Evaluation of Farmer-Grown Improved Sorghum Cultivars for Stover Quality Traits

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Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is an important staple food crop in semi-arid tropical tracts of India where mixed crop and livestock farming systems are mostly prevalent. Sorghum not only provides grains for human consumption, but also provides fodder for livestock. For farmers, both grain and stover (crop residue) are of equal importance and they consider harvested stover as almost equal in market value to harvested grain. However, the feeding/nutritive value of sorghum crop residue is generally poor and it provides sub-maintenance levels of nutrients. The limited adoption of improved sorghum varieties has been mainly attributed to the lower nutritional value of their crop residue (Kelley and Rao 1994). The farmers feel that the stover yield and stover quality of improved cultivars in terms of nutrition and digestibility is lower than that of the local cultivars. This study attempts to examine the validity of farmers' perceptions about stover yield and stover quality traits of improved cultivars *vis-à-vis* local cultivars. The study was conducted as one of the activities of the Department For International Development (DFID)-funded project on *Exploring marketing opportunities through a research, industry and users coalition: sorghum poultry feed* aimed at enhancing the access to and availability of rainy-season sorghum for poultry feed rations.

Materials and Methods

Selection of villages and farmers. The Mahabubnagar and Ranga Reddy districts of Andhra Pradesh, India, where rainy season sorghum cultivation is predominant were selected for farmer participatory evaluation of improved and local cultivars for stover yield and stover quality traits. After studying district profiles, two mandals were selected from each district. Four villages (one from each mandal) that are close to market yards, accessible in all seasons, and have existing farmers associations were selected for the study. During the 2003 rainy season, based on their willingness, 48 farmers were selected from these four villages for participation in the evaluation trials. The farmers were apprised of objectives and methodology of the study. The farmers' fields in which cultivars were grown could be classified into four soils type (Table 1), Black, *Barka*, *Chalka* and Red (*Chalka* - red colored with large pebbles and low fertility; *Barka* - light black in color with low fertility and low moisture retention capacity). All sorghum farmers in the selected villages traditionally cultivate a yellow sorghum variety, locally called *patcha jonna* intercropped with pigeonpea [*Cajanus cajan* (L.) Millsp.].

Cultivars and design of experiment. Seed of four improved high-yielding sorghum cultivars CSH 16, CSV 15, PSV 16 and S 35 were supplied to the 48 farmers from the selected villages for planting in a 4000 m^2 area. Each improved cultivar was planted by 12 farmers along with the traditional yellow sorghum cultivar as a check intercropped with a local pigeonpea cultivar in a row ratio of 5 sorghum: 1 pigeonpea. Leaflets containing information on production practices printed in the local language were supplied along with seed bags to the farmers. The project staff monitored the evaluation trials frequently for proper conduct of the trials.

Stover sampling for laboratory analysis. An entire field planted by a farmer to a particular cultivar was divided into four plots and from each plot, one sample was collected at random, using an 1 m^2 area sampler. While samples from improved cultivars were drawn from 48 farmers for stover quality analysis, those from local cultivars were drawn from only 5 randomly selected farmers bringing the total sample size to 48. During sampling, sufficient care was taken to draw samples from each of the predominant soil types of the region. The grain and stover yield from each 1 m^2 area were estimated. The stover samples were then ground to 1 mm particle size and analysed in the laboratory of the International Livestock Research Institute (ILRI) – South Asia Project located at ICRISAT, Patancheru, India for stover nitrogen content and stover in vitro digestibility using combinations of conventional laboratory analysis with near infra red spectroscopy (NIRS). For calibration and validation procedures for the development of NIRS equations, stover nitrogen content was determined by auto-analyser and stover in vitro digestibility as per the technique of Menke and Steingass (1988). Computed mean of data from four samples was treated as one replication, making each farmer field one replication.

Statistical Analysis. Mean values of stover nitrogen content and in vitro digestibility of each cultivar were used for statistical analysis considering cultivar and soil type as fixed factors. A Restricted Maximum Likelihood (REML) variance components analysis (fixed model) (Payne 2002) was carried out to assess variability due to cultivars, soil types and cultivar × soil type interaction for stover nitrogen and in vitro digestibility. The Wald statistic, which follows an approximate Chi-square distribution, was used to test the overall significance of differences among treatments (Thompson and Welham 1993).

Results and Discussion

The REML analysis indicated significant cultivar differences only for stover in vitro digestibility (Table 2). Differences due to either soil type or cultivar × soil type interaction were not significant for stover nitrogen content and in vitro digestibility. These findings suggested that cultivars rather than soil types and cultivar × soil type interaction contribute towards the variation in stover nitrogen content and in vitro digestibility and strongly supported options for genetic enhancement for stover quality traits.

Stover nitrogen content in improved cultivars was slightly higher than in the local check (Table 3). However, these differences are unlikely to be of nutritional significance. In ruminant nutrition, a feed nitrogen content of about 1.2% is considered to be the minimum requirement for rumen microbes to degrade feed effectively (Van Soest 1994) and the nitrogen content of stover from both improved and local cultivars investigated in the present study were well below this minimum level. In contrast, stover in vitro digestibility was on an average about five units higher in the improved compared to the local cultivar (Table 3). Five units difference in in vitro digestibility is considered to be of practical nutritional significance, as livestock productivity will be higher on a stover with a digestibility of 45% than of 40% (Van Soest 1994). While the stover yield of improved cultivars was better or on par with that of local cultivar, the grain yield of improved cultivars was two to three times that of the local cultivar. The average stover yield of the improved cultivars in Mahabubnagar and Ranga Reddy districts was 2297 kg $ha^{-1}$and 1560 kg ha^{-1} compared to 1900 kg ha^{-1} and 1260 kg ha^{-1} for local cultivars and the cost benefit ratio of improved cultivars was estimated at 2.02 and 1.44 compared to 1.35 and 0.98 for local cultivars, respectively. The soil type did not appear to have significant bearing on stover nitrogen content and in vitro digestibility. The improved cultivars were found better or comparable to local cultivars for stover nitrogen content and in vitro digestibility.

Table 1. Distribution of soil types of selected farmers' fields across villages.

Soil type	Village Name				
	Manmarry	Udityal	Ganagpur	Kandawada	Total
Black	3	*	2	*	5
Barka	5	*	*	7	12
Red	*	4	6	6	16
Chalka	*	10	5	*	15
Total	5	14	13	13	N=48

*Data not available.

Conclusions

It appears from the present study that the genetic component rather than soil type and genotype × soil type interaction components is important in total variation of the cultivars for stover nitrogen content and stover in vitro digestibility. The nonsignificant mean squares due to soil type and genotype × soil type interaction would support genetic improvement of stover nitrogen content and stover in vitro digestibility for wide adaptation. Stover nitrogen dry matter (NDM) content was highest in CSH 16 followed by S 35, CSV 15, and PSV16. The stover digestibility of improved cultivars was better than that of the local sorghums. While the improved cultivars

Table 2. REML components variance analysis for sorghum stover nitrogen and in vitro digestibility of five sorghum genotypes, across four soil types.

		Wald Statistic/df.	
Source	Degrees of freedom	Nitrogen	In vitro digestibility
Genotype	4	1.77	5.82**
Soil type	3	1.03	2.12
Genotype × Soil type	9	1.11	0.59

** Significant at 0.01 level of probability.

Table 3. Estimated mean values of nitrogen, crude protein content and in vitro digestibility of stover of improved and local sorghum cultivars (values based on dry matter).

Cultivar	Nitrogen Dry Matter (NDM) (%)	Crude Protein (CP) content* (%)	*In vitro* digestibility (%)	Grain yield ($t\ ha^{-1}$)	Fodder yield ($t\ ha^{-1}$)
CSH 16	0.43	2.7	43.0	0.9	1.9
CSV 15	0.36	2.2	45.9	0.9	2.3
PSV 16	0.36	2.2	46.0	0.8	2.2
S 35	0.40	2.5	46.3	0.6	2.6
Local	0.39	2.4	40.5	0.3	2.5

* Crude protein content = 6.25 × NDM

were on par with the local cultivars for stover nitrogen content irrespective of soil type, they were significantly superior to local cultivars for stover digestibility in *Barka* and red soils. The study provides sufficient evidence to dispel farmers' perceptions that improved cultivars have poor stover nutritive value and digestibility when compared to local cultivars. Complementing the stover quality, the quantity obtained by the farmers with improved cultivars was better or comparable with local cultivars.

However, a word of caution is necessary here taking into consideration the variable number of farmers representing each soil type and that the sampling of farmers was not based on soil type. A more systematic evaluation of the cultivars involving higher number of farmers sampled from different soil types spread across larger areas would validate the present results.

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