed the rice hay at 2 pounds per head per day and the vertical dairy fed at 5 pounds per head per day. The horizontal mixer was able to mix the product without any additional time. This is an important factor in dairies, as they want to optimize labor and equipment utilization to feed. The vertical mixer required 20 more minutes to achieve adequate mixing. The horizontal mixer feed did contain some balls of rice hay in the ration (See left side picture below a ball is near the person's shadow).

Horizontal Mixer

Clumps in Feed   Remaining Day After

The vertical mixer had additional wear on the mixer knife blades according to the dairymen. He also experienced some problem with the ration coming out in lumps and not feeding smoothly. Some of the experiences that the vertical dairy experienced could be related that they fed rice hay at more than twice the daily level of the other diary. The higher moisture content (17%) could have also impacted the mixing of the rice hay. The rice hay quality was much higher that experienced in past 8 years of research and animal intake of all the straw could have been related to that higher quality of the product. The vertical mixer diary was willing to feed rice hay at 2 pounds per head per day that was put up with a baler that had a slicer that could cut the material into 5 inch length. This material will be evaluated for performance on December 18, 2006 in a visit and interview with the dairy owner and consulting nutritionist. Preliminary reports are that it mixes better. The quality of the second load due to the difficulty of finding a slicer baler straw was much lower and was baled five weeks after harvest, which is outside of the 10 days post harvest that the researchers think is required to make the forage the quality to be called rice hay.

OBJECTIVE 2. *Improvement of chemical qualities of rice hay forage*

Dr. Kevin Holtman at the USDA Ag Research Service (ARS) laboratory at Albany, California was contracted to study the chemical properties of rice hay that may be causing the vast change in digestibility that occurs during drying that is not seen in wheat or barley. He has focused on the pectin layer on the out side of the plant. Results of the study work are not available at this time to report.

Previous Research

Previously Rice Research Board funded research has now been published in a peer review publication targeting Beef and Dairy veterinarians. The Bovine Practitioner Vol. 40, No.2, summer 2006 article "Effects of Feeding High Manganese Rice Straw on the Mineral Status of Beef Cattle" is attached to this report. This study indicated that the high levels of manganese that exceed toxic standards had no impact on the animals' mineral status and thus the availability of this mineral to animals is very limited and no problems feeding the product will occur.

PUBLICATIONS OR REPORTS:

NADER, G.A., S.P. DOYEE, J.M. CONNOR, AND J. MAAS. 2006. Effects of feeding high manganese rice straw on the mineral status of beef cattle. The Bovine Practitioner 40 (2): 59-64.

NADER, G., AND P.H. ROBINSON. 2006. California rice hay: an opportunity for California dairies? California Dairy, pp. 6-7.