ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE
January 1, 2003 - December 31, 2003

PROJECT TITLE: The Influence of Processing on the Comparative Feeding Value of Rice Straw in Diets for Feedlot Cattle

PROJECT LEADER: Richard A. Zinn
1004 E. Holton Rd.
El Centro, CA 92243

PRINCIPAL UC INVESTIGATORS: Richard A. Zinn
Professor
Animal Science Department
University of California, Davis

COOPERATORS: R. A. Ware, A. Plascencia

LEVEL OF 2003 FUNDING: $24,000

OBJECTIVES AND EXPERIMENTS CONDUCTED BY LOCATION TO ACCOMPLISH OBJECTIVES:

1) Feedlot growth-performance trials to evaluate the influence of maceration and fibrolytic enzyme supplementation on comparative feeding value of rice straw.
   Cattle fed 15% forage finishing diet
   Cattle fed 10% forage growing-finishing diet
2) Feedlot growth-performance trials to evaluate influence of pelletizing on comparative feeding value of rice straw.
3) A lactation trial is in progress evaluating the influence of enzyme supplementation and maceration on dry matter intake, milk yield and milk composition in response to partial substitution of alfalfa hay with rice straw. (This is the trial sponsored by the rice board last April)

SUMMARY OF 2003 RESEARCH (MAJOR ACCOMPLISHMENTS) BY OBJECTIVE:

Trial 1. Ninety Holstein steers weighing 468 kg were blocked by weight into to 18 pens (5 steers/pen) in a 116-d comparative slaughter study. Treatment consisted of steam-flaked corn-based finishing diet containing 15% forage as sudangrass, rice straw, or macerated rice straw supplemented with either 0 or 15g/d of Fibrozyme (Alltech, Inc.). Forages were ground to pass through a 2.6 cm screen prior to incorporation into complete mixed diets. Treatments were arranged as a 3 x 2 factorial. Results of Trial 1 are shown in Table 1. Maceration without the addition of enzymes, improved feed efficiency (7.47 vs. 7.90, P<.05) over that of chopped straw, but had no effect on DMI or ADG. The combination of fibrolytic enzyme supplementation and maceration produced positive synergistic effects on energy intake and hence, daily weight gain.

This is latter effect was apparently due to an increased rate of ruminal turnover. Enzyme supplementation did not appear to have a direct effect on the NE value of the diet.

Trial 2. One hundred eight Holstein calves were blocked by weight and randomly assigned within weight groupings to 18 pens (6 steers/pen) in a 241 d comparative slaughter study. Treatments are the same as in Trial 1 except that forage level was reduced to 10%. Results are shown in Table 2. Maceration increased DMI and ADG.

Trial 3. Ninety crossbred steers (349 kg) were used in a 116-d finishing trial to evaluate the influence of pelletizing on the feeding value of rice straw. Steers were balanced by weight and assigned to 18 pens (5 steers/pen). Experimental diets contained 12% forage as sudangrass hay, rice straw, or pelletized rice straw. The sudangrass hay and non-pelletized rice straw were ground to pass through a 2.6 cm screen prior to incorporation into complete mixed diets. Results are shown in Table 3. Feeding chopped rice straw produced greater ADG (1.52 vs. 1.44 and 1.36) than feeding sudangrass or pelletized rice straw. This was due in part to the 9 % increase in DMI for the chopped straw (7.66 vs. 7.00 and 7.05 for sudangrass and pelletized straw, respectively). Feed conversion was best for sudangrass (.206 vs. .199 and .192) and did not differ between rice straw treatments.

Trial 4. Three steers with cannulas in the rumen and proximal duodenum were used in a 3 x 3 Latin square experiment to evaluate treatment effects on digestion. Diets were the same as Trial 3 with Cr_2O_3 being added as a digestive marker. Trial is still in progress.

Trial 5. Seventy-two yearling crossbred steers were used in a 125-d finishing trial to evaluate the influence of pelletizing on the feeding value of rice straw. Steers were balanced by weight and randomly assigned to 18 pens (4 steers/pen). Treatments consisted of a steam-flaked corn-based diet containing 12% sudangrass, 12% pelletized rice straw or 24% pelletized rice straw. Sudangrass hay was ground to pass through a 2.6 cm screen prior to incorporation into complete mixed diets. Results are shown in Table 4. There were no treatment effects ($P > .10$) on ADG. At the 12% forage level, DMI, gain efficiency and dietary NE were similar ($P > .10$) for sudangrass and pelletized rice straw. Increasing the inclusion rate of pelletized rice straw from 12 to 24% increased (11%, $P < .05$) DMI, and decreased ($P < .05$) gain efficiency (14%) and dietary NE for maintenance and gain (5 and 6%, respectively). The decrease in gain efficiency with the 24% pelletized rice straw diet was less than expected, considering the energy dilution of the diet by substituting straw pellets for flaked corn. This trial demonstrates the great potential for incorporation of higher levels of rice straw pellets in growing-finishing diets for feedlot cattle to enhance digestive function without detrimentally affecting ADG.

Trial 6. Three steers with cannulas in the rumen and proximal duodenum were used in a 3 x 3 Latin square experiment to evaluate treatment effects on digestion. Diets were the same as Trial 5 with Cr_2O_3 being added as a digestive marker. Results are shown in Table 5. There were no treatment effects ($P > .10$) on ruminal digestion of OM, NDF, and feed N. Ruminal starch digestion was similar ($P > .10$) for 12% sudangrass and 12% palletized rice straw, but increased (5%, $P<.05$) with 24% pelletized. Total tract digestion of OM and DE were similar ($P > .10$) for 12% sudangrass and 12% pelletized rice straw, but decreased (5 and 6%, respectively, $P < .05$) with 24% pelletized rice straw. There were no treatment effects ($P > .10$) on total tract digestion of NDF, N, and starch. At lower inclusion rates (12% forage level), the NEm and NEg values of pelletized rice straw are equivalent to sudangrass hay (1.18 and .61 Mcal/kg, respectively). At higher forage levels (24%), the NEm and NEg values of pelletized rice straw are enhanced (1.46 and .87 Mcal/kg, respectively).

Trial 7. Twelve Holstein cows are being used in a replicated 3 x 3 Latin square design experiment to evaluate the effects of maceration on dry matter intake, milk yield and milk composition in response to partial substitution of alfalfa hay with rice straw.

PUBLICATIONS OR REPORTS:

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

Maceration: Maceration enhances the feeding value of rice straw by creating greater surface area and points of attachment for fibrolytic enzymes. Given that the net energy value of sudangrass was 1.18 and .61 for maintenance and gain, respectively (NRC, 1996), then the corresponding net energy values for nonmacerated rice straw are .95 and .42 Mcal/kg, respectively, and for macerated rice straw the values are 1.51 and .92 Mcal/kg. The comparative NE values obtained for nonmacerated rice straw are appreciably greater than the published tabular values (.61 and .11 Mcal/kg, respectively; NRC, 1984). Maceration increased the NE values of straw for maintenance and gain by 59 and 119, respectively! In Trial 1, maceration without the addition of enzymes, improved feed efficiency (7.47 vs. 7.90, $P<.05$) over that of chopped straw, but had no effect on DMI or ADG. The combination of fibrolytic enzyme supplementation and maceration produced positive synergistic effects on energy intake and hence, daily weight gain. This is latter effect was apparently due to an increased rate of ruminal turnover. Enzyme supplementation did not appear to have a direct effect on the NE value of the diet. In Trial 2, at the lower level of forage inclusion (10%), maceration permitted greater DMI and ADG.

Pelletizing:

Trial 3. Great variation exists in forage quality when dealing with rice straw. In this trial, feeding chopped rice straw produced greater ADG (1.52 vs. 1.44 and 1.36) than feeding sudangrass or pelletized rice straw. This was due in part to the 9 % increase in DMI for the chopped straw (7.66 vs. 7.00 and 7.05 for sudangrass and pelletized straw, respectively). Feed conversion was best for sudangrass (.206 vs. .199 and .192) and did not differ between rice straw treatments.

Trial 5. There were no treatment effects ($P > .10$) on ADG. At the 12% forage level, DMI, gain efficiency and dietary NE were similar ($P > .10$) for sudangrass and pelletized rice straw. Increasing the inclusion rate of pelletized rice straw from 12 to 24% increased (11%, $P < .05$) DMI, and decreased ($P < .05$) gain efficiency (14%) and dietary NE for maintenance and gain (5 and 6%, respectively). Although, the decrease in gain efficiency with the 24% pelletized rice straw diet was less than expected, considering the energy dilution of the diet by substituting straw pellets for flaked corn. This trial demonstrates the great potential for incorporation of higher levels of rice straw pellets in growing-finishing diets for feedlot cattle to enhance digestive function without detrimentally affecting ADG.

Trial 6. There were no treatment effects (P > .10) on ruminal digestion of OM, NDF, and feed N. Ruminal starch digestion was similar (P > .10) for 12% sudangrass and 12% palletized rice straw, but increased (5%, P<.05) with 24% pelletized. Total tract digestion of OM and DE were similar (P > .10) for 12% sudangrass and 12% pelletized rice straw, but decreased (5 and 6%, respectively, P < .05) with 24% pelletized rice straw. There were no treatment effects (P > .10) on total tract digestion of NDF, N, and starch. At lower inclusion rates (12% forage level), the NEm and NEg values of pelletized rice straw are equivalent to sudangrass hay (1.18 and .61 Mcal/kg, respectively). At higher forage levels (24%), the NEm and NEg values of pelletized rice straw are enhanced (1.46 and .87 Mcal/kg, respectively).

Table 1. Treatment effects on feedlot growth performance for cattle fed 15% forage diet. (Trial 1)

	Fibrozyme®, g/d						
	0			15			
Item	Sudan	RSG	RSM	Sudan	RSG	RSM	SD
Pen Replicates	5	5	5	5	5	5	
Weight, kg							
IW	467	469	467	465	468	466	
FW	606	604	603	598	603	609	
DM Intake, kg/d							
d 1-116[a]	9.06	9.23	8.76[a]	8.95	9.15	9.20[b]	.29
Avg Daily Gain, kg/d							
d 1-116[ab]	1.19	1.17	1.17[a]	1.14	1.17	1.23[b]	.05
Feed/Gain							
d 1-116[b]	7.61	7.90	7.47	7.83	7.84	7.46	.29
Yield Grade[cde]	2.80	2.71	2.54	3.36	2.63	3.33	.22
Quality Grade[e]	5.94	6.28	4.80	5.61	3.17	6.33	1.32
Fat Thickness, cm[ef]	.81	.76	.66	1.05	.67	.93	.12
Dressing percentage, %	61.7	62.5	62.1	62.6	62.1	62.0	.9
Diet net energy, Mcal/kg							
Maintenance[a]	2.25	2.19	2.30	2.22	2.21	2.27	.06
Gain[a]	1.57	1.51	1.61	1.54	1.53	1.58	.05
Observed/Expected Net Energy							
Maintenance	1.02	1.04	1.09	1.01	1.04	1.07	.03
Gain	1.03	1.05	1.11	1.01	1.05	1.09	.04

[a] Ground vs. Macerated, (P<.05)
[b] Forage x Enzyme Interaction, (P<.10)
[c] Effect of Enzyme, (P<.01)
[d] Effect of Maceration, (P<.10)
[e] Forage x Enzyme Interaction, (P<.01)
[f] Effect of Enzyme, (P<.05)

Table 2. Treatment Effects on Feedlot Growth Performance for cattle fed 10% forage diet. (Trial 2)

Item	GRS	MRS	SE
Weight, kg			
Initial	185.1	185.4	
Final	379.2	387.3	
ADG, kg/d [a]	1.45	1.51	.04
DMI, kg/d [a]	6.83	7.06	.14
Gain/Feed	.212	.214	.003
Dietary NE, MCal/kg			
Maintenance	2.09	2.09	.02
Gain	1.42	1.43	.02

Table 3. Treatment effects of pelletization on feedlot cattle growth performance. (Trial 3)

Item	12% Sudan	12% RSG	12% RSP	SE
Pen Replicates	6	6	6	
Weight, kg				
IW	350	346	351	
FW	516	522	511	
DM Intake, kg/d				
d 1-113[a]	6.85	7.57[a]	6.90[a]	.24
Avg Daily Gain, kg/d				
d 1-113 [b]	1.47	1.58[b]	1.41[b]	.08
Feed/Gain				
d 1-113	4.67	4.81	4.94	.12
Yield Grade[c]	2.48[c]	3.08	2.85	.15
Quality Grade[bd]	4.77[d]	5.72[b]	5.18[b]	.25
Fat Thickness, cm[be]	1.14[e]	1.47[b]	1.22[b]	.11
Dressing percentage, %	64.0	64.4	64.1	.62
Diet net energy, Mcal/kg				
Maintenance[c]	2.53[c]	2.42	2.44	.03
Gain[c]	1.81[c]	1.71	1.73	.03
Observed/Expected Net Energy				
Maintenance	1.13	1.11	1.12	.01
Gain	1.16	1.14	1.15	.02

[a] Effect of Pelletization, (P<.05)
[b] Effect of Pelletization, (P<.10)
[c] Effect of Sudan vs RS, (P<.01)
[d] Effect of Sudan vs RS, (P<.05)
[e] Effect of Sudan vs RS, (P<.10)

Table 4. Treatment effects on feedlot cattle growth-performance (Trial 5).

	SG	PRS		
Item	12%	12%	24%	SE[b]
Days on test	125	125	125	
Pen replications	4	4	4	
Weight, kg				
Initial	357	355	357	1.7
Final[c]	503	503	501	6.3
ADG, kg/d	1.18	1.19	1.16	.07
DMI, kg/d	6.67[d]	6.44[d]	7.30[e]	.22
ADG/DMI	.175[d]	.184[d]	.159[d]	.01
Dietary NE, Mcal/kg				
Maintenance	2.30[d]	2.30[d]	1.19[e]	.03
Gain	1.61[d]	1.60[d]	1.51[e]	.02

[a] SG= Sudangrass, PRS = Pelletized Rice straw

[b] Standard Error Mean

[c] Adjusted for carcass weight (carcass weight/.6445, average dressing percentage)

[de] Means in a row with different superscripts differ, $P < .05$.

Table 5. Treatment effects on ruminal and total tract digestion (Trial 6)

	SG	PRS		
Item	12%	12%	24%	SE[b]
Weight, Kg	275	275	275	
Animal replicates	3	3	3	
Intake, g/d				
DM	2,998	3,001	3,002	
OM	2,821	2,816	2,776	
NDF	386	366	560	
N	54.9	53.3	53.1	
Starch	1,479	1,481	1,282	
Ruminal digestion, %				
OM	67.2	66.0	65.9	.4
NDF	45.3	44.9	50.8	2.5
Feed N	63.0	64.8	61.6	.9
Starch	85.0	81.7[d]	86.3[e]	1.0
Total tract digestion, %				
OM	83.8[d]	84.7[d]	80.3[e]	.5
NDF	50.7	53.4	51.1	2.3
N	74.7	75.3	72.4	.8
Starch	99.5	98.9	99.6	.3
DE, MCal/kg	3.65[d]	3.67[d]	3.45[e]	1.36