PROJECT NO. RU-5

ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE
January 1, 2008 - December 31, 2008

PROJECT TITLE: **Dairy Feeding of Rice Hay**

STATUS OF PROPOSAL: ____/New x___/Continuing

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LEVEL OF 2OO8 FUNDING: $38,900

OBJECTIVES OF RESEARCH:

Objective 1 – Dairy demonstrations of rice hay forage in replacement heifer rations. Expose more dairy owners and consulting nutritionist to the positive experience of mixing and feeding rice straw.

Dairy use of rice hay has great potential in rations of non-lactating cows and heifers due to sharply increased costs of alfalfa and other hays. Rice straw can be used to give diets forage structure to stimulate rumen development in heifers. It is estimated that there are at least 1.2 million dairy replacement heifers in California. Rice straw fit nicely at up to five pounds per head per day, as their targeted weight gain is 1.5 pounds per day.

***Objective 2* – Determine if different baling conditions will allow for amounts above 2 pounds/head/day of rice straw to be fed in dairy replacement heifers rations.**

There are questions of the optimum level of rice straw the can enter the ration and still obtain complete mixing of the ration in a TMR. In the 2007 study, the dairy heifer rations that were used 2 to 3 lbs per head per day. Although the straw mixed well, at one dairy they were not able to replace the 4 pounds per day of wheat straw with rice straw and obtain the same level of mixing. To allow for optimal use of rice straw, the chopping by the bale slicer in the rice field needed to be increased. The goal is to optimize the mixability, and thus the potential marketable amount, of rice straw. It is assumed that

baling at dryer straw moisture or swathing before baling will increase the chopping impact of the baler.

Objective 3 – Improvement of Chemical qualities of rice hay forage
Last year's research proved that the bulk of the loss of forage quality occurred from harvest to 48 hours post harvest during dry down. Research also indicated that freezing the straw at harvest reduced its digestibility when it was thawed later and analyzed again.

Now that the time period (i.e., 1 to 48 hours after harvest) when the critical loss in forage quality occurs occurs, the chemical changes during that 48 hour period need to be studied more intensely. The research will now focus on cellulose and silica changes during this crucial drying period.

As rice straw dries, the cell wall dehydrates and the cellulose chains form intermolecular and intramolecular bonds. The degree of crystallinity may increase as dehydration is completed and the cellulose chains come into closer proximity. Once highly crystalline cellulose has dried, it rehydrates at a very slow rate and it might be assumed that the effects of drying are not reversible. It is likely that this is a major factor in the change in the nutritive value of rice straw with drying.

Silica is located in the leaf predominately next to the cuticle layer and may form a permeable hydrated barrier in the living plant. The silica may be in a gelatinous form until the plant senesces and the straw dries. Upon drying the silica may form an impermeable barrier of amorphous SiO_2.

EXPERIMENTS CONDUCTED:

Objective 1 – Dairy demonstrations of rice hay forage in replacement heifer rations. Expose more dairy owners and consulting nutritionist to the positive experience of mixing and feeding rice straw.

***Objective 2* – Determine if different baling conditions will allow for amounts above 2 pounds/head/day of rice straw to be fed in dairy replacement heifers rations.**

Five dairy nutritional consultants were identified that cover the southern San Joaquin Valley and one in the Sonoma area. Each identified a progressive dairy producer that was provided one truck load (23-25 tons) of sliced forage quality rice straw to feed to replacement heifers. No instructions of how to use the straw were given and each operation designed their own ration. Each operation was toured during the feeding period and both the dairy manager (and/or feeder) and the nutritionist were surveyed. The results of the survey of the Dairy Managers are below.

Restrict feeding?	**2 – yes 4 – no**				
Level (lbs\head\day)	**5**	**2,5**	**2,5**	**3**	**1,5**
Miixing properties	**9**		**9**		**9**
Classes of animal fed	**Heifers Dy cows**				
Sorting behavior	**8**		**8**		**7**
Main differences vs. Wheat straw	**“Mixes better than some wheat straw”**		**“Sorting maybe a little better”**		
Forage replacement	**2 – silage 3 – wheat straw 4 – oat straw**				
General experience of the dairy that had fed our rice straw last year	**“Better than last year, exactly were I wanted it”**				

Past Experiences with rice straw	**6**	**6**	**2**
Initial Expectations (after project explanation)	**7**	**8**	**-**
Feed more with shorter length?	**no**	**no**	**no**
Experience overall	**9**	**9**	**8**
How likely are you buying more rice straw after this?	**10**	**10**	**10**



This year's research indicates that the finer sliced material allows for feeding at up to 5 pounds without mixing or sorting problems. There also was increased satisfaction with the product versus 2007. However there remains a need is to be able to work with rice growers in order to supply a consistent finely sliced rice straw product with a fiber length of less than four inches. The number of knives in the slicer baler does not affect the consistent length as much as the moisture at baling. Rice straw window moistures above 13% started to significantly increase fiber length above 4 inches. Lower moistures of 8 - 11% provided finer slice and faster baling. Field reports suggest that these slicer balers capacities are about 20 - 30% less than the same baler without knives. This is more of a problem in October when baling moisture below 13% compresses the time that baling can be conducted.

Information to dairy operation was provided through following articles in trade magazines and newsletters:

- California Dairy Magazine, June 2008 "Rice Straw Use in Dairy Heifer Rations"
- Ag Alert, August 27, 2008 "Dairy producers find ways to Stretch their feed dollars"
- Dairy Herd Management July 2008 "Rice Straw Use in Dairy Heifer Rations"
- Ag Alert, October 29, 2008 "Rice Straw shows promise as a dairy ration"
- Dairy Farm Advisor fall newsletters "Rice Straw in a free choice Dairy Heifer Rations" (Kings County, Tulare, Glenn and Stanislaus counties)
- Poster- Rice Straw Feeding to Dairy Heifers. California Nutrition Conference. May 21, 2008, Fresno, Ca.

An educational meeting for rice growers on preparing straw for diary markets was held in Colusa on March 6, 2008. It reported on the demonstrational findings of 2007 and featured a one hour conference call with three dairy representatives (a dairy nutritionist, dairy owner and dairy manager).

On November 6, 2008 a tour to the Sonoma dairy feeding rice straw was offered to rice growers putting up straw to see for themselves the final mixed ration looked and hear from the dairy owner his thoughts on the product.

Objective 3 – Improvement of Chemical qualities of rice hay forage

1). Silica effect on organic matter digestibility

A world wide literature review was conducted to determine the present knowledge of the impacts of the silica on digestibility. At this point, there is no defining research in this area. We also had discussion with silica researchers. Much of the information refined our study proposal.

Silica Location and Amount

A preliminary study of silica location in different varieties, analysis, and preparation techniques was preformed on addition plants remaining from the digestion study that was reported on last year. The silica allocation on ADF, NDF and ADNDF fraction of frozen and dry rice straw from M202 and M401 varieties is presented on Table 1. Variety had an impact on total silica, values for M401 were 27.9/100 higher than for M202 variety ($P < 0.01$). Silica on the ADF fraction was 8.3/100 higher for dry straw when compared to frozen rice plants ($P = 0.04$).

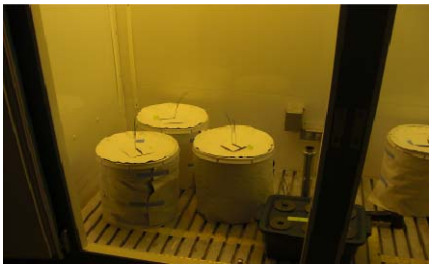
TABLE 1. SILICA ALLOCATION ON ADF, NDF AND ADNDF FRACTION OF FROZEN AND DRY RICE STRAW FROM TWO VARIETIES.

	Variety			Stage[2]			*P*		
	M202	M401	SEM	Fz	D	SEM	V	S	V*S
Total Si (%DM)	4.30	5.50	0.150	4.98	4.82	0.149	< 0.01	0.45	0.43
Si-ADF[1]	79.7	75.7	1.77	74.6	80.8	1.76	0.15	0.04	0.33
Si-NDF[1]	27.0	37.2	2.21	30.5	33.7	2.19	0.01	0.33	0.42
Si ADF/NDF[1]	18.7	26.0	3.44	19.2	25.5	3.40	0.18	0.24	0.25

[1] Values as % of total silica.
[2] Fz, frozen plants sampled before harvest; D, rice plants sampled during the storage of rice straw.

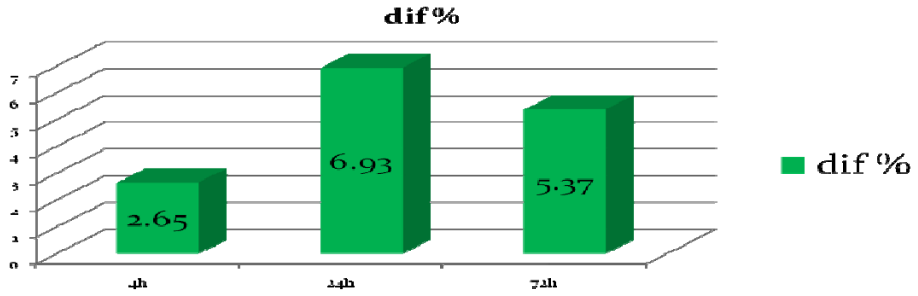
Silica Normal and Deficient Plants and Digestibility

Twelve rice straw plants were grown in growth chambers at UC Davis by Dr Emanuel Epstein and Dr. Bill Rains. Half were grown in media with silica and the other half without (see containers below). The concept of the study was to determine the impact of silica on digestibility of rice straw.



The plants presented stress at the boot stage and the plants were harvested and analyzed to provide preliminary data while the researchers address the growth problems. All plants from both treatments were analyzed through *in vitro* digestion. The difference in

digestibility from the silica normal plants to the silica deficient plants can be seen in the graph below.



Although the use of stressed plants in the boot stage limits the conclusion that can be concluded, silica appears to be having an impact on the structural carbohydrate digestion. This data indicates that this study needs to be continued and new plants are being grown with different media and collars in chambers and will be analyzed this summer.

2. Rice Straw Field Sampling

Samples were taken from 53 rice straw stacks throughout northern California to evaluate the cutin and silica content and their correlation to digestibility. Information was gathered from the producers on the following attributes that have been determined to vary forage quality:

- % Head moisture at harvest
- N fertilization
- Variety

The samples are presently be analyzed for the following: Crude Fiber, Neutral Detergent Fiber, Acid Detergent Fiber, ADL, % Cutin, % Silica, %Nitrogen. Each sample will also be evaluated by In vitro digestion.

The results will be reported later.

3. Forage Quality Reduction During Drying

Materials:

Live rice plants (M206) from the Biggs Research Field Station plant breeder Jeff Oster on December 8, 2008, were from four sets of plants that are a week apart in maturity. Ten plants will be selected from the initial 12 and three tiller stocks will be taken from each plant for in vitro gas production at UCD at harvest maturity. Kernels of grain will be sampled for head moisture from the seeds striped at the time of clipping of the stock to obtain a plant maturity determination. The same day, Kevin Holtman picked up rice plants at UCD and transported them to Albany where they were sampled for analysis and five drying treatments that day.

Sampling:
Each of the 10 plants will serve as a replicate of the five treatments. X-ray diffraction, SEM and CP/MAS NMR was performed on green and dry samples to provide a connection between changes in gas production and cellulose crystallinity.

These materials will be further subdivided and dried by different techniques:

1. Sun-dried to mimic field drying.
2. Solvent exchanged to remove water and dried in desiccator.
3. Dried gradually in a desiccator.
4. Dried at 55 ^{0}C overnight.
5. Dried at 105 ^{0}C for two hours.

Methods:
Whole samples will be submitted to scanning electron microscopy (SEM) for analysis of changes in the cell wall due to drying or scenescence. This work will be done at WRRC. Of particular interest will be the effect of the acetone on the cuticle.

Whole straw will be submitted to CP/MAS ^{13}C NMR (frozen by liquid nitrogen) verses dry). This work will be performed by Dr. Jingdong Mao at Old Dominion University. X-ray Diffraction will be performed at WRRC.

Samples will be reduced in particle size via cryomilling to avoid as much structural changes as possible. Material that passes a 53 μm screen will be divided and used for analysis.

The results from this research will be reported later.

Extension of Research Findings
Our previous three years of research on maceration entitled: "Effects of maceration of rice straw on voluntary intake and performance of growing beef cattle fed rice straw-based rations" was published in Animal Feed Science and Technology, 146 (2008) 74–86.

The reduction in digestibility between fresh and dry rice forage research findings were presented as a scientific poster at the World Association of Animal Production, Capetown, South Africa. November 2008.