ON FARM DEMONSTRATION OF VARIOUS STORAGE METHODS FOR UREA TREATED WHEAT STRAW

A. G. Khan[1], W. Ullah[2], A. Azim and A. Ali[2]

Animal Nutrition Program, National Agricultural Research Centre, Islamabad, Pakistan

Summary

On farm demonstration of urea treatment (5 kg urea dissolved in 60 litre water/100 kg) of straw was performed at 6 different sites and treated straw was stored by three different methods i.e., plastic covered, mud plastered and existing farmers technique (mud plastered on the top and open from sides) to determine the best storage method in field. Untreated and treated samples were taken after 5 week storage period and subjected to crude protein, crude fibre and cell wall constituents analysis. *In situ* dry matter digestibility of straw was measured by nylon bag technique in buffalo bulls.

Crude protein content increased by 100 to 153 percent in treated straw stored by different methods. Maximum increase in crude protein of treated straw was noticed in mud plastered method. Urea treatment of straw resulted in significant decrease in crude fibre contents in all the storage methods. Treatment of straw enhanced the *in situ* digestibility by 25-49 percent and maximum digestibility (53%) was found in mud plastered storage method. It was concluded that the mud plastered storage method for urea treated straw was found to be the best at farm level.
(**Key Words**: On-Farm Demonstration, Urea Treatment, Storage Methods)

Introduction

Crop residues share the highest as 47% in the feed resource pool in Pakistan. It is estimated that about 28.5 million ton of crop residues were produced in 1986, where as by year 2000 the production of crop residues will increase to the tune of 45.7 million ton (table 1).

The low level nitrogen contents, essential minerals and high lignin contents of the crop residues are considered to be responsible for their low voluntary intake and digestibility (Shin, 1976; Acock et al., 1978 and Khan et al., 1989). Methods of enhancing the feeding value of crop residues have been reviewed extensively by Jackson (1978) and Lesoing et al. (1981). Among the chemical treatment, urea treatment of straw logically seems to have some advantages such as 1) easy availability of urea (fertilizer grade) at farm level, 2) easy to manage and handle urea and its solution and 3) comparatively cheaper source of protein.

Urea treatment of wheat straw in India has already exhibited its application value by supporting the milk production level of 6 kg/head/day without any concentrate (Verma, 1988). Most of the work on urea treatment in Pakistan is limited to laboratory level and only in some research studies productive response of animals to such treatment was also measured (Ajmal, 1986; Khan, 1988; Khan et al., 1990 and Khalid, 1988). Practically, no due attention was paid to the application of urea treatment of straw technology on-farm level. Wheat straw is commonly

TABLE 1. PRODUCTION OF CEREAL CROP RESIDUES IN PAKISTAN (MILLION TONS)

Crop residue	Year	
	1986[1]	2000[2] (estimated)
Wheat straw	18.02	31.14
Rice straw	4.99	6.74
Barley straw	0.20	0.35
Sorghum straw	0.88	0.90
Millet straw	1.03	1.23
Maize residue	3.03	4.88
Oats straw	0.31	0.42
Total	28.46	45.66

[1] Agricultural Statistics of Pakistan, 1986.
[2] FAO, 1987.

[1]Address reprint requests to Dr. A. G. Khan, Animal Nutrition Program, National Agricultural Research Centre, Islamabad, Pakistan.

[2]Buner Development Project, Dagger, Buner, Pakistan.

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stored in mud plastered heap (Dher) in irrigated area. In rain-fed areas, it is more carefully stored in kup or in room and is used when grazing is scare. Transformation of treatment technology of wheat straw and it sustainable adoption at farm level under village condition still remain the subject of future research in Pakistan.

The on-farm demonstration of urea treatment of straw was performed with an objective to find out the most suitable storage method under village condition and to convince the farmers for its adoption for sustainable and efficient livestock farming system.

Materials and Methods

This study was carried out in two phases i.e., laboratory experiment and on-farm demonstration. The procedural description of each phase is as follows:

Laboratory Experiment

In this experiment, batches of 500 g of chopped wheat straw was treated with 0, 3, 4, 5 and 6 kg urea dissolved in 60 litre water/100 kg straw (on dry matter basis) sealed in polythene bags and stored at room temperature for a period of 5 weeks. After this treatment period, the bags were opened and treated straw was kept at room temperature to liberate the free ammonia which was generated from urea during storage period. After oven drying, treated straw was ground to 1 mm and stored at room temperature. Untreated and treated straw were analyzed for crude protein and crude fibre contents (AOAC, 1984). Cell wall constituents of straw were determined according to the method described by Goering and Van Soest (1970). *In situ* dry matter digestibility was measured by nylon bag technique (Orskov et al., 1980). Samples of straw in nylon bags of 3 g each were placed in the rumen of fistulated buffalo bulls. The bulls were fed on a basal diet having 60% wheat straw, 39% cotton seed cake and 1% mineral mixture. The nylon bags were withdrawn after 48 hour and subjected to measure dry matter contents.

On-Farm Demonstration

On-farm demonstration of various storage methods for urea treated straw was carried out to determine the best type of storage method which can be replicated and adopted under livestock farming system. On-farm demonstration of urea-treatment of wheat straw was performed at 6 different sites of Punjab (rain fed) and NWFP (tube well irrigated). The straw was treated with 5 kg urea dissolved in 60 litre water and applied to 100 kg straw and stored in 3 different storage methods; i) plastic covered heap (Dher) ii) mud plastered (top and side) and iii) farmer's technique (mud plastered on the top and open on the side) to determine the best storage system on the farm. While storing, the treated straw was manually pressed to expell the air. Untreated and treated straw was taken after 5 weeks storage period. The samples were dried, ground and subjected to crude protein and crude fiber (AOAC, 1984) and cell wall constituents (Goering and Van Soest, 1970) analyses. *In situ* dry matter digestibility of straw was determined according to the technique described by Orskov et al. (1980).

In subsequent year, on farm demonstration of urea treatment was continued and carried out at 3 sites on large scale (4,000 kg-10,000 kg straw). The urea: water: straw ratio remained the same as in previous demonstration. On-farm I, treated straw was stored in bricked wall boundary store (open on one side) and in a shed (partially open on 3 sides). The treated straw was covered with polythene and then mud plastered on the top and thus making the storage almost air tight. On the same farm, treated straw was also stored in a shed and only polythene was used to cover it. Some bricks were placed on the extreme end of polythene to ensure that it will not blow away with the wind.

On-farm II, treated straw was stored in bricked wall boundary store and covered with polythene and then mud plastered. On farm III, treated straw was stored in Kup method and Dher method and comparison was made to ascertain the density of straw in each storage method. The quality of treated straw was also monitored in respect of mould and other spoilage. At these farms, farmers were keeping about 60 indigenous and 20 cross bred cows, 200 sheep and 20 high milk producing cross bred cows. Due to difficulties and lack of physical facilities for grouping of animals at these farms, no appropriate data could be recorded. However, general information on the acceptability of treated straw, its effect on milk production and general health and cost of feeding was obtained.

Results and Discussion

Laboratory experiment

The crude protein contents of urea treated straw correspondingly increased with the increasing levels of urea treatment (table 2). Significantly ($p < 0.05$) higher retention of nitrigen from urea was found at 5 and 6% urea treatment. Increase in percentage of crude protein in treated straw was maximum (167.17%) at 6% followed by 5%, 4% and 3% urea treatment. Data on crude fibre and cell wall constituents of various levels of urea treated straw also suggested that increasing levels of urea

TABLE 2. EFFECT OF VARIOUS LEVELS OF UREA ON CHEMICAL COMPOSITION (%DM) AND *IN SITU* DRY MATTER DIGESTIBILITY OF WHEAT STRAW

Parameter	Urea levels (%)				
	0	3	4	5	6
Crude protein	3.29[d]	7.56[c]	7.85[b]	8.60[a]	8.79[a]
(% increase in crude protein)	–	129.78	138.60	161.39	167.17
Net increase in crude protein (% age unit)	–	4.27	4.56	5.31	5.50
Crude fiber	43.29[a]	41.49[b]	41.49[b]	40.38[c]	40.06[d]
Neutral detergent fibre	79.64[a]	77.40[b]	75.50[c]	74.80[d]	74.01[e]
Acid detergent fibre	53.93[a]	51.89[b]	51.40[b]	53.40[b]	52.33[b]
Acid detergent lignin	9.50[a]	7.20[b]	7.50[b]	6.80[c]	6.90[c]
In situ dry matter digestibility	36.61[d]	42.29[c]	45.19[ab]	44.47[b]	45.49[a]
% increase in dry matter digestibility	–	18.76	26.9	24.88	27.75

[abcd]:Means within same rows with different superscripts differ ($p < 0.05$).

TABLE 3. INFLUENCE OF VARIOUS STORAGE METHODS ON THE CHEMICAL COMPOSITION OF UREA TREATED WHEAT STRAW

Parameter	Untreated	Methods of storage		
		Plastic covered	Mud plastered	Farm technique
Crude protein	3.29[d]	7.71[b]	8.33[a]	6.58[c]
(% increase in crude protein)	–	134.35	153.19	100.00
Net increase in crude protein (% age unit)	–	4.42	5.04	3.29
Crude fibre	43.29[a]	42.49[b]	42.47[b]	41.47[c]
Neutral detergent fibre	79.63[a]	77.10[c]	76.00[d]	77.60[b]
Acid detergent fibre	53.90[a]	52.41[c]	51.90[d]	53.40[b]
Acid detergent lignin	9.50[a]	8.30[b]	8.61[b]	8.53[b]
In situ dry matter digestibility	35.61[c]	51.53[a]	53.0[a]	44.6[b]
% increase in dry matter digestibility	–	44.71	48.83	25.25

[abcd]:Means within same rows with different superscripts differ ($p < 0.05$).

significantly ($p < 0.05$) reduced these contents.

In situ dry matter digestibility of treated straw was noticed to be significantly ($p < 0.05$) higher at increasing levels of urea treatment. The findings of this experiment are in agreement with those of Rios et al. (1985) and Khan et al. (1989).

On-farm demonstration

The crude protein contents of urea treatment when stored by 3 different storage methods were found to be significantly ($p < 0.05$) higher in case of mud plastered (mud plastered on the top and sides) followed by plastic covered and farmer technique (table 3). The reason for maximum retention of crude protein in treated straw stored by mud plastered method was that through mud plastering treated straw was completely sealed and air tight, thus there was no release of ammonia. Storage of treated straw by farmer technique is hence needs to be modified by mud plastering from the sides. Urea-ammonia treatment of straw was noticed to be effective in reducing the neutral detergent fibre and acid detergent fibre.

In situ dry matter digestibility of treated straw was found to be significantly ($p < 0.05$) better in mud plastered storage method followed by plastic covered and farmer technique storage method. The results of on-farm demonstration of various storage method for treated straw have clearly established that mud plastered storage method is the best one. The only modification in the existing farmer technique (Kup method) needed is to mud plastered the Kup from all the sides which will only require some extra hours of the farm labour. Economics of treatment of wheat straw is highlighted in (table 4) and the information given therein revealed that urea treatment of straw in term of crude protein is economical.

Observations noted by feeding the treated straw to indigenous and cross bred cows and sheep have led to the following

i) Treated straw was noticed to be mouldy at the upper layer of 4 to 6 inches and also in the bottom layer. This can be avoided by spreading a layer of untreated straw at the bottom and top of the treated straw while storing.

ii) The treated straw was readily accepted by the dairy cows/bulls as a single feed ingredient or in

TABLE 4. ECONOMICS OF UREA TREATMENT OF WHEAT STRAW (Rupees)

Cost of wheat straw	15.00
Cost of urea (2 kg)	9.00
Cost of labour	1.48
Polythene	0.15
Cost of treated straw	25.63
Cost of 1 kg crude protein of untreated straw	11.36
Cost of 1 kg crude protein of treated straw	6.39

Calculated at the basis of 40 kg wheat straw.

combination with green fodder or concentrate feed. Sheep accepted the treated straw only during the period of severe scarcity of green fodder and other grazing.

iii) Farmers are convinced that treated straw is beneficial to their animals particularly when there is nothing or very little to offer their animals. Significant body weight reduction during feed scarcity period was also believed to be controlled to some extent by feeding the animals on treated straw with little green fodder or concentrate.

iv) Cross bred dairy cows performed better and yielded higher milk when fed on treated straw (8 litre per day) compared to cows fed on untreated straw (6.8 litre per day).

v) No adverse effects were noticed when the animals were fed treated straw.

Storage density of treated straw

Storage density of treated wheat straw in two commonly storage methods i.e., Kup method and Dher method was measured at 174.0 kg/m^3 and 79 kg/m^3; respectively (table 5). Kup method used for storage of straw has almost more than double storage capacity and this is because higher manual compaction of straw is done during starting process.

TABLE 5. STORAGE DENSITY OF TREATED WHEAT STRAW IN TWO DIFFERENT STORAGE SYSTEM

STORAGE SYSTEM-I (KUP METHOD)	
Wheat straw	6,600 kg
Total volume of store	37.95 m^3
Density of straw	174 kg/m^3
STORAGE SYSTEM-II (DHER METHOD)	
Wheat straw	7,000 kg
Total volume of store	88.62 m^3
Density of straw	79 kg/m^3

Literature Cited

Acock, C. W., J. K. Ward, I. G. Rush and T. J. Klopfenstein. 1978. Effect of location, variety and maturity on characteristics of wheat straw. J. Anim. Sci. 47 (Suppl. 1):327.

Agricultural Statistics of Pakistan, 1986. Ministry of Food, Agriculture and Cooperatives, Govt. of Pakistan. Islamabad, Pakistan.

Ajmal, J. 1986. Effect of urea treatment on the nutritive value of wheat straw in the fattening of buffalo calves. M. Sc. Thesis. University of Agriculture, Faisalabad.

A.O.A.C. 1984. Official Methods of Analysis. (14th ed). Association of Official Analytical Chemists. Washington D.C.

FAO. 1987. Pakistan Livestock Sector Study, Phase-I. Report of the FAO/Asian Development Bank Cooperative Programme, Investment Centre. Food & Agriculture Organization of United Nations, Rome.

Goering, H. K. and Van Soest, P. J. 1970. Forage Fiber Analysis. Agric. Handbook No. 379. ARS, USDA. Washington, D.C.

Jackson, M. G. 1978. Treating straw for animal feeding. An assessment of its technical and economic feasibility. FAO Animal Production and Health Paper No. 10. FAO-UN-Rome.

Khalid, F. A. 1988. Effect of feeding urea-treated wheat straw on milk production and milk composition. M. Sc. Thesis. University of Agriculture, Faisalabad.

Khan, A. G. 1988. Effect of various chemical treatments on nutritive value of crop residue, PARC Annual Report pp. 217 Islamabad, Pakistan.

Khan, A. G. 1989. *In vitro* and *in vivo* digestibility of alkali treated wheat straw and its utilization by ruminants. Ph. D. dissertation. Universtiy of Agric. Faisalabad.

Khan, A. G., A. Azim and M. A. Nadeem. 1990. Effect of type and levels of alkali on the nutritive value of corn cobs. Proc. 3rd Intern. Vet. Congr. (abstract) p. 54.

Lesoing, G., T. J. Klopfenstein, I. Rusha and J. Ward. 1981. Chemical treatment of wheat straw. J. Anim. Sci. 51:263.

Ørskov, E. R., F. D. DcB Hovell and F. Mould. 1980. The use of nylon bag technique for the evaluation of feedstuffs. Trop. Anim. Prod. 5:195-213.

Rios, J. Z., F. N. Owens, G. W. Horn and R. W. McNew. 1985. Effect of ammoniation of wheat straw on performance and digestion kinetics in cattle. J. Anim. Sci. 60(3):814-820.

Shin, H. T. 1976. Study on utilization of wheat straw by sheep. Ph. D. thesis, Univ. of Illinois, Urbana, U.S.A.

Verma, M. L. 1988. Availability and intensive utilization of cereal straws and fibrous agricultural residues in South Asia. In non-conventional feed resources and fibrous agricultural residue (Ed. by Devendra, C.) IDRC. Indian Council of Agricultural Research.