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Comprehensive Research on Rice

Program Area: Residue Utilization

Project Number and Title: 70-26, The Value of Rice Straw As an Animal Feed

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Objectives: The long range objective is to determine the potential value of natural and processed rice straw as a feed for ruminant animals.

Short term objectives have been:

1. An evaluation of processed rice straw with animal metabolism and feeding trials.
2. Laboratory investigations to extend and compliment the animal experiments.
3. An evaluation of natural rice straw as a component of a ration for wintering cattle.

Work in Progress: (1) Completion of the laboratory analysis of samples collected in the earlier animal metabolism and feeding trials. (2) A feeding trial is under way with beef calves being fed three cubed rations high in rice straw each estimated to produce a particular rate of gain with comparisons being made with alfalfa cubes. (3) Preliminary evaluation of rice straw ensilage.

Experiments Completed:

The results of a series of metabolism trials with sheep are shown in the accompanying tables.

A ration containing 65% rice straw unprocessed or treated with 4% NaOH (by weight) for 15 or 60 minutes was fed to lambs. The results are shown in Tables 1 and 2. The ration containing the NaOH treated straw was palatable and when fed in the milled form was consumed in larger amounts than the ration containing unprocessed straw. The digestion trials indicated the digestable energy content of the straw was improved about 30% by the alkali treatment.

Shown in Table 3 are the results of treating rice straw with ammonia. The ammoniated straw was palatable when fed in a mixed ration or when fed alone. This treatment increased digestibility of the rice straw by about 35% and had the additional advantage of adding approximately 0.5% of nitrogen (3.3% crude protein equivalent) to a protein deficient straw.

Other digestion trials were conducted on alkali treated rice straw as shown in Table 4. In this trial a 93% rice straw ration was used. Calcium hydroxide or a combination of $Ca(OH)_2$ and NaOH were not effective in increasing the digestibility of rice straw and appeared to depress the digestible energy content. The 4% NaOH treatment increased the digestibility of the dry matter as in the previous trial, but the digestible energy content was not greatly increased above that obtained for the untreated straw.

Table 1. Dry matter consumption of a 65% rice straw ration by sheep[a]

Variable measured	Treatment and type of feed					
	Control		15 min. NaOH		60 min. NaOH	
	Milled	Pellets	Milled	Pellets	Milled	Pellets
Daily intake, lb.	3.0	4.2	3.7	4.2	3.7	4.3
Intake, % of animal wt.	2.5	3.4	3.0	3.4	3.0	3.4

[a]Mean values of ad lib consumption over a 20 day period with 8 or 9 sheep. See footnote Table 2 for the ration.

Table 2. Proximate analysis, digestible dry matter and digestible energy of a 65% rice straw ration[a]

Variable measured	Straw treatment		
	Control	15 min. NaOH	60 min. NaOH
Ash, %	14.22	16.5	21.4
Nitrogen, %	1.70	1.50	1.64
Crude fiber, %	29.4	30.4	25.5
Lignin, %	4.8	5.3	4.8
Cellulose, %	31.7	33.1	27.6
Gross energy, mcal/kg	3.92	3.83	3.58
Digestible dry matter,[b] %	50.5 ± 2.7	61.8 ± .9	64.6 ± .9
Digestible energy,[b] mcal/kg	2.05 ± .10	2.33 ± .04	2.36 ± .03
Estimated digestibility of straw			
Digestible dry matter,[c] %	40.0	57.4	61.7
Digestible energy,[b] mcal/kg	1.50	1.92	1.97

[a]Ration: rice straw, 65% cottonseed meal, 15%; molasses, 10%; barley, 9%; trace mineral salt, 0.5%; dicalcium phosphate, 0.5%, vitamin A also added. Fed as a pellet and as milled feed.

[b]Mean value from 8 or 9 sheep; with standard error.

[c]Assumes a dry matter digestibility of non-straw ration components of 70%.

Table 3. Proximate analysis, digestible dry matter[a] and digestible energy of a 65% rice straw ration[a] and a rice straw only ration

	Ammonia treated straw	
	65% straw	100% straw
Ash, %	15.6	
Nitrogen, %	2.2	1.56[c]
Crude fiber, %	27.1	
Lignin, %	6.3	
Cellulose, %	28.0	
Gross energy, mcal/kg	3.96	
Digestible dry matter,[b] %	56.3 ±2.2	51.6 ±.7
Digestible energy,[b] mcal/kg	2.29± .07	2.06±.01

[a]See ration Table 2.

[b]Mean value from 3 sheep; with standard error.

[c]NH_3-N, .53%.

Table 4. Proximate analysis, digestible dry matter and digestible energy of a 93% rice straw ration[a]

Variables measured	Straw treatment				
	13	14	15	16	17
	4% NaOH	2% NaOH 2% $Ca(OH)_2$	11% $Ca(OH)_2$	4% $Ca(OH)_2$	Control
Ash, %	19.9	-	22.1	21.7	17.2
Nitrogen, %	1.39	1.32	1.41	1.32	1.24
Crude fiber, %	35.5	34.8	-	31.0	32.1
Lignin, %	5.2	5.4	5.5	5.2	5.8
Cellulose, %	40.0	-	35.9	34.6	36.1
Gross energy, mcal/kg	3.50	3.41	3.46	3.55	3.75
Digestible dry matter,[c] %	51.5 ±.7	46.3 ± 1.3	42.8 ±1.0	35.6 ±2.4	46.9±.6
Digestible energy, mcal/kg	1.73±.02	1.58± .04	1.67± .03	1.40± .11	1.70±.02

[a]Ration: rice straw, 93%; cottonseed meal, 5%; urea, 1%; trace mineral salt, 0.5%; dicalcium phosphate, 0.5%; vitamin A and elemental sulfur also added. Fed as a pellet.

[b]Mean value from 3 sheep; with standard error.

Major Accomplishments:

The feeding value of rice straw can be improved by appropriate treatment with sodium hydroxide and by treatment with ammonium hydroxide. The treated straws are readily consumed by animals.

Work planned:

During the winter and spring of 1972 additional metabolism experiments will be conducted on rice straw processed by the cooperating U.S.D.A. scientists at Albany and a performance trial will be run on straw processed by two or three of the most promising techniques. At the present it appears that some form of ammoniation or a combination of steam and NaOH treatment is most beneficial. The laboratory analysis of the processed samples will be completed and hopefully provide some clues as to how further improvement in the feeding value of rice straw may be obtained.

Immediately Applicable Research Results:

It is too early to make an accurate assesement of the applicability of the present results. The information obtained to date is of considerable benefit to animal nutritionists contemplating the use of rice straw as a feedstuff.

Evaluation of Project:

It is now possible to be somewhat optimistic concerning the feasibility of improving the utilization of rice straw as an animal feed. More work is needed before an economic analysis can be made concerning the practical adoption of a particular processing procedure, however, some estimates in this regard may be possible within a year. This project has the advantage of being a cooperative venture and for this reason the information being realized per dollar spent is much greater than could be obtained through individual efforts. The project has already supplied animal nutritionists with information which can be used to more effectively utilize rice straw for feeding purposes and upon the completion of the planned experiments should enable us to make a reasonable assessment of the future outlook for utilizing this waste product as a source of nutrients for animal production.

Publication of Reports:

Garrett, W. N. 1970. Utilization of Rice Straw by Ruminants. 10th California Feeders Day Report p. 67.

Garrett, W. N. 1971. Feed value of rice straw. Western Agr. Exp. Sta. Collaborators Conf. Abstracts. U.S.D.A. - Western Regional Research Laboratory, Albany, Calif.

Guggolz, Jack, G. M. McDonald, H. G. Walker, Jr., W. N. Garrett and G. O. Kohler. 1971. Treatment of farm wastes for livestock feed. Proc. West. Sec. ASAS 22:71-76.