

# OVERCOMING THE NUTRITIONAL LIMITATIONS OF RICE STRAW FOR RUMINANTS

## 3. UREA AMMONIA UPGRADING OF STRAW AND SUPPLEMENTATION WITH RICE BRAN AND COCONUT CAKE FOR GROWING BULLS

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### Summary

Forty eight growing bulls of two breed types (red Sahiwal and white Kilari), fed rice straw, were allocated to nine treatment groups:

- |                                    |                                  |
|------------------------------------|----------------------------------|
| 1. Control straw (CS)              | 6. UUS + 1.00 kg RB              |
| 2. Urea upgraded straw (UUS)       | 7. UUS + 0.25 kg RB + 0.25 kg CC |
| 3. UUS + 0.25 kg coconut cake (CC) | 8. UUS + 1.00 kg RB + 0.25 kg CC |
| 4. UUS + 0.75 kg CC                | 9. CS + 1.00 kg RB + 0.25 kg CC  |
| 5. UUS + 0.25 kg rice bran (RB)    |                                  |

Liveweight gain was measured weekly during 15 weeks and tested in three analyses of variance. The results are:

Urea upgraded straw produced a liveweight gain  $180 \text{ g.d}^{-1}$  higher ( $P < 0.01$ ) than control straw. The groups supplemented with 0.25 kg coconut cake and 1.00 kg rice bran showed an increase of  $100 \text{ g.d}^{-1}$  ( $P < 0.05$ ) over the unsupplemented groups. No interaction between straw upgrading and supplementation was present ( $P > 0.10$ ).

Both rice bran and coconut press cake, supplemented to upgraded straw at a level of 0.25 kg, did not increase liveweight gain ( $P > 0.05$ ), but 1.0 kg rice bran increased gain by  $90 \text{ g.d}^{-1}$  ( $P < 0.05$ ). A supplement of 0.75 kg coconut press cake to upgraded straw increased liveweight gain by  $160 \text{ g.d}^{-1}$  compared with 0.25 kg or 0.00 kg coconut cake supplement ( $P < 0.05$ ).

There were no significant differences between breed types ( $P > 0.10$ ) or interactions between breed and the other two main treatments (upgrading and supplementation). It was concluded, that both urea upgrading and supplementation of rice straw increase animal performance. The effect of urea upgrading was the same for both supplemented and unsupplemented animals. There was no indication of a non-linear effect of supplements on growth.

(Key Words: Rice Straw, Urea Supplementation, Concentrate, Growing Bulls)

### Introduction

The nutritional limitations of rice straw may be overcome by supplementation with concentrates, urea or green forage (Creek et al., 1984; Ghebrehwet et al., 1988; Preston and Leng, 1984) or by upgrading of straw by chemical or physical treatment (Ibrahim, 1983), of which urea upgrading has proven to be very practical (Perdok et al., 1982; Schiere et al., 1988).

In order to understand more about the effect of

urea upgrading of straw versus supplementation with concentrates, an experiment was conducted using coconut press cake and the relatively cheap rice bran fed as supplements to urea upgraded and untreated rice straw at different levels and combinations.

### Materials and Methods

#### Treatments

A group of forty eight growing bulls fed rice straw was divided into the following nine treatment groups:

1. Control straw (CS)
2. Urea upgraded straw (UUS)
3. UUS + 0.25 kg coconut cake (CC)
4. UUS + 0.75 kg CC
5. UUS + 0.25 kg rice bran (RB)
6. UUS + 1.00 kg RB

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7. UUS + 0.25 kg RB + 0.25 kg CC
8. UUS + 1.00 kg RB + 0.25 kg CC
9. CS + 1.00 kg RB + 0.25 kg CC

The design of the experiment allowed for three treatment comparisons:

- A. Control straw (1)
  - Upgraded straw (2)
  - Control straw + 0.25 kg CC + 1.00 kg RB (9)
  - Upgraded straw + 0.25 kg CC + 1.00 kg RB (8)
- B. Upgraded straw (2)
  - Upgraded straw + 0.25 kg RB (5)
  - Upgraded straw + 1.00 kg RB (6)
  - Upgraded straw + 0.25 kg CC (3)
  - Upgraded straw + 0.25 kg RB + 0.25 kg CC (7)
  - Upgraded straw + 1.00 kg RB + 0.25 kg CC (8)
- C. Upgraded straw (2)
  - Upgraded straw + 0.25 kg CC (3)
  - Upgraded straw + 0.75 kg CC (4)

A general objective was to determine whether the effect of concentrates is linear. In some cases, a stimulative effect of very small quantities of supplements on intake and liveweight gain have been reported (Leng and van Houtert, 1986; Saadullah, 1984).

#### Animals

The 48 growing animals used consisted of two different breed types, red (mainly Sahiwal) and white (mainly Kilari). These were allocated to the treatments groups in such a way, that breed effects could be tested. Each treatment group contained five animals (three red and two white), except three groups, which contained six animals (four red and two white).

All animals were young uncastrated bulls, weighing 80-160 kg (average 123 kg). The animals were housed and fed in groups. Before the experiment started, the animals were dewormed.

#### Feeds and feeding

The basal feed was rice straw obtained from village farmers. It was of unknown variety and cultivated under unknown fertilizer regimes. It was fed unchopped and *ad libitum*, either untreated or upgraded with 4% urea.

The upgraded straw was produced by addition of 4 kg urea in 100 l water to 100 kg air-dry straw allowed to react for 9-11 days in large open heaps under a roof, not exposed to wind. After nine days, the upgraded straw was fed over the

next three days. On the 12th day, a new lot of upgraded straw was started that had been made on the fourth day, etc.

Rice bran and coconut cake were fed in the morning and evening before the straw was offered. The rice bran was obtained from a local mill and was of the low quality generally available in Sri Lanka. For groups fed both rice bran and coconut cake, the concentrates were mixed together.

In addition to the experimental diets, all animals were fed 1 kg of fresh grass to supply vitamin A and simulate practical conditions. The grass was cut in the field irrespective of maturity and fed unchopped on top of the straw in the feed troughs. All animals were fed 30 g sodium sulphate, 20 g di-calcium phosphate and 50 g mineral mixture. The animals had free access to drinking water.

#### Measurements

The experiment lasted for 15 weeks, and live-weights were recorded before feeding at weekly intervals using a cattle scale. Liveweight gain was calculated by means of linear regression analysis (Snedecor and Cochran, 1980).

#### Statistical analysis

Liveweight gain was tested using analysis of variance (Snedecor and Cochran, 1980), in which initial body weight was added as a covariable. The Student-Newman-Keuls' test was used to check differences between treatment groups (Steel and Torrie, 1980). For comparison A, a three-way analysis was used with urea upgrading (control, upgraded), supplementation (unsupplemented, supplemented) and breed (red, white) as main effects. Comparison B was a three-way analysis with level of coconut cake (0, 0.25 kg) and level of rice bran (0, 0.25, 1.00 kg) and breed (red, white) as main effects. For comparison C, a two-way analysis was used with level of coconut cake (0, 0.25, 0.75 kg) and breed (red, white) as main effects. Comparison C was also combined with comparison B in a three-way analysis of variance with level of coconut cake (0, 0.25, 0.75 kg), level of rice bran (0, 0.25, 1.00 kg) and breed as main effects, to include more observations for the first two levels of coconut cake. In all analysis, interactions between main effects were tested.

#### Results and Discussion

UREA-AMMONIA TREATMENT OF RICE STRAW FOR GROWING BULLS

TABLE 1. EFFECT OF UREA UPGRADING AND SUPPLEMENTATION WITH 1.00 KG RICE BRAN PLUS 0.25 KG COCONUT CAKE ON LIVEWEIGHT GAIN OF GROWING BULLS OF 2 BREED TYPES<sup>1</sup>

	Control straw		Upgraded straw	
	without supplement	with supplement	without supplement	with supplement
Liveweight gain (g.d <sup>-1</sup> )				
Red animals	22	98	179	235
White animals	98	30	108	318
All animals <sup>2,3</sup>	-26 <sup>a</sup>	68 <sup>ab</sup>	146 <sup>b</sup>	256 <sup>c</sup>

<sup>1</sup>abc Values with the same superscripts are not significantly different ( $P > 0.05$ ). Breed effects were not significant ( $P > 0.10$ ).

<sup>2</sup> these average values are corrected for covariable effect of initial body weight.

<sup>3</sup> Breed effects were not significant ( $P > 0.10$ ).

TABLE 2. EFFECT OF SUPPLEMENTATION WITH RICE BRAN AND COCONUT CAKE TO UREA UP-GRADED STRAW ON LIVEWEIGHT GAIN OF GROWING BULLS OF 2 BREED TYPES<sup>1</sup>

	Level of coconut cake (kg fresh matter)					
	0.00			0.25		
Level of rice bran (kg)	0.00	0.25	1.00	0.00	0.25	1.00
Liveweight gain (g.d <sup>-1</sup> )						
Red animals	179	169	274	206	142	235
White animals	108	196	196	102	246	318
All animals <sup>2,3</sup>	154 <sup>a</sup>	154 <sup>a</sup>	254 <sup>b</sup>	145 <sup>a</sup>	208 <sup>a</sup>	271 <sup>b</sup>

<sup>1</sup>a,b Values with the same superscripts are not significantly different ( $P > 0.05$ ). Breed effects were not significant ( $P > 0.10$ ).

<sup>2</sup> These average values are corrected for covariable effect of initial body weight.

<sup>3</sup> Breed effects were not significant ( $P > 0.10$ ).

The results for comparisons A, B and C are summarized in tables 1, 2 and 3. Means for treatment groups used in more than one comparison, differ slightly from one comparison to the other, due to the respective corrections for covariable effects.

**Comparison A: Urea upgrading and supplementation with 1.00 kg rice bran plus 0.25 kg coconut cake.**

Urea upgrading of straw increased liveweight gain by 182 g.d<sup>-1</sup> ( $P < 0.01$ ). Similar increases were found by Ghebrehiwet et al. (1988) and Schiere et al. (1989) who found liveweight gains on untreated straw of approximately -100

g.d<sup>-1</sup> and on urea upgraded straw of +90 g.d<sup>-1</sup>. Those levels are lower, however, than the levels found in this experiment, maybe due to a difference in the quality of the straw used. Tharmaraj et al. (1989) found a smaller improvement with upgrading (-121 g.d<sup>-1</sup> on untreated straw and -4 g.d<sup>-1</sup> on urea upgraded straw), maybe due to a less efficient treatment process in small open heaps as used in their experiment. The superiority of the urea upgraded straw is probably caused by a higher intake and digestibility of upgraded straw (Saadullah et al., 1982; Chesson and Ørskov, 1984; Ghebrehiwet et al., 1988; Schiere et al., 1989). Doyle et al. (1986) found that in urea-ammonia upgrading about 75 % of the increase

in digestible organic matter intake was due to the supplementation with nitrogen and only a minor part to the chemical reaction of the ammonia released from urea with the cell wall component in straw.

Supplementation with 1.0 kg rice bran and 0.25 kg coconut cake to control straw or urea upgraded straw (table 1) caused an increase of 98 g.d<sup>-1</sup> ( $P < 0.05$ ). No interaction between straw upgrading and supplementation was present ( $P > 0.10$ ), indicating that the effect of urea upgrading is the same for supplemented and for unsupplemented groups, as also found by others (Ghebrehiwet et al., 1988; Tharmaraj et al., 1989). These improvements are somewhat lower than those found by Ghebrehiwet et al. (1988) who supplemented both untreated and urea upgraded straw with five levels of rice bran and found increases of 180 and 150 g.d<sup>-1</sup> per kg rice bran addition for untreated and urea upgraded straw, respectively. The higher response to rice bran in their trial is probably due to a difference in rice bran quality. The quality of rice bran produced in Sri Lanka is highly variable, partially due to its variable ash content of 25-45% (Ibrahim, 1987).

Although the red animals performed better than the white animals in three of the four groups, no significant difference in favour of either type of animal emerged ( $P > 0.10$ ). With the small number of animals used, interactions between breed and straw upgrading or between breed and supplement could not be detected ( $P > 0.10$ ). No effect of initial weight (as a covariable) on liveweight gain was observed ( $P > 0.10$ ).

#### Comparison B: Supplementation with three levels of rice bran and two levels of coconut cake to urea upgraded straw

Rice bran supplementation to upgraded straw at a level of 1.0 kg significantly ( $P < 0.05$ ) increased the liveweight gain with 100 g.d<sup>-1</sup>. This resulted in a gain of 254 g.d<sup>-1</sup> (table 2), which is the same growth as found by Ghebrehiwet et al. (1988) for Sahiwal crosses on urea upgraded straw supplemented with 1.0 kg rice bran. The effects of 0.25 kg coconut cake or 0.25 kg rice bran were not significant ( $P > 0.05$ ). Initial body weight affected liveweight gain significantly ( $P < 0.05$ ), due to a high variation in initial weight within some of the treatment groups. No breed effect and no interactions were present ( $P > 0.10$ ).

#### Comparison C: Supplementation with three levels of coconut cake to urea upgraded straw.

Table 3 shows that liveweight gain at a supplementation level of 0.75 kg coconut cake is approximately 160 g.d<sup>-1</sup> higher than at 0.25 kg or 0.00 kg supplement. However, in the two way analysis of variance coconut cake supplementation did not affect liveweight gain significantly ( $P > 0.05$ ), due to low animal numbers per class. At the higher animal numbers included in the

TABLE 3. EFFECT OF SUPPLEMENTATION WITH COCONUT CAKE TO UREA UPGRADED STRAW ON LIVWEIGHT GAIN OF GROWING BULLS OF TWO BREED TYPES<sup>1</sup>

	Level of coconut cake (kg fresh matter)		
	0.00	0.25	0.75
Liveweight gain (g.d <sup>-1</sup> )			
Red animals	179	206	315
White animals	108	103	331
All animals	154 <sup>a</sup>	146 <sup>a</sup>	322 <sup>b</sup>

<sup>1</sup> a, b: Values with the same superscripts are not significantly different ( $P > 0.05$ ).

<sup>2</sup> These average values are corrected for covariable effect of initial body weight.

<sup>3</sup> Breed effects were not significant ( $P > 0.10$ ).

three-way analysis (including the treatment groups involved in comparison B), the effect of 0.75 kg coconut cake became significant ( $P < 0.05$ ). In an experiment with growing Sahiwals, Perdok et al. (1984) found a similar increase of 150 g.d<sup>-1</sup> ( $P < 0.05$ ), when urea upgraded straw was supplemented with 0.6 kg (dm) coconut cake. No breed effect or interaction between breed and coconut cake level was observed at these numbers of animals ( $P > 0.10$ ). Inclusion of initial weight as a covariable did not result in a significant covariable effect ( $P > 0.10$ ).

#### Conclusion

This experiment shows clearly that animal performance on rice straw can be increased by either upgrading or supplementing straw, or by a combi-

nation of these. In this experiment, the supplements consisted of rice bran and coconut cake at several levels and combinations. Non-linear effects of small amounts of supplements could not be indicated. Such non-linear effects might be expected, considering the non-linear effect as found by Saadullah (1984) in the case of fish meal and considering the effect of small quantities (50-100 g.d<sup>-1</sup>) of protein meal on liveweight gain (Van Houtert and Leng, 1986). In this experiment, small supplements of both rice bran and coconut cake did not increase liveweight gain significantly. The absence of interaction between straw upgrading and supplementation, as also found by others (Ghebrehiwet et al., 1988; Schiere et al., 1985a; Tharmaraj et al., 1989), indicates that the effect of urea upgrading is the same for animals that are supplemented or not supplemented. In this experiment animals on urea upgraded straw alone grew at a rate of 150 g.d<sup>-1</sup>, while for animals on untreated straw, rice bran should constitute almost 50% of the ration to obtain the same growth rate. At such high levels of concentrates, problems can arise regarding the intake of straw. The choice between the alternatives has to be based on economics. Ration calculations have shown that feeding urea upgraded straw is profitable at higher levels of production or when concentrates are expensive (Schiere et al., 1985b; Nell et al., 1986).

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