ANNUAL REPORT COMPREHENSIVE RESEARCH ON RICE
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PROJECT TITLE: **Demonstration of Rice Strawlage Production**

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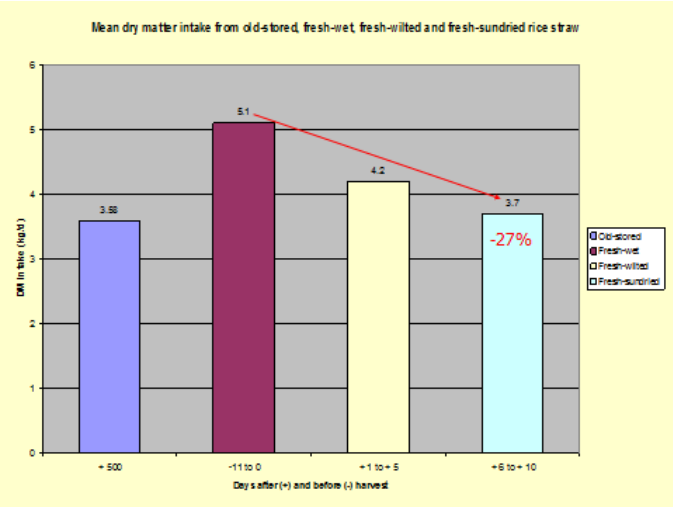
LEVEL OF 2014 FUNDING: **$31,500**

OBJECTIVES AND EXPERIMENTS CONDUCTED:

Research by Robinson and Nader has previously documented the substantial loss of forage quality by rice straw during drying. At the time of harvest, the metabolizable energy (ME) values for rice straw were near that of low quality alfalfa, but by the end of the 48 hour drying period, these had declined to those of a very low quality forage. This results is a sharp reduction in voluntary intake of the rice straw (see figure below). The reasons for these dramatic changes are not yet fully understood.



Strawlage is the process of preserving straw with high (45 to 65%) moisture and thus not allowing the drying that causes the substantial loss in ME. At the time of harvest (head moisture of 18%) most rice forage is about 55% moisture, which is acceptable moisture level for making strawlage. Previous research with rice strawlage was with individual bale plastic wrapping that made the process too costly to implement in California. Field testing of a much less expensive method of tarping a large stack of bales was conducted, in which a 100 x 40 foot tarp was used to cover 54 large bales of 4 x 8 x 3 feet as a less expensive method of preserving the strawlage. The bottom bales were set on a 25 x 100 tarp to decrease loss of strawlage that touched the ground.

We put the stacks in a well drained area that allowed for winter access and minimal water accumulation on the bottom bales. Maintaining tarped stacks in windy areas in the winter was a challenge, but putting them in a wind sheltered area near trees or buildings decreased the displacement of tires and the tarp.

SUMMARY OF 2013 - 2014 RESEARCH

Objective 1 –Research Rice Strawlage Production from Rice Straw

Research by Robinson, Davy and Nader in 2013 demonstrated the value of rice strawlage in increasing rice straw consumption by cattle. The objective of this year's study was to compare treatments with added urea and propionic acid to prevent mold formation and impact strawlage nutrient value.

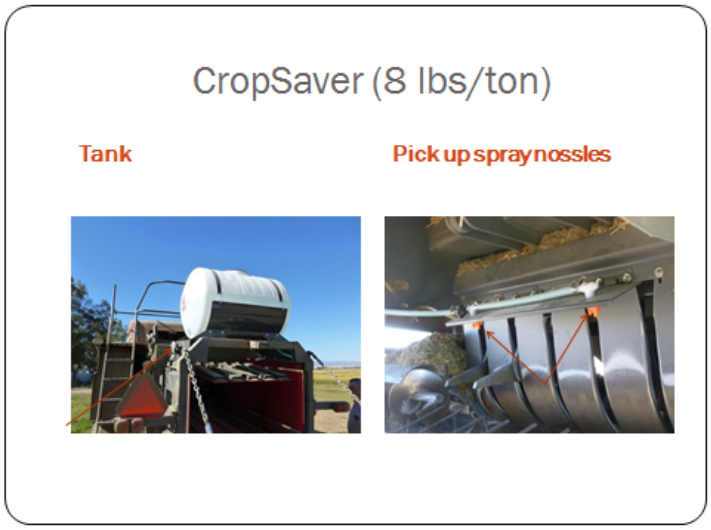
Rice straw was baled at the time of rice harvest with a big baler to obtain three treatments:

1. Strawlage without treatment
2. Strawlage with Crop Saver applied at the time of baling
3. Urea and UN32 application

Each treatment was stacked separately and individually tarped. Two temperature monitors were be placed in each stack to record the temperature hourly. The average temperature of rice strawlage covered stacks of 95 to 105^{o}F allows curing. Samples from 4 sections of each stack were collected on Days 0, 27, 64, 95 and 130. Each sample was analyzed for dry matter, ash, organic matter, pH, crude protein, ADF, NDF and *in vitro* gas production to allow estimation of ME.

Mold can be a problem with baled high moisture forage. Last year, it appeared that fields treated with Qaudris, had less mold in the strawlage. There are two proven methods of controlling mold, being application of 8.4 lbs/ton of CropSaver (a chemically buffered and neutralized proprionic acid) in the baler pick area. The application units and material can be purchased from New Holland dealers. A 200 gallon tote weighs 1800 lbs

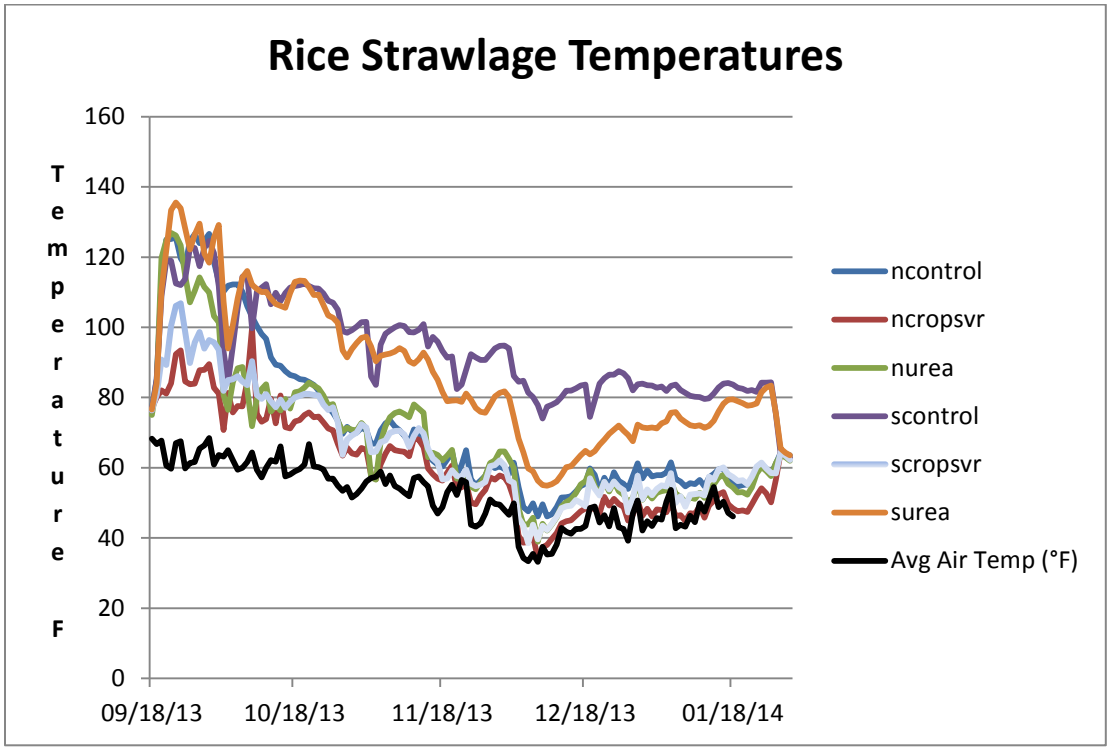
and costs $2497. At the 8.4 lb application rate per ton it costs $11.65/ton. The application unit part #HT4914518 thru an AGCO dealer costs about $8,000.



The other method is to apply urea and UN 32. Some producers thought this was labor intensive, but the positive is that it improved the N level of the strawlage in a form that the rumen microbes can use to create microbial protein which that cattle can use to meet their needs, as well as help to control mold. In this method. urea is spread on top of the bottom tarp and also on the bales using a can with holes in the bottom. As bales are brought in they are sprayed with UN 32 on the outside. For 24 bales that averaged 1640 lbs or 19.7 tons total weight, and we applied 6.7 lbs of urea/ton or $3.35/ton and UN 32 application at 52 lbs/ton or $12.87/ton. The total lbs of N applied were 19.4 lbs/ton at a total cost of $16.22. Labor was not calculated in the costs of application.

Below are the temperature data for each of the three treatments with 2 monitors on each stack (N = north S = south side of the stack). The CropSaver treated strawlage, both north and south, had lower temperatures than Control (no treatment) or Urea/UN 32. The rest stayed over 100^{o} for 2 weeks. The CropSaver treatment may prevent a Maillard reactions that bind proteins, which becomes a problem at 140^{o}.

Ranchers are concerned about the potential of stack fires. In 3 years of research we have not had any, and the reason is likely that at 50% moisture there is a too much water that needs to be driven off before combustion can occur, at which times temperatues are already falling. Covering the stack with plastic limits the amount of oxygen that is available to support a fire, and there is a low amount of soluble energy to drive heat production.



General Nutritional Findings

Three stacks of rice strawlage were treated as follows: Control (no treatment), Urea plus UN-32, and Cropsaver®. Each stack was sampled on days 0, 27, 64, 95 and 130 after treatment application. The nutritional evaluation is in the tables below. A few parameters (e.g., DM, ash, NDF, ADF) are impacted in the first 27 days and then are largely stable. The energy content of the strawlage decreased with time in the stack, but values are well above the 0.35 Mcal/lb DM which is common for dry baled straw at 8 to 13% moisture. The high gas production values at 4 h of incubation for the Day 0 samples represent sugars in the strawlage which are largely consumed by day 27. The nitrates levels were higher for the Urea/UN-32 treated strawlage, but all values are well below levels of concern in ruminant animal feeds. The linear increase in ash with time shows that carbon compounds are continuing to be used up and emitted as gases. That levels of NDF/ADF/CP (as a % of DM) are little impacted suggests that it is the soluble fractions in the rice strawlage which are being used up resulting in lower ME levels of all strawlages with time of storage.

Cows eating Rice Strawlage as it is dumped into the feeder

RICE STRAWLAGE STACKS AFTER FIVE SAMPLINGS

	Treatment			Days						*P*		
											Time	
	Control	Urea	CS	0	27	64	95	130	SEM	Trt	Linear	Quad
Chemical Components												
Dry matter (%)	51.2[a]	56.3	62.6[b]	46.5	62.2	61.5	54.3	59.0	2.20	0.03	0.14	0.05
Ash (% DM)	17.72[a]	17.27[a]	15.93[b]	15.56	16.47	16.79	17.60	18.43	0.319	0.02	<0.01	0.87
ND ash (% DM)	5.32	4.56	4.49	3.38	4.58	5.35	6.03	4.58	0.266	0.17	0.01	<0.01
CP (% DM)	4.88	5.60	5.11	4.47	4.90	5.58	5.82	5.20	0.226	0.21	0.05	0.08
Nitrates (ppm DM)	83[a]	218[b]	86[a]	120	96	90	178	158	22.3	<0.01	0.18	0.44
aNDFom (% DM)	62.63	62.47	64.55	59.05	64.70	64.82	63.48	64.03	0.920	0.37	0.08	0.05
ADF (% DM)	56.34	54.99	54.11	49.95	56.37	56.75	55.92	57.75	0.870	0.36	<0.01	0.13
Gas Production (ml/g OM) at:												
4 h	14.6[a]	16.4[b]	16.6[b]	32.3	11.4	12.7	10.4	12.5	0.43	0.03	<0.01	<0.01
24 h	98.5	99.2	117.2	131.8	116.7	102.6	87.7	86.1	5.76	0.14	<0.01	0.45
30 h	116.3[a]	119.7[a]	138.0[b]	154.2	133.6	123.2	105.1	107.4	6.01	0.12	<0.01	0.30
48 h	142.0[a]	141.6[a]	161.6[b]	173.0	156.4	147.9	130.0	134.6	5.91	0.12	<0.01	0.36
Calculated value (Mcal/lb DM)												
Metabolizable energy	0.519[a]	0.525[a]	0.568[b]	0.601	0.565	0.533	0.498	0.490	0.0130	0.09	<0.01	0.51

Within treatment, values with different superscripts differ (P<0.05)

There were no other statistically significant interaction of trt*time

Moisture Content, Temperature and Density of Bales

RICE STRAWLAGE STACKS AFTER FIVE SAMPLINGS -WILLOWS, CA.

	Start			27 days			64 days			95 days			130 days			Sample Depth (D: inches)			Trt		Time			Depth (linear)		Trt*Time	
Treatment	Control	Urea	CS	Control	Urea	CS	Control	Urea	CS	Control	Urea	CS	Control	Urea	CS	5 to 10	10 to 15	15 to 20	*P*	SEM	Linear P	Quad P	SEM	*P*	SEM	*P*	SEM
Temperature (0C)	28.12	31.72	29.93	34.83	36.72	41.45	28.08	24.53	25.75	31.85	28.40	26.77	23.25	22.17	21.58	25.81	30.06	31.18	0.86	0.68	<0.01	<0.01	0.86	<0.01	0.67	0.02	1.50
Temperature (0F)	82.6	89.1	85.9	94.7	98.1	106.6	82.5	76.2	78.4	89.3	83.1	80.2	73.9	71.9	70.8	78.5	86.1	88.1									
pH	7.07	7.35	5.89	8.58	8.15	8.56	8.61	8.15	8.17	8.43	9.20	8.37	9.17	8.93	8.37	8.37	8.18	8.04	<0.01	0.104	<0.01	<0.01	0.139	0.03	0.106	<0.01	0.229
DM%	44.0	49.0	54.6	59.1	73.0	74.6	70.0	65.3	75.6	59.9	52.0	74.7	53.4	74.8	78.6	62.6	64.2	65.0	<0.01	2.11	<0.01	<0.01	2.69	0.43	2.08	0.06	4.65
Wet density (lbs/ft^3)	10.47	9.85	8.52	7.23	5.18	4.83	5.57	6.27	5.82	6.80	9.78	8.35	6.30	7.03	5.92	6.68	7.19	7.83	0.18	0.46	0.06	<0.01	0.59	0.09	0.46	0.37	1.02
Dry density (lbs/ft^3)	4.62	4.72	4.58	4.25	3.75	3.27	3.9	4.75	4.45	4.30	4.68	6.33	3.30	5.25	4.63	3.96	4.45	4.95	0.31	0.301	0.49	0.75	0.383	0.03	0.297	0.34	0.663

There were no other statistically significant 2 way interactions, or the three way interaction

The pH values vary at first with (CS) Cropsaver propionic acid dropping the value for the first month. The deeper the sample into the bale the higher the temperature and density.

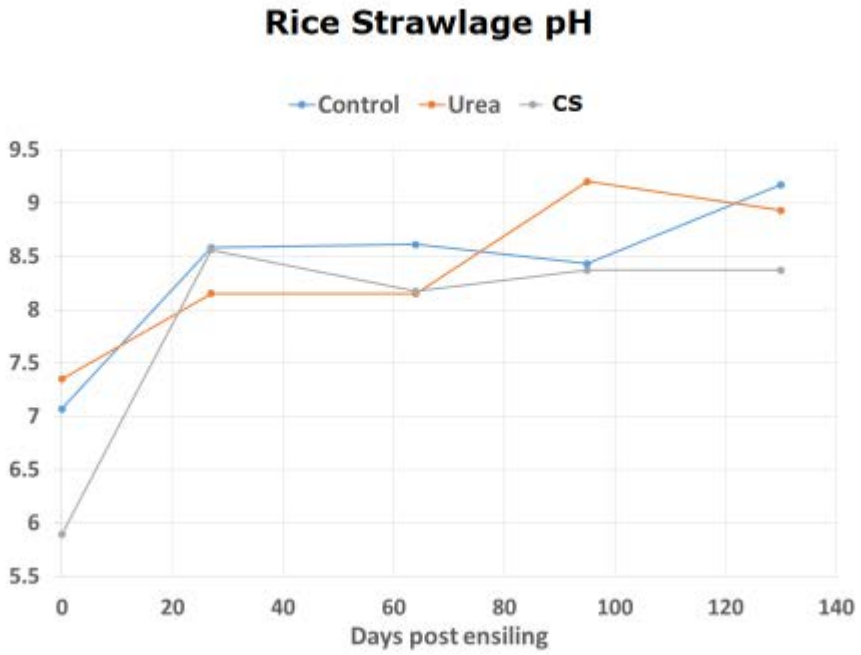
STACKS AFTER TWO SAMPLINGS - WILLIAMS, Ca.

	Start		Day 32		Side		Sample Depth (D: inches)			Trt		Side		Time		Depth (linear)		Trt*Time	
	UN32	UN32 + Urea	UN32	UN32 + Urea	North	South	5 to 10	10 to 15	15 to 20	*P*	SEM	*P*	SEM	*P*	SEM	*P*	SEM	*P*	SEM
Temperature (0C)	31.3	36.1	27.6	30.7	30.4	32.5	29.5	29.8	35.0	0.03	1.25	0.23	1.25	0.01	1.25	0.02	1.53	0.64	1.77
Temperature (0F)	88.3	97.0	81.7	87.3	86.7	90.5	85.1	85.6	95.0										
pH	7.66	8.38	8.32	8.24	8.53	7.77	8.71	8.21	7.53	0.12	0.142	<0.01	0.142	0.22	0.144	<0.01	0.177	0.06	0.207
DM%	56.5	64.7	71.5	56.2	61.9	62.5	61.7	63.6	61.4	0.30	2.40	0.85	2.40	0.34	2.37	0.35	2.40	<0.01	3.39
Wet density (lbs/ft^3)	11.6	7.4	7.3	13.5	9.6	10.3	9.8	9.1	11.0	0.40	0.85	0.57	0.85	0.46	0.85	0.40	1.04	<0.01	1.20
Dry density (lbs/ft^3)	6.5	4.7	5.2	7.2	5.6	6.2	5.8	5.5	6.4	0.76	0.42	0.33	0.42	0.30	0.420	0.38	0.51	<0.01	0.59

There were no other statistically significant 2 way interactions, or the three way interaction

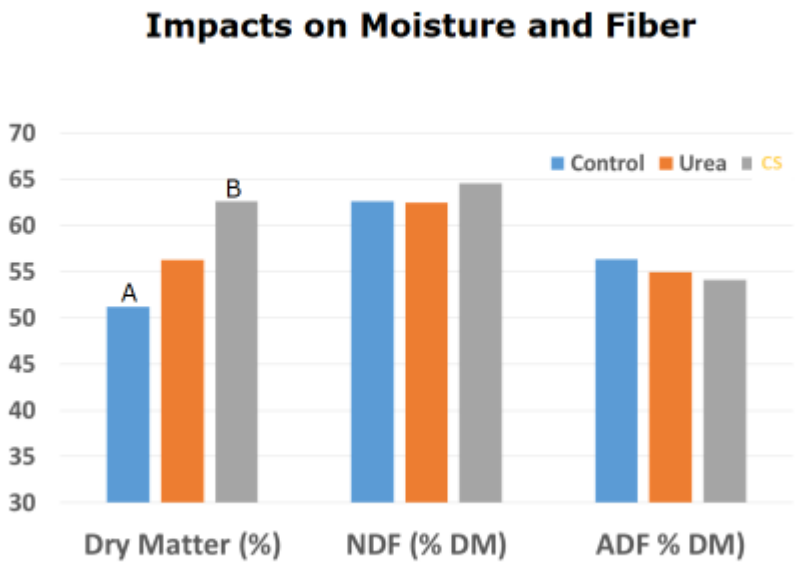
Results

The treatment with Crop Saver (CS), a buffered propionic acid product, dropped the pH of the strawlage on Day 0, but there is no significant difference during the rest of the sampling period (sSee graph below). The early reduction in pH may limit mold formation and/or kill existing molds.

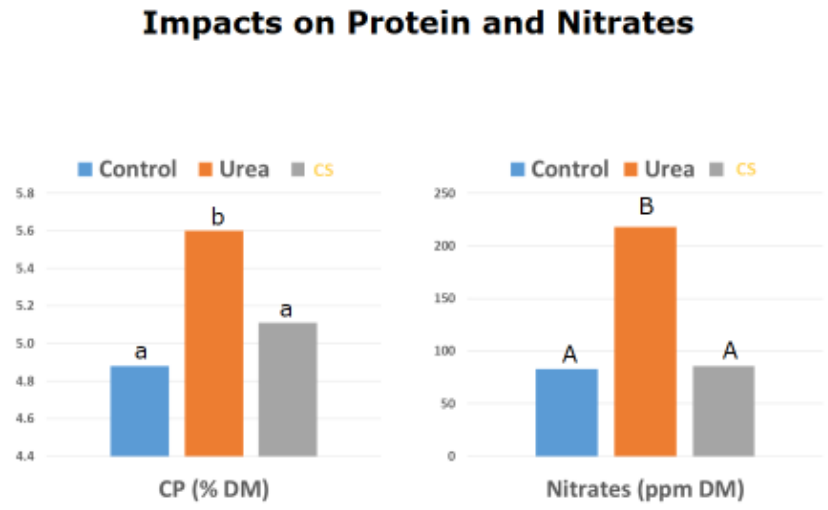


Visual evaluation suggested a color difference of the control and Cropsaver strawlage from day 60.

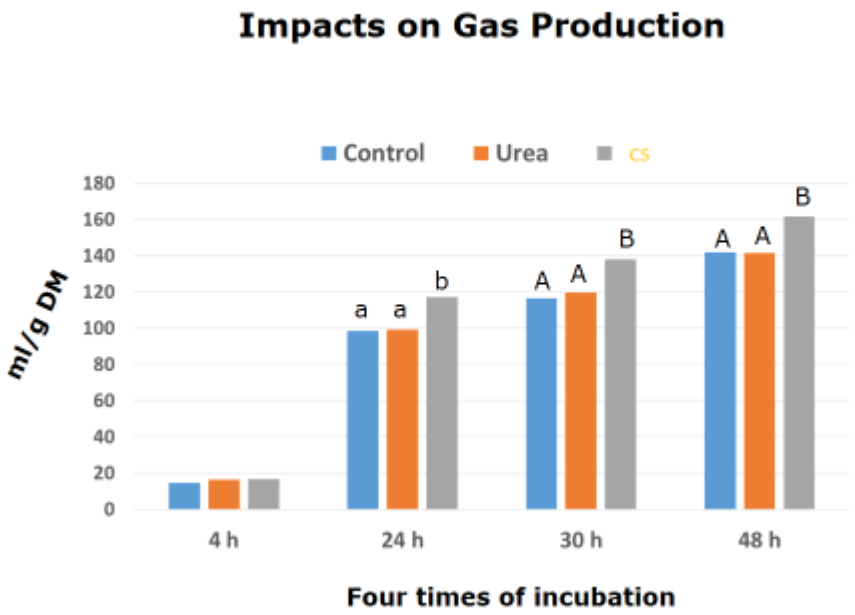
There was a difference in the dry matter by treatment. There is no data on the optimum moisture to obtain the highest ME value in rice strawlage. It is assumed that with higher moisture there is less drying which we havbe previously shown to decrease ME from fiber in rice strawlage. There were no differences in NDF or ADF among treatments.



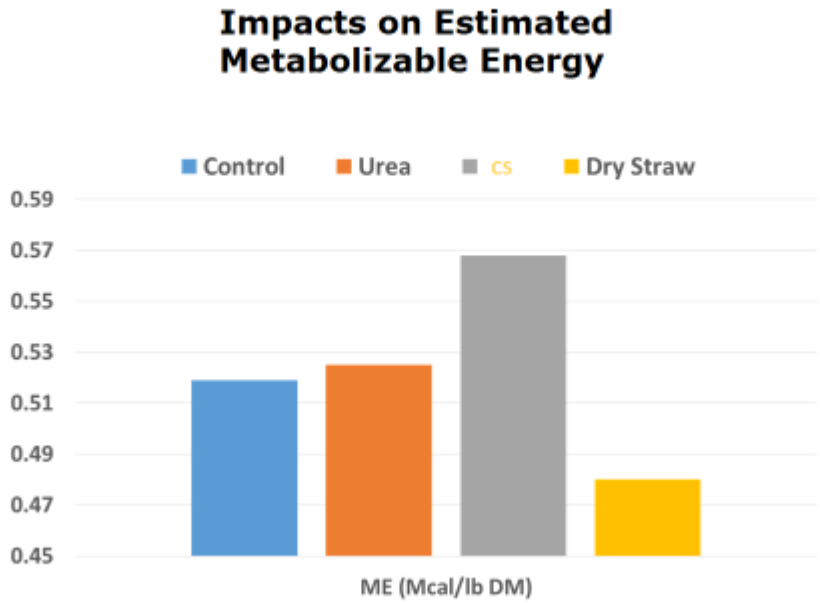
Addition of UN-32 and urea increased the CP level of the strawlage. This merits further study since, if the CP level was raised to 7%, it would create a forage that meets the protein requirements of a non-lactating beef cow. While this level of N addition increased the nitrate level, values were well within safety levels for ruminant feeds.



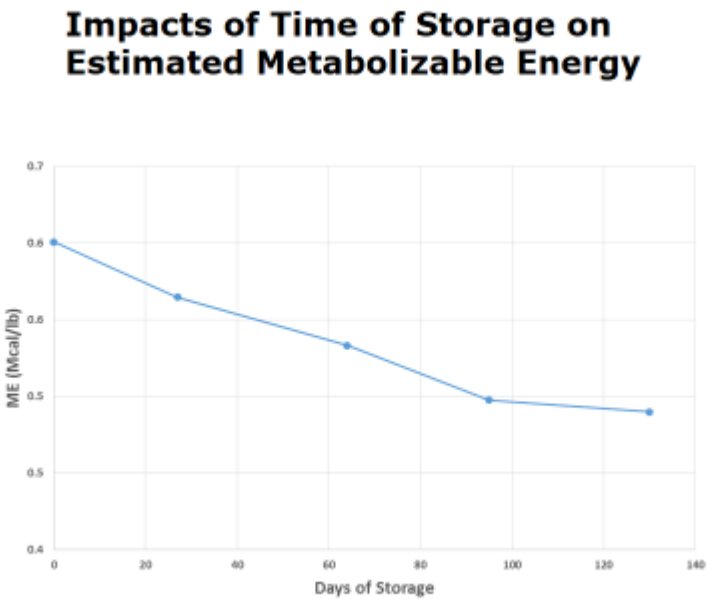
In vitro gas production estimates the amount of digestion of the strawlage by rumen microflora. The Cropsaver treated strawlage had significantly higher gas production at all times of incubation, except for the 4 hour period when mainly simple sugars and pectins are digested.



The overall ME levels of the propionic acid treated strawlage was higher than in the other treatments. All of the treatments are much higher in energy than the traditional method of feeding dry rice straw.



The loss of energy value with time of storage, as seen in the graph below, may be related to the loss of volatile fatty acids through tears and holes in the tarp. If this cannot be ameliorated, then feeding out the strawlage soon after baling would be a sound recommendation. We are examining this phenomina, with VFA determination, in the current year's project



The strawlage bales failed to keep their structural integrity with time and most stacks slumped badly. Indeed the resulting strawlage often looked terrible, was difficult to move and smelled odd. Producers feeding the strawledge would be encouraged to transport and store the product close to the feeding area within 30 days of harvest. At harvest the bales, similar to tradition rice straw, are easily transported but lose their integrity quickly. In addition, the bales should not be stacked over three bales high to lessen worries of collapse. However cattle provided access to it at two cooperating producer sites did not appear to notice, or care, as they ate the strawlage with gusto. Our observations of a relationship of poor appearance of the strawlage being associated with high intakes by cattle is similar to reports from Japan where strawlage in made in plastic wrapped round bales.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS

Objective 1 –Research Rice Strawlage Production from Rice Straw

Higher ME levels occurred in the propionic acid treated rice strawlage. However, with increased time in the tarped stacks, the ME in the strawlage dropped. Improved tarping methods may decrease this loss. Limited mold was found in the control strawlage that had been treated with Quadris during production to prevent blast from lowering grain production. This indicates that Quadris treated straw may save the need to treat for mold. A notable finding is that the strawlage bales failed to keep their structural integrity within 30 days and most stacks slumped badly. Indeed the resulting strawlage often looked terrible, even though the cattle allowed access to it appeared to differ in their assessment (see below).

Objective 2 - Demonstrate the feeding of Rice Strawlage

Two feeeders fed out the rice strawlage and reported very good consumption. Rice strawlage was also demonstrated at the January 2014 UC SFREC drought meeting for ranchers. An August meeting was held in Willows with rice producers and cattlemen to educate them on the process in advance of the rice harvest. This resulted in more use of the process in the 2014 crop year. However, each grower used a slightly different approach to the process. Much may be learned from the various methods used, and we are tracking some of them in the current years study. Publication of the strawlage findings were reported in Ag Alert, California Cattlemen's Hot Irons and Capital Press.

PUBLICATIONS OR REPORTS

Rauch, R., Cun, G., Nader, G., Robinson, P.H.. 2014. Effects of rice straw *versus* wheat straw as ingredients in a total mixed ration on intake, digestibility and growth of Holstein heifers. Animal Production Science, 2014, 54, 1047–1055.