

## Development of dual-purpose sorghum for grain and forage

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### Abstract

Sorghum varieties have been developed specifically for grain, forage or stem sugar but not for dual-purpose combining grain and forage use. Dual-purpose varieties could be beneficial to the resource-poor farmers by providing grain for human consumption and forage for livestock feed. In addition, there is also limited information about the combining ability, gene action and genetic effects and relationships between grain and forage yield which is required in devising appropriate strategies for developing dual-purpose sorghum varieties. Furthermore, there is also lack of information about the perceptions of resource-poor, small-scale farmers and other important stakeholders on the potential of dual-purpose sorghum production. This study has just been initiated. Its specific objectives are: determination of the farmers views on the potential use of sorghum as a dual purpose crop for grain and forage, characterization of the phenotypic and genetic diversity of sorghum genotypes for grain and forage yield and determination of gene action associated with grain and forage yield in sorghum.

**Key words:** Dual purpose ,grain, forage, gene action, phenotypic and genetic diversity

### Résumé

Les variétés de sorgho ont été développées spécifiquement pour les grains, le fourrage ou de la tige du sucre, mais pas pour un double usage qui combine l'utilisation de grain et de fourrage. Les variétés à double usage pourraient être bénéfiques pour les agriculteurs pauvres en ressources, en fournissant des céréales pour la consommation humaine et le fourrage pour le bétail. En outre, il y a aussi peu d'informations sur l'aptitude à la combinaison, l'action des gènes et les effets génétiques, et les relations entre les grains et le rendement en fourrage qui est nécessaire à l'élaboration de stratégies appropriées pour développer des variétés de sorgho à double usage. En plus, il ya aussi le manque d'informations sur les perceptions des pauvres en ressources, les petits agriculteurs et les autres acteurs importants sur le potentiel de production de sorgho à double usage. Cette étude vient juste d'être lancée. Ses objectifs

spécifiques sont les suivants: la détermination des perceptions des agriculteurs sur l'utilisation potentielle du sorgho comme culture à double objectif, pour le grain et le fourrage. La caractérisation de la diversité phénotypique et génétique des génotypes de sorgho, pour le rendement de grain et de fourrage, et la détermination de l'action des gènes associés à des grains et le rendement en fourrage de sorgho.

Mots clés: double objectif, le grain, le fourrage, l'action des gènes, la diversité phénotypique et génétique

## Background

Sorghum (*Sorghum bicolor* (L) Moench) is one of the most important drought tolerant crops in the semi-arid regions of the world. Livestock farming is also an important activity in these regions. The inability of producers to feed animals adequately throughout the year remains the major technical constraint. Improving the feed supply, both in yield and quality, is an effective means to increase livestock productivity. The feed value of crop residues has been largely ignored, as a result, most improved crop varieties produce less residues. Reddy *et al.* (2003) argues that smallholder farmers will increasingly depend on crop residues to feed livestock among other feed resources for some time to come. This is because availability of grazing land is decreasing. This is exacerbated by the limited use of introduced forages in tropical developing countries.

In the early days of cereal crop improvement, emphasis was placed on grain yield, and many dwarf, high-yielding varieties were released. Since recognition of the need for crop residues as feed for livestock, the emphasis has shifted to dual-purpose cultivars for grain and forage. The crop residues comprise leaves and stems remaining after grain harvest. Similarly, residues of sorghum and other cereals are becoming important feed sources for livestock raised by resource-poor smallholders in southern Asia and sub-Saharan Africa (Mohanraj *et al.*, 2011). Use of crop residues as fodder depends not only on productivity but also on quality. Sorghum, for example, continues to synthesize new vegetative material even after physiological maturity thus potentially accumulating nutrient in stubble. Also, sorghum stubble does not decrease in quality as rapidly as maize after physiological maturity (Rattunde *et al.*, 2001). Furthermore, sorghum productivity is higher in drier areas with rainfall less than 650 mm. Given the foregoing, the overall objective of the study is to develop dual purpose sorghum with high grain and

forage yield. The specific objectives will include determination of farmers views on the potential use of sorghum as a dual purpose crop, characterization of the phenotypic and genetic diversity of sorghum for grain and forage yield and to determine gene(s) action associated with grain and forage yield in sorghum.

## Literature Summary

In most crops, intermediate optima were observed for many traits including grain and forage yield and quality. In sorghum, for example, grain and fodder (crop residue) yields increased positively up to 1.8 m plant height with 68–70 days to flowering but the relationship reversed beyond 2.0 m plant height (Reddy *et al.*, 2002). In another study of crop residues, Reddy *et al.* (2003) reported that in almost all crops, a positive association was found between fodder and grain yield indicating simultaneous improvement in both characters. In most cases, fodder yield and digestibility were positively correlated and showed positive association with plant height, leaf number and the number of tillers per plant, but there were limits and variation among crops. In India, crop residues from dual-purpose crops (grown for grain and forage) accounted for 61% of total livestock feed on a dry matter basis. Evaluations of sorghum crop residues remaining after grain harvest in Kansas revealed total dry matter yields exceeded 6000 kg ha<sup>-1</sup> and comprised equal amounts of leaves and stem (Lenne *et al.*, 2003). Hybridization has been successfully used to develop hybrid cultivars in self-pollinating crops like rice and sorghum (Kenga *et al.*, 2004). This has enabled the exploitation of both gene additivity and non-additivity with the computation of combining abilities and heritability becoming more important in sorghum breeding.

## Study Description

A total of 100 sorghum genotypes mainly from the East Africa region and some from Zambia and ICRISAT will be evaluated. This study will be multi-locational and will be done at Kabanyolo, Namulonge (both in the Lake Victoria basin), and Serere (in the drier eastern Uganda). The genotypes will be characterized for phenotypic and genotypic diversity using 10\*10 lattice design. Phylogenetic analysis will be done using simple sequence repeats. Agronomic data will be analyzed using GenStat (14th edition) computer package (Payne *et al.*, 2011). Determination of gene action associated with grain and forage in sorghum will involve crossing and evaluation of identified superior genotypes using NCDII mating scheme. Data will be subjected to REML procedure in GenStat. The general combining ability and specific combining ability effects for the parents will be calculated

according to Kearsey and Pooni (1996). Heterosis (%) will be computed according to Alam *et al.* (2004).

Crop and livestock producing farmers will be sampled in the predominant Sorghum growing areas in Serere, Soroti and Kumi districts of Eastern Uganda. Questionnaires will be administered and six focused group discussions will be conducted to obtain data regarding the potential use of dual purpose sorghum for grain and forage. Data will be analyzed using SPSS 15.0 computer package (SPSS Inc., 2006).

### Research Application

Crop residues are still the most important feed for ruminants in small-holder crop–livestock production systems of Africa. Crop residues still contribute substantially to the supply of nutrients for animals in mixed farms in the tropical and sub-tropical developing countries. Results obtained in this study will be useful to crop and/or Livestock farmers who rely on crop residues to feed their animals and will also create a niche for dual-purpose sorghum where farmers can harvest the grain for food and animal feed, reaping twice from the same crop and same piece of land. The results will also benefit plant breeding programmes in the East African Community and beyond.

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