Rice Strawlage

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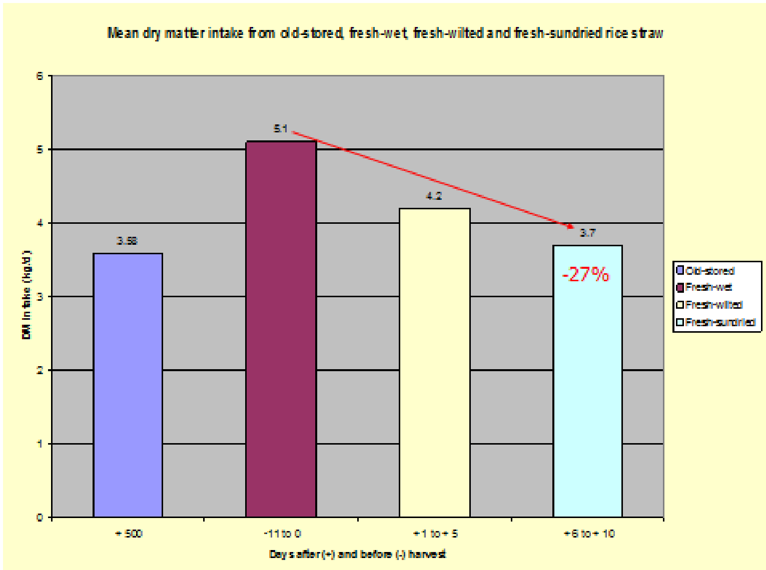
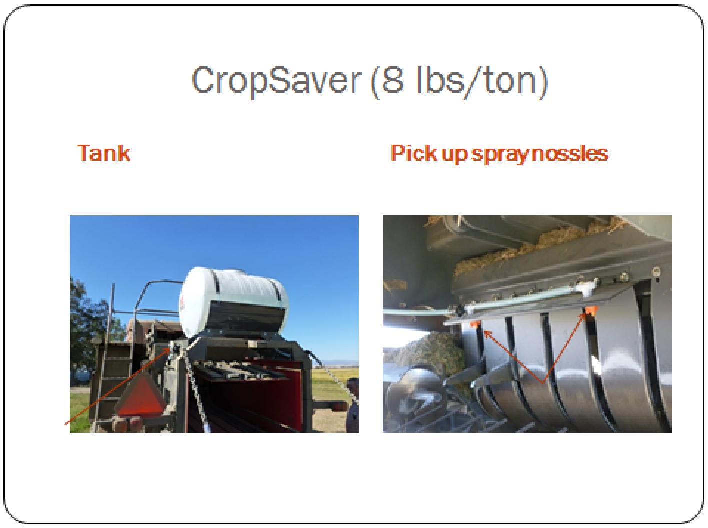
Research by Robinson and Nader has previously documented the significant loss of forage quality by rice straw during drying. At the time of harvest, the energy values for rice straw were near that of low quality alfalfa, but at the end of the 48 hour drying period, these had declined dramatically to those of a very low quality forage. The reasons for these dramatic changes are not understood at this time.



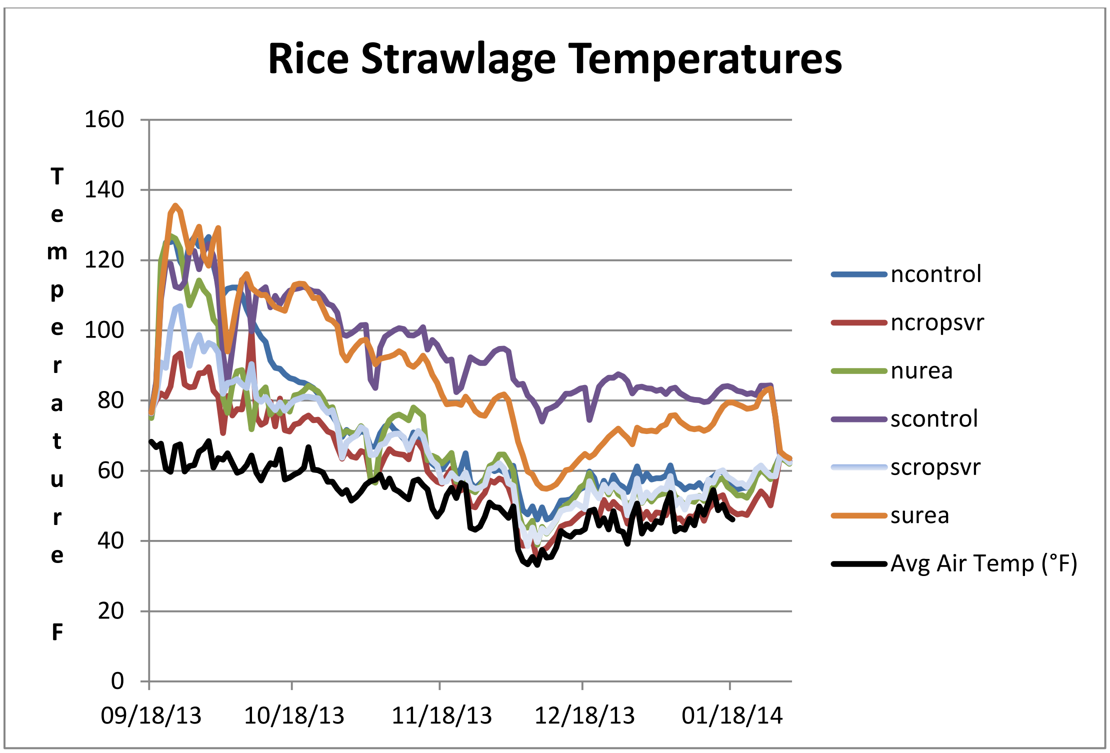
Strawlage is the process of putting up forage under high (45 to 65%) moisture and thus not allowing the drying that allows for a significant loss in digestiblity. At the time of harvest (head moisture of 18%) most rice forage is about 55% moisture, which is acceptable moisture level for strawlage. Previous work with rice strawlage was done with individual bale plastic wrapping that made the process too costly to implement. Field test of a much cheaper method of tarping a large stack of bales was conducted. Now a 100 x 40 foot tarp is used to cover 54 - 4x8x3 large bales as a much cheaper method of preserving the high moisture forage. The bottom bales are set on a 25 x 100 tarp to decrease loss of the forage that touches the ground.

Put the stacks in well drained areas that allow for winter access and no water accumulation on the bottom bales. Keeping the tarps on windy areas in the winter can be a challenge. Putting them in a wind sheltered area near trees or building decreases the displacement of tires or the tarp.

Mold can be a problem with the high moisture forage baling. Last year, it appeared that fields treated with Qaudris, had less mold in the strawlage. There are two proven methods of controlling mold. Application of 8.4 pounds per 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 weighed 1800 pounds and costs $2497. At the 8.4 pound 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. The positive is that it improved the nitrogen content that cattle can use to meet protein needs along with controlling mold. 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 pounds or 19.7 tons total weight, we applied 6.7 pounds of urea/ton or $3.35/ton and UN 32 application at 52 pounds/ton or $12.87/ton. The total pounds of nitrogen applied were 19.4 pounds/ton at a total cost of $16.22. Labor was not calculated in the costs of application.



Above are the temperature data for each of the three different treatments with 2 monitors on each stack (N = north S = south side of the stack). The CropSaver treated north and south appears to be lower temperatures than Control (no treatment) or Urea/UN 32 treated. The rest stayed over 100 degrees for two weeks. The CropSaver treatment may prevent a Maillard reactions that bind proteins, which becomes a problem at 140 degrees.

Ranchers are concerned about the potential for fires. In three years of conducting research we have not had any fires. The reason is that at 50 percent moisture there is a significant amount of moisture that needs to be driven off for combustion to occur. Covering the stack with plastic also limits the amount of oxygen that is available to support a fire. Lastly, there is a limited amount of soluble energy to drive the heat process.

Cows eating Rice Strawlage as it is dumped into the feeder

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. 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 are 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 for ruminant animal feeds. The linear increase in ash with time shows that carbon compounds are continuing to be used up and emitted as gases. The fact that the 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 energy levels of all strawlages with time of storage.

RICE STRAWLAGE STACKS AFTER FIVE SAMPLINGS

										P		
	Treatment			Days							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

Variability of Rice Straw

Rice straw varies greatly in its forage value with crude protein (CP) from 2 - 7 % and acid detergent fiber (ADF) from 46 - 56 %. Research has not been able to completely explain the reasons for this variability of rice straw forage values, but some of the factors that may influence quality include nitrogen management, location or soils and the variety of rice. Figures 1 and 2 are a summary of three years nutritional variability of 133 different stacks of rice straw from across Northern California. Each year is different in the quality of rice straw that is produced and in 2008 the CP and ADF were both much lower. ADF is a laboratory method of determining the fiber content that can assist in predicting the digestibility of a feed. The lower the ADF, the more digestible the feed is. A non lactating beef cow requires a diet containing 7% crude protein (National Research Council). The lower the CP percent of the straw the higher costs of the addition of other feeds or supplements to meet the cow's nutritional requirements.

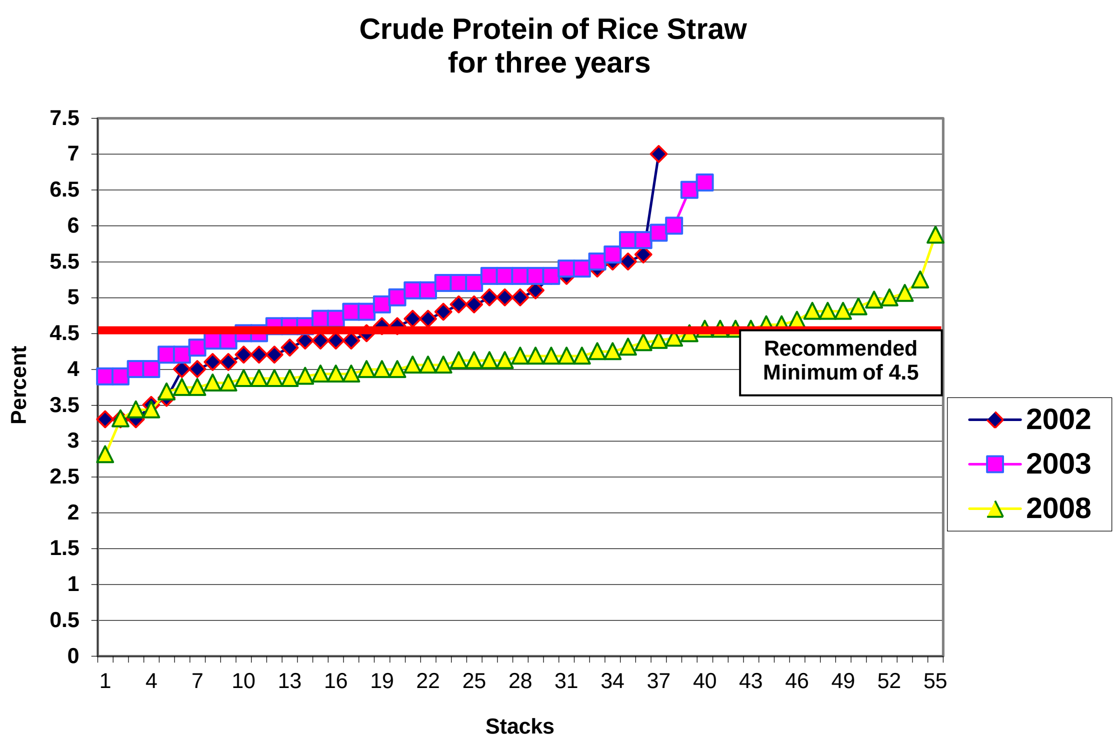


Figure 1. *Variation rice straw crude protein (CP) levels in samples of 56 different stacks.*

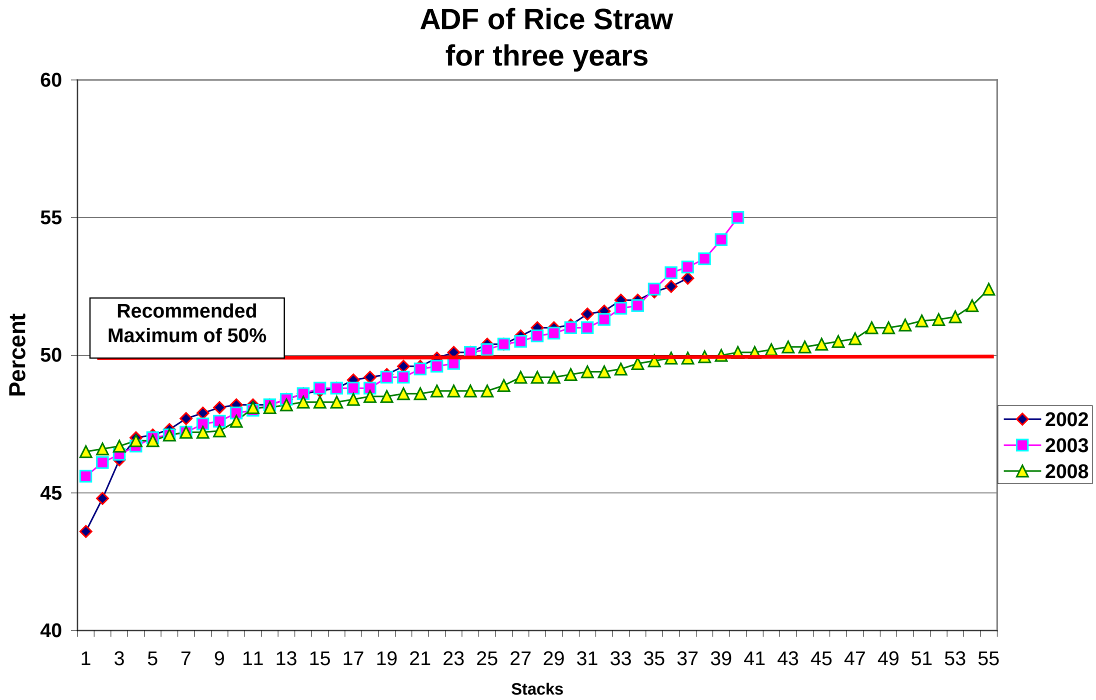


Figure 2. *Variation rice straw Acid Detergent Fiber (ADF) levels in samples of 56 different stacks.*

<u>Sampling before Harvest to Determine Forage Quality at Time of Baling</u>

Most rice producers only have time (instead of testing) to bale those fields that had higher rates of nitrogen fertilizer, cold water checks, or rice varieties that harvested at higher head moisture (due to early plant maturity). Improved marketing can come with sampling the straw before harvest to determine which fields to bale for cattle feed. Research data (Nader, Williams, and Ingram 1998) can be used to estimate the loss of nutrition from sampling at 18 or 12 days before harvest to the time of baling to estimate the final crude protein (CP) and acid detergent fiber (ADF) of the straw.

18 days to harvest - 1.8 % reduction in CP and 2.2 % increase in ADF

12 days to harvest - 1.25% reduction in CP and 0.4% increase in ADF

To collect a sample for analysis, randomly walk across the field cutting plants at the height of expected harvest. Strip the grain from the head, place the remaining straw in a paper sack and dry it for two to three days at ambient temperature, or in an oven at below 90^{o} F for 24 hours. Once dry, ship the sample to the laboratory with a request for crude protein (CP) and acid detergent fiber (ADF) analysis. Sample each field that has a different variety, soil, or nitrogen management.

Management that can impact the forage value.

Research has shown that the higher the nitrogen fertilization of rice, the higher the crude protein content of straw (Nader and Robinson 2000). This is **not** intended to recommend that growers increase nitrogen applications to improve forage quality. It should only be used as a strategy to pick the higher fertility management fields for potential livestock forage production and understand that there is a very high correlation between the nitrogen fertilization and straw crude protein content.

Head moisture of rice is highly correlated to plant's maturity. The higher the rice head moisture at harvest the higher the straw digestibility. As the rice plant matures, the rice straw has less digestible nutrients. This is why cold water checks and rice harvested at higher head moisture will have higher straw nutritional quality.

Rice Straw Removal Costs

In addition to the cost of baling rice straw (i.e. to bale and stack) there are also costs associated with nutrient losses that occur with straw removal as compared to incorporation. Burning rice straw volatizes most of the nitrogen and sulfur causing most to be lost into the atmosphere, whereas most of the potassium remains in the ash. Straw removal takes away potassium and nitrogen as well as sulfur. Conversely the majority of nutrients are retained in the field when the straw is incorporated. The nutrient impacts from different straw management processes need to be considered as part of the costs.

Typical rice straw nutrient content based on 100% dry matter basis as reported by Summers (2001) are:

.07% nitrogen

1.7% potassium

Research by Nader and Robinson. (2004) on rice straw samples from 77 different stacks over two years reported similar N and K levels in rice straw, in addition to the nutrient concentrations for several other nutrients (Table 1).

Table 1. Concentration (%) of selected nutrients in rice straw collected at several locations.

	Nitrogen	**Potassium**	**Calcium**	**Phosphorus**	**Magnesium**	**Sulfur**	**Sodium**	**Chloride**
Average	0.77	1.74	0.30	0.10	0.20	0.08	0.15	0.52
Maximum	1.12	2.70	0.50	0.17	0.30	0.15	0.50	1.20
Minimum	0.53	1.10	0.19	0.05	0.12	0.04	0.01	0.10

Rice growers report that baling harvester windrows cut at the waterline yield an average of 1.5 tons of straw per acre. Most straw is baled at 6-12% moisture levels. Table 2 represents the average nutrient loss at different straw removal rates as compared to incorporation. The example assumes the straw is baled at 6% moisture and that 100% of the nitrogen and potassium are recycled by incorporation.

Table 2. Average nutrient loss at different straw removal rates.

Tons straw removed/acre	**1**	**1.5**	**2**	**3**
Nitrogen (lbs) removed/acre	14.5	21.7	29	43.4
Potassium (lbs) removed/acre	32.7	49.1	65.4	98.1
Phosphorus (lbs) removed/acre	1.9	2.8	3.8	5.6

Japan Experience

Larry Roth with Provimi North America has worked with growers in Japan in making what they call rice balage. He provided this summary of his experience. The Japanese farmers are cutting, windrowing, baling and wrapping the whole-crop rice balage at 55-65% moisture with the grain included. Most of the rice balage on Honshu (the main island) is made in early November and the plants mature and brown, and the feed is used for heifers, dry cows and lactating cows as a local, lower cost forage than imported forages from Australia or the USA. The energy value seems to be similar to medium-quality grass hay, and livestock producers are wanting to harvest and feed more of the rice balage. The weather is typically in the 40'sF and this forage is treated at baling with our Storage-Mate liquid product featuring buffered prop acid, sodium benzoate and potassium sorbate (the three-way combination gives very good control against yeasts and molds). Some farmers use formic acid, others propionic acid and few use a microbial inoculant due to the cool weather not fostering the growth of bacterial inoculants. Rice balage not treated or improperly typically becomes coated with a white mold.

The rice balage from the southern island Kyushu is made in mid- to late-November when there is still some green to the forage. The southern rice balage is treated similarly to the Honshu balage, except there are some bacterial inoculants used due to the warmer weather. The southern rice balage seems to be of a higher nutritive value than the northern rice balage; however, the same comment about white mold describes untreated or undertreated balage.

The rice balage feeds much better than the appearance and nutrient assays would imply, which fits with UC Cooperative Extension observations on the rice strawlage. In the USA, we have treated higher moisture wrapped hay (up to 30% moisture) and corn stalks with very good preservation for a retail price of $4.80 per ton with a bacterial fermentation extract called HayDefender, which might be an alternative to the prop acid or urea with the rice strawlage.

His contact information is Larry Roth, Ph.D., PAS, Technical Services Nutritionist, Provimi North America, 612-418-8684 cell phone, Lroth@provimi-na.com

Ration

We looked at a possible ration analysis for using rice strawlage for feeding dry beef cows. Giving the computer rice bran as a supplement, it recommended 27 lbs of strawlage/day (at 50% moisture) and 6 pounds of rice bran. To save labor of feeding each day, ranchers have mixed salt to limit intake of rice bran. Starting with a 50% salt and adjusting down to get the proper intake is an option. Salt limiting diets require a suitable water source to be provided. Rice bran on the week of July 21 was quoted at $210/ton fob the mill. Previous experiences with feeding rice strawlage, has it out preforming the lab analysis used in this computer ration. Rice bran provides both protein and energy. The protein is needed as the average rice strawlage is about 5% protein. A dry cow requires 7%, thus some sort of protein supplement is needed.

Concentrated Energy Sources

Average Values (%)	Dry Matter	Crude Protein	TDN	Crude Fiber	Ash
Rice Bran	91	14	76	12	14.8
Almond hulls	91	4.2	54	17	6.6
Canola meal	88	36	63	10.6	6.3
Walnut meal	93	17.1	67	27	4.9
Safflower meal	92	23.9	55	34	4.3
Pinto beans	90	25.2	83	4.5	4.8

***Source** –By-Products and Unusual Feedstuffs in Livestock Rations. Western Regional Extension Publication No. 39, October 1980. 22 pages*

Rice bran historically has been popular as an energy feed due to its 13% fat content. It also contains protein, B vitamins, and very high levels of readily available phosphorus. Feeding levels should not exceed 20% of the ration, as high amount of unsaturated fats can lower the cellulose digestion and impacts fat metabolism and absorption. Animals fed too much rice bran will go off feed or scour. Rice bran can be fed with salt to limit intake on a range operation. Intake needs to be monitored to adjust the salt level to reach the desired intake. Those producers that have hammer mills have just poured it over the top of the bale before it goes in for processing. The salt levels can increase water consumption.

Almond hulls are a good source of energy, but are lower in protein (4.5%). They can be fed in troughs or a hot wire can be placed on the edge of the stack and moved it in as the cattle consume the hulls. There is some waste of the product with electric fence method, but it saves labor. The major problem with the purchase of hulls is that some processors sell loads of hulls that may also contain low nutrient contaminates of shell or twigs. It is prudent to get a purity percent and or nutrient testing before comparing price quotes on almond hulls.

As consumption of vegetable oils by humans increases, more oil seed meal is available. The effectiveness of the processing plant to extract the oil from the seed will vary the energy content of the meal. Safflower is the most common in Northern California. Dairies are now using canola meal from Canada. It comes in pellets, as that is only way they can ship it in rail cars down here. Feed brokers can be one method of locating this feed.

Bean processors will have some tested lots that are rejected for human consumption and then are sold to livestock operations. Beans work best for sheep and need to be cracked or softened to facilitate consumption by cattle.

Corn has come down in price, with some ranchers reporting $190/ton for whole corn. In other droughts, corn has been used to spare limited hay supplies. The general rule of thumb is that one pound of corn will replace 2 pounds of alfalfa or 3 pounds of meadow hay. The challenge for range operations is finding a way to feed corn at the ranch. Troughs or feeders work best. One rancher bought a used large 3 foot wide conveyer belt from a Nevada mine and runs the feed wagon down it. They put a connection on one end of it to pull it around the ranch to different locations. For more information see the Oklahoma State article on feeding corn to spare hay at http://www.okstate.edu/OSU_Ag/oces/timely/feeding.htm

Feeding alfalfa every other day has been documented to maintain a constant protein level in the rumen. Some producers have fed 5 to 7 pounds of alfalfa on an every other day basis while providing a lower quality forage free choice.