FORAGE SORGHUM BREEDING FOR ANIMAL PRODUCTION

M. Ahluwalia

Genetics Division, Indian Agricultural Research Institute, New Delhi-12

The role of forage sorghum as a cultivated fodder for ruminants for increased animal productivity can be enhanced in breeding improved cultivars by selection for higher nutritive value of the forage. Improvement of forage quality in terms of animal production, in general, refers to the chemical composition of forage, its digestibility and the nature of the resulting products of digestion. Nutritive value of a cultivar is also determined from its voluntary intake by the animal.

Some of the major quality parameters in forage sorghum relate to crude protein (CP) or digestible crude protein (DCP) and total digestible nutrients (TDN) which are measurable in synonymous terms as measures of dry matter digestibility (DMD) or digestible dry matter (DDM). In addition, the ancillary quality traits include total soluble sugars (TSS), HCN, tannins, acid detergent fibre (ADF), neutral detergent fibre (NDF), sweetness (reducing sugars), in vitro dry matter digestibility (IVDMD), intake (cellulose digestibility after 24 and 48 hours of incubation), nutritive value index (NVI) and metabolizable energy (ME).

Forage sorghum breeding for animal production is neither breeding for gross tonnage nor for mere quality. Breeding for yield per se for forage production is not meaningful in conventional or dairy farming unless it combines a higher quantity and quality of digestible nutrients. The future forage sorghum breeding objectives in this context may be listed as, dry matter yield, leaf spot disease resistance, shoot fly/stem borer resistance, seed setting ability, quality parameters/sweetness/intake, low HCN/tannins, high protein yield, harvest index (digestibility/biological yield), and single cut/double cut/triple cut manageability.

Development and evaluation of forage sorghum germplasm: There is at present little attempt at collection, maintenance, evaluation and classification of forage sorghum germplasm. There is need for augmenting the available elite groups of sorghum with sudan or sorghum sudan derivatives developed in United States, Australia and other countries. These along with a fresh effort of collections from the native sources in the African continent could help to build up a useful germplasm of forage types.

Screening of collections and breeding materials for nutritional quality parameters: A multi-disciplinary plan for a collaborative effort is required to be planned between the breeders, the nutritionists and applied animal geneticists. Recent researches have shown that the chemical in vitro technique for predicting the NVI of forage based on 0.2% pepsin dissolved in 0.075 N HCL, is highly correlated.
(r = 0.95) with the NVI of forages as measured in vivo. Correlation studies showed that the in vitro dry matter disappearance technique accounted for 90% of the variability in the in vivo measurements. Thus it appears probable to undertake testing of large number of samples through in vitro technique for estimating the effective feeding value of forages that constitutes the sole ration of ruminants. The acid-pepsin digestant technique is simpler as compared to rumen-fermentation system as it avoids the problems involved in obtaining and using rumen inoculum. It also eliminates the cellulose determination. Another advantage in this technique lies in testing of single plant small samples in segregating generations for selection of digestibility potential with a fair degree of accuracy.

**Importance of protein content for effective animal production:** Animal nutritionists have established the requirement of a minimum of 8% crude protein (CP) for rumen-inhibitive animal productivity measurable in terms of metabolizable energy (ME). In other words, a higher DMD digestibility with protein content lower than 8% may not be useful selection criterion for animal production. The sorghum fodders in general possess about 4–6% protein content. Thus unless it is fortified with urea application with a view to raise its protein content to the desired limit, most of the selected lines could not conform to the requirement of the animal nutritionists for increased productivity. One way out to meet this requirement is to go in for mixed cultivation of sorghum and cowpea mixture in desired proportion but its agronomic aspects relating to workable package of practices may pose certain limitations. The development of dual purpose sorghums with 8% protein in the grain cum fodder feed of sorghum alone is a compromise that needs to be studied in evolving a suitable harvest index of digestibility over biological yield of grain and fodder.

**Selection of associated morphological characters with digestibility:** Several workers have shown that dry matter production and dry matter digestibility of forage sorghum is higher at the 50% flowering stage which also has safer limits of HCN (below 100 ppm) in single cut schedules. But for better regeneration, cutting after 40 days and subsequent cutting after 30 days would constitute a desirable practice in the development of multi-cut varieties wherein selection for lower HCN at these stages of cutting would form an important prerequisite. Studies by Paroda and co-workers (personal communication) in very recent years have shown a highly positive and significant correlation between leaf width and digestibility. Association of green mid rib with TSS which has corresponding influence on palatability and intake is another important morphological attribute in selection schemes.

**Breeding for low HCN and Tannin content:** Preliminary screening at various stages of cutting at Hisar, has amply demonstrated the desirability of using Piper, 2877 and Pusa Chari-2 as donor parents for low HCN content. Similarly *Sorghum roxburghii*, 10626A, PJ 7R and 3297 were found to be possessing low tannin content (<0·03%) at 45 days cutting stage. This range of tannin content does not seem to adversely affect the digestibility and palatability.
It needs to be pointed out that breeding effort for low HCN (<100 ppm) and tannin content (<0·03%) for cutting intervals at 40 days of plant growth need intensification in future strategies of breeding plans for efficient animal utilisation.

**Importance of metabolizable energy (ME):** Metabolizable energy (ME) is measured in K. Cal./g of dry matter (DM). Animal nutritionists in recent years have worked out various feeding schedules of required metabolizable energy produced by the intake of forages and/or roughages or nutrient feeding through costly concentrates. This brings forth the importance for relay fodder cropping patterns so as to produce the optimum requirements of nutrients for dairy farming. In this context, the role of breeding forage sorghum boils down to selection of types which produce better intake and metabolizable energy of the green forage or its equal quantity of silage in improving dry matter intake of animals and digestibility of its nutrients.

Any forage amelioration programme for the future would require breeding effort for intensive agricultural package of practices when the objectives relate to dairy farming which is one of the most pressing needs for animal productivity. Thus selection effort in breeding improved forage sorghum must be aimed at selection for early maturity, quick growing and highly productive (in terms of dry matter and digestibility) forages cultivable for optimum returns of high input/output potentials.

**Breeding snags in forage sorghum:** In the conventional breeding programme involving hybridisation and selection for development of improved single cut and multi-cut varieties of forage sorghum, the following difficulties need to be encountered.

(a) **Hand emasculation and crossing:** Since the success of hand emasculation and crossing in forage sorghum types is very limited, the need for the development of hot water technique for emasculation requires closer study.

(b) **Studies of quality parameters:** The in vitro DMD estimation facilities need to be developed at some important centres.

(c) **In vivo studies:** A coordinated approach for testing elite material at centres such as Karnal and Pantnagar for in vivo studies should be intensified for development of improved forages for animal production.

(d) **Coordinated testing:** Coordinated testing plans for increased animal productivity need to be more clearly planned and executed for future selection programmes.

(e) **Breeding scheme for combining yield and quality parameters in forage sorghum:** Some of the studies conducted in recent years have consistently shown that whereas forage yield components display a higher magnitude of additive gene effects, the quality characters in general showed non-additive gene effects. Furthermore, forage yield per se and such quality parameters as DMD and CP were found to be negatively associated. The only feasible approach, therefore, in combining these characters lies in following a reciprocal recurrent selection scheme.
(f) *Breeding for leaf spot diseases and stem borer:* Preliminary screening for red leaf spot diseases has resulted in the isolation of some lines which show consistent field resistance in some environments. However, the selected lines need to be studied for multi-location effects prior to their utilisation in the breeding programme. The same applies to initiating a programme for stem borer resistance.

The effective plant protection schedule for shoot fly and stem borer incidence prevalent most widely in sorghum growing areas in the case of forages requires study for its time and stage of insecticide application free from animal health hazards.

(g) *Development of dual purpose types:* Forage sorghum extension programme is greatly handicapped if the improved types do not have the inherent capacity to produce economic grain yields in addition to the fodder productivity. In this context, a compromise on the development of dual purpose types with studies on the feeding economics of grains cum fodder for animal production deserves due consideration.

**Summary**

The problems of breeding improved varieties of forage crops such as sorghum, including the importance of nutritional quality parameters such as protein content, digestibility, metabolizable energy and presence of toxic substances are discussed.