Project No. RS-6

COMPREHENSIVE RESEARCH ON RICE
ANNUAL REPORT

January 1981 - December 1981

PROJECT TITLE: Baler-Ammoniation of Rice Straw

PROJECT LEADERS AND PRINCIPAL UC INVESTIGATORS:

Don Toenjes, Farm Advisor, Glenn-Butte-Colusa Counties
Monte Bell, Farm Advisor, Glenn-Colusa Counties
Robert Curley, Extension Engineer, UC Davis
Bryan Jenkins, Professor, UC Davis
William Garrett, Professor, UC Davis
Clay Brooks, Development Engineer, UC Davis
Ben Norman, DVM, UC Davis
Jim Quick, Technologist, UC Davis
Howard Walker, USDA-ARS, Albany, CA

LEVEL OF FUNDING: 1980-81 $3,000 1981-82 $19,800

OTHER CONTRIBUTORS:

Daryl Alberico, Artois
Alvernaz Bros., Maxwell
Gates Machinery Sales, Willows
Glenn Fertilizer, Willows
Glenn Tractor, Willows
Larry Lowe, Orland
Mansfield Assoc., Yuba City
Monsanto, Los Angeles
Pacific International Rice Dryer, Woodland
Payer Custom Chopping, Orland
Pure Gro, Los Angeles
USS Agri-Chemicals, Atlanta, Georgia
Vermeer Manufacturing, Pella, Iowa

STATUS: Continued from 1980. Study is expected to continue through summer of 1982. No additional funds will be requested for 1981-82.

OBJECTIVES AND EXPERIMENTS CONDUCTED TO ACCOMPLISH OBJECTIVES:

Baler-Ammoniation: The general objective of this project was to explore the possibility of a practical field application of concepts of cellulosic changes brought about by NH_3 application to straws and stovers reported by Weiss and Walker in 1972 and Garrett et al in 1974 and 1979. It was also the purpose to measure the results by laboratory and feeding studies to determine the changes in the characteristics of the baler ammoniated rice straw. It was also the intent to determine if the practice would be economically feasible with available machinery.

SUMMARY OF RESEARCH:

Procedure 1980

Preliminary report submitted in December of 1980 outlined major problems in the fall of that year at the Alvernaz Ranch near Maxwell, California. Field conditions were excellent with the project starting in mid September. Rice variety was M-9. Fields baled were both close cut or cut normal height which varied from a stubble of 10-12" down to 3" depending on the extent of lodging. A 375 gallon NH_3 tank was mounted on the front of a 4 wheel drive Versatile tractor. A flow regulator and cold-flow device with distributor manifold was mounted on the Vermeer 504 high density round baler. Hay saver crowd wheels were mounted on the baler to compensate for windrow width. The NH_3 was applied at minus 25°F in liquid form at intervals of 7" across the top of the baler windrow pick-up.

Baling rate was measured and NH_3 rate set to approximate the required 5 lbs. of NH_3/cwt of dry matter. Alternate 5.5' wide windrows left by the combine were baled with ammonia at moisture levels ranging from 20 to over 40%. The remaining straw windrows were allowed to dry to levels close to 15% or below. Some ammoniated bales were made within 6 hours of combining while the normal was 2-5 days after combining. Control bales were generally baled 7-10 days after combining.

Estimates of windrow moistures were made with a Delmhorst Model F-4 hay moisture detector prior to baling. The average of 20-25 measurements randomly placed per untreated 4' x 5' round bale was found to be within 1-2% of oven dry matter estimates and was used for field adjustments. Ammonia caused the meter to read off scale so oven dried samples were used to estimate ammoniated bale moisture levels.

Bale size was 4' x 5' and weights varied from 400 lbs. to 1300 lbs. depending on moisture level. Seventy five control bales averaged 658 lbs. at 13% moisture while sixty five NH_3 bales average 915 lbs. at 23.5% moisture. Four bales were covered with commercially available black plastic sleeve so observations might be made relative to the effect a gas and moisture restrictive film might have on bale aging.

Samples for dry matter and laboratory tests were taken with the Penn State forage sampler driven by a ½" electric drill with a minimum of three cores (3/4" diameter - 16-18" deep) per sample. Dry matters were determined by oven at both Orland and Davis. NH_3 levels and other laboratory analyses were determined by standard methods at the UCD regional Extension laboratory. Samples for NH_3 measurement were placed in glass containers and mixed with 1 N-H_2SO_4 to prevent voltilization of NH_3 during transit and storage prior to analysis. All samples were protected against moisture loss and were immediately cooled if required.

Bales were transported by trailer to animal feeding location and stored outside.

Procedure 1981

Test site was near Highway 45 and County Road 39 in Glenn County. Fields were rectangular of varying lengths, severe lodging conditions resulted in close cutting with stubble height averaging 3-4". Two balers were selected, a new Heston 4800 which produced a 4' x 4' x 8' bale and a used Vermeer 604 high density baler which produces a 5' x 6' round bale. The Vermeer 604 differed from 1980's 504 in as much as bale density was not easily controllable.

Other modifications to improve bale ejection on the 604 were made and dual tires mounted. As in 1980 the windrows were taken as left by combine with 18' headers. Company representatives were present to initially adjust the Heston baler which was fitted with an ammoniation system similar to the one used in 1980 on the 4' x 5' Vermeer baler. Field conditions September 22 were excellent during the first week of the field trial after which intermittent rains, heavy dews, and mechanical problems limited baling. Last date baling was possible was November 9. After which the accumulated 11.5" of rain measured at the test location flooded the fields. Equipment was mounted on the Heston 4800 to evaluate the mold preventative properties of a commercial innocoulum utilizing aspergillus oryzae.

Procedure Animal Feeding Studies 1980

Fifty yearling replacement Hereford heifers were randomly assigned to one of two groups. The heifers were individually identified and weighed on two consecutive days at the beginning and end of the 100 day feeding period. (December 16, 1980 to March 26, 1981) One group was fed non-ammoniated rice straw and the other ammoniated rice staw in separate 3 acre lots. The baled rice straw was fed free choice in round bale feeders. In addition, the heifers were fed rice bran and calcium hydroxide daily and had continuous access to cafeteria style trace minerals and Loomix liquid supplement. Water was available in a stream.

Fecal samples were taken for parasite egg counts and blood samples for selenium and other blood nutrition and health factor analyses.

The round rice straw bales were stored adjacent to the feedlots on the ground unstacked and uncovered. They were fed when the previous bale was almost consumed. At the end of the trial the residual straw, mineral and liquid supplement was weighed and deducted from the total amount fed to each group.

The rice straw bales were core sampled (as previously described) at the beginning and on February 6, 1981 and analyzed for feed value. (Proximate analysis and calcium, phosphorus and potassium.)

Summary 1981 Research By Objective

Effect of Ammoniation

Laboratory analysis of samples taken 12/14/80 from 14 ammoniated bales and 14 control bales showed higher total N in ammoniated bales 1.35% vs. .75% dry matter basis (1-N H_2SO_4) and 1.11% vs. .70% N dry matter basis oven dried samples. NH_4-N was higher in ammoniated bales 6.11 gm/kg vs. .26 gm/kg. Tilley-Terry tests to evaluate changes in dry matter showed a 29% improvement in ammoniated straw vs. untreated. TSAE tests to evaluate changer in the cellulose showed a 23% change ammoniated vs. non-treated. Group means for ash ranged 13-14%.

Laboratory analysis of samples taken 2/6/80 of 10 ammoniated and 10 control bales showed higher total N in ammoniated bales 1.27% vs. .70% dry matter basis (1-N H_2SO_4) and 1.15% vs. .69% dry matter basis oven dried samples. NH_4-N was higher in ammoniated bales 5.63 vs. .22 gm/kg. Tilley Terry tests showed a 14% increase in dry matter disappearance due to ammoniation. TSAE have not been run on these samples. Group means for ash in ammoniated samples 14.36 vs. 16.95 control.

Two bales were split with a chain saw in March and samples taken from various cross sectional zones. Means of samples tested for NH_4N 252 ppm center, plus 6" - 413 ppm, plus 12" - 338 ppm, plus 18" - 226 ppm, plus 24" - 282 ppm, outside layer 56.2 ppm. At the time of sampling moisture was 19% and 25%. Color difference was obvious within zones of the bales. No visible signs of mold.

A third bale was split in July. Ammonia smell was obvious when layers were separated. No observable mold or other spoilage in interior after nine month unsheltered storage and a record season total of 27" of rain in the area.

Covering

Four covered vs. six uncovered ammoniated bales were core sampled in July, nine months after baling. Mean % NH_4-N in H_2SO_4 dry basis uncovered .355 vs. .562 covered for 158% increase over uncovered. Percent total N in H_2SO_4 extract dry basis .525 vs. .772 for a mean increase of 147% for covering. It should be noted that plastic covers had disintegrated by June.

No bales were covered at 1981 harvest. No laboratory results are available for 1981 harvest.

Baler Adaptability

Windrow width, high moisture, bale ejection, and choking were major problems encountered in 1980 with the Vermeer 504 baler. When the passive Hay Saver crowd wheels were installed and adjusted windrow width became a minor problem, but still a problem particularly in following a winding windrow or turning into a windrow. Choking sometimes resulted. Dry rice straw presented much fewer problems with average bale formation at 20 per hour averaging 572 lbs. dry matter/bale. High moisture rice straw bale formation averaged 10/hour at about 705 lbs. of dry matter/bale. Primary problem restricting speed was high moisture bale ejection. High moisture bales were removed by high centering on levees in 1980.

Bales were easily removed one at a time from field by 55 hp tractor with rear mounted forklift. Rate of removal to roadside was approximately 15/hour in fields of ½ - 3/8 mile in length. Two bales easily fit on 8' wide bed. 8 bales single stacked fit 21' long bed. Two layer stacking appears possible.

1981 experience was much different due to a wet fall. The Heston baler took many days of adjustment to compensate for the characteristics of rice straw. By the time the baler was adjusted for dry fall conditions it changed to a wet fall. Properly adjusted, the baler pick-up (6') worked even in the rain. However, choking was more prevalent. The Vermeer 604 pick-up (5') with passive crowd wheels did not work well when surface straw was wet. However, performance was better when the under portion of the windrow was wet and the top dry.

Choking was a primary problem for both balers. Choking in the Heston 4800 often resulted in shearing a bolt which took a lone inexperienced operator 60-90 minutes to clear and 4 or 5 additional bolts sheared to become operative. If a high moisture bale was left in the chamber or a rain storm occurred, a bolt was often sheared at start up. Simple choking took 15-30 minues to clear in both balers, but could use up 2-3 hours of baling time. Two high moisture bales were set on fire in the used Vermeer baler as a result of bearing failure. Incidental choking was decreased in the Vermeer 604 baler at the November 9th baling after modification of the pick-up despite the fact that water could be squeezed from windrowed straw next to the ground. The 10 bales made during late afternoon ranged from 22-50% dry matter (oven).

Soft fields proved to be a problem with both balers. While the Heston 4800 proved to be difficult to pull in the rutting fields with the Case 2470 4 wheel drive 185 hp tractor, the Vermeer 604 tended to choke more because the floating pick-up moved upward to reduce throat area. This throat area appeared to be a limiting factor controlling speed of baling high moisture straw. Other limits may be due to extreme flexibility of pick up teeth.

Powering the crowd wheels was attempted. However, the orbit motors provided by Hay Saver manufacturers were inadequate and/or defective. Not enough time was available to develop an appropriate design.

Bale Durability

The 4 x 5 or 5 x 6 round bales were easy to move intact from the field by forklift or tractor mounted forklift.

Ten 4 x 5 bales made in October 1980 were easily moved 60 miles in July of 1981 despite the fact that the twine had deteriorated.

The 4 x 4 x 8 bales of rice straw with needed density for ammoniation required 7 twine ties to remain intact. Six twine bales sometimes broke open and five twine bales always broke. Bales had to be tipped on to their side to prevent twin breakage when moved by standard forklift. Rebaling was impractical. Problems did occur in the regulation of bale density. High density bales which may prove to be the most durable were very difficult to produce. Low density bales were difficult to move even with a squeeze lift and high moisture stacks of these had a tendency to fall.

Weather Resistance

The round bales showed little deterioration or loss of quality after a winter of high rainfall if spaced adequately on a drained surface. Rain usually wet only the surface 1-2". The 4 x 4 x 8 bale depending on density, appeared to vary in wetness from totally penetrated (less dense) to only the upper 12-14" (more dense) after 11" of rainfall.

Animal Performance Feeding Study

Some annual grass and weeds grew in the three acre lots and it was evident that the heifers were spending a good deal of time grazing. Clippings of the grass were analyzed and we estimated the heifers ate about seven pounds of green feed which amounted to only one pound of dry matter daily.

The fecal and blood samples indicated no parasite or nutritional problems.

The Loomix liquid supplement available to the control heifers was higher in protein equivalent than that for the NH_3 heifers in an attempt to compensate for the higher protein equivalent due to ammoniation. Both rations were adequate in protein, calcium, phosphorus, potassium and vitamin A.

The rice bran was mixed by hand with the lime in the proper amounts and fed once a day in wooden sheep feed bunks. The feeding space was somewhat limited for the number of animals, but the variation in gain among the heifers was not excessive (CV 20%).

Results and Discussion

The Average daily feed intake for each group is presented in Table 1.

Table 1. Average Daily Feed Intake as Fed

Feedstuff	Control lbs.	NH_3 lbs.
Non-ammoniated Rice Straw	5.69	0
Ammoniated Rice Straw	0	7.77
Rice Bran	4.40	4.37
Loomix 5R:1R	1.82	0
Loomix 5EE	0	1.14
Hydrated Lime	.13	.13
Salt & Mineral	.05	.07
TOTAL	12.09	13.48

The heifers ate more of the ammoniated rice straw, less Loomix and slightly more mineral averaging about 1½ pounds more total feed per day than the non-ammoniated rice straw heifers.

Both groups ate about 4½ pounds of dry matter, less than predicted by the LC gain computer program.

The weights and gain are shown in Table 2.

Table 2. Average Weights and Gains of Heifers Fed Non-Ammoniated and Ammoniated Rice Straw

Item	Control	NH_3
No. Heifers	25	25
Initial Weight lbs.	556	557
Final Weight lbs.	592	604
100 day gain lbs.	36**	47**

$^{**}P < .01$

The gains were not satisfactory for replacement heifers, but those fed ammoniated rice straw gained significantly more than the control group (47 vs. 36 lbs. over 100 days).

Rice straw is a low quality feed and would not normally be fed in large amounts to young cattle expected to gain. It is probably more suited in a maintenance ration for older cattle. Heifers were chosen for experimental animals because weight gain differences are easier to measure and in a relatively short term feeding trial.

Extra rice straw bales were fed to the cooperating rancher's cows on pasture and he reported they readily ate them.

PUBLICATIONS OR REPORTS:

Progress Report RM-7 Baler Ammoniation of Rice Straw

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

Data collected to date indicates that baler ammoniation is a practical and effective means of modifying high moisture rice straw when a Vermeer 504 baler is used. Data indicates a moderate degree of NH_4 retention even after 9 months of storage exposed to relatively high rainfall.

Observations on animal acceptance of 4 x 5 high density round rice straw bales indicates that even non-ammoniated rice straw put up with color is quite acceptable to beef cattle grazing on irrigated pasture when presented free choice. On a more restricted basis, ammoniated rice straw is preferred over non-treated rice straw. Cattle tended to prefer the center 3/4ths of the ammoniated 4 x 5 round bales.

Observations found no mold visibly present in the interior of ammoniated 4 x 5 round bales even after over winter.

Observation indicates that while the balers used were basically sound they could not be used on a commercial basis without extensive modification and adaptation to the unusual baling conditions found in average rice fields during the fall harvest. Manufacturers when notified of problems expressed no interest in making modifications. The 4' x 5' bales was deemed a more practical size for commercial production of round bales and bale ejection problem appeared easily solved.

Observation of control bales point out the need for prevention of mold and oxidation if ammoniation is not used. Data shows the variability of moisture in the windrowed straw.

Differences in ash levels ammoniated vs. non-ammoniated bales at February sampling may indicate a difference in rate of oxidation and should be examined further.

Data indicates a long term beneficial effect from the use of plastic wrapped ammoniated round bales vs. non-wrapped ammoniated round bales.

Both the feeding trial and the invitro digestion study resulted in a 30% increase in feed value of rice straw due to baler ammoniation.

Ammoniation increased the animal acceptance of the rice straw by about a third. There were no health problems associated with any of the feeds.

Animal feeding studies and laboratory analysis on 1981 harvest will be reported at a later date.

Time, motion and economic studies for 1981 harvest will be included in a report by Bryan Jenkins under project heading RM 6.