CHAPTER 9

GENERAL DISCUSSION

Sweet sorghum is not a new crop in Botswana, it has long been grown for its sweet stems. Recently the crop has attracted interest as a potential cash crop. Growers of sweet sorghum are faced with problems of poor crop establishment, lack of uniformity in stem size and low concentrations of sucrose in the juice.

Difficulties in establishing good crop stands under local conditions are probably associated with poor seed quality, unsuitable planting depths and sub-optimal soil moisture levels during germination and emergence. It is a prerequisite that farmers must use seed of high quality. In this study it was observed that sweet sorghum seedlots of a number of landraces collected from small scale farmers in Botswana were of low quality. Causes of poor quality in these seedlots were not established. However, according to Powel & Matthews, (1992) seed quality (seed viability and vigour) is affected by the environmental and cultural conditions under which the seed developed and matured, as well as by harvesting and storage practices. Growers of sweet sorghum need advice in the handling of seed to improve seed quality. The formal seed industry can contribute by either producing seed of high quality for farmers or by testing the quality of farmers' seedlots. In the testing of seed quality the seed industry should not only rely on the standard germination test but must include the Accelerated Ageing test because it approximates emergence under sub-optimal conditions and correlates well with stand establishment (Medina & Filho,1991; Romkaew, 1996). For instance in this study the germination test indicated that 61% of the of the sixty-five landraces had germination

capacities above 85%, whilst the AA test revealed that only 20% had germination capacities above 80%.

Harvesting sweet sorghum before mass maturity (physiological maturity) results in poor seed quality (Joyce *et al,* 1989). Observations on seed development and maturation of sweet sorghum in this study indicated that the highest seed germination occurred 14 to17 days after mass maturity. These results confirm that harvesting before mass maturity results in seed of low quality. Similar results were reported by Van de Venter *et al,* (1996); and Zanakis *et al,* (1994). Therefore, farmers should be advised to allow parent plants to mature for seed purposes.

A range of genetic diversity in Botswana sweet sorghum landraces was identified during the characterization exercise. This was indicated by differences in the morphology of vegetative and reproductive structures, as well as differences in phenology ranging from early to late maturing landraces. The late maturing landraces have tall, thick stems with more internodes as observed by Coleman (1970) and Ferraris & Charles-Edwards (1986a). Such stem characteristics are desirable in the marketing of sweet sorghum and realise high prices. The hard rind and high fibre content in the late maturing landraces cause concern because such stems become difficult to peel off and chew with more juice being retained in the fibre (Bryan *et al,*1985).

The late maturing landraces have better juice quality than the early maturing landraces, confirming observations of Ferraris (1981a). These observations suggest that improvement of juice quality in sweet sorghum may be possible through selection and breeding programmes.

Although seed yield is not a priority in sweet sorghum, the late maturing landraces, and some of the early maturing landraces, displayed high potential for seed production and compared well with grain sorghum. This means that during drought years, sweet sorghum seed can alternatively be utilized as grain (Ferraris & Stewart, 1979). Unfortunately sweet sorghum seeds are often bitter and not very palatable.

Panicle and floret removal in this study improved juice quality as was also observed by Broadhead (1973). However, this strategy proved not to be viable in improving juice quality where stems are the economic yield. Deheaded plants remained with scars and side branches which left stems unattractive, confirming reports of Coleman (1970) and Broadhead (1973). Breeding and selection of genotypes with smaller panicles and reduced tillering to benefit stem size and juice quality may be possible. Similarly, determining whether male sterile varieties may be sweeter and juicier than male fertile varieties is recommended. Chemically induced barrenness may be an alternative.

In Botswana the most common method of planting amongst small scale farmers is broadcasting. This results in areas of high and low crop density and farmers are usually reluctant to thin highly populated areas. Farmers grow a variety of crops in mixtures and this causes complex competition between crops. Inter-cropping practices impede the introduction of improved management practices to increase yields. Improved crop management strategies are a prerequisite to allow crop yield potential to be expressed. Studies of planting date, spacing and nitrogen have demonstrated that sweet sorghum yield and quality can be improved by raising levels of management. Early planting (October) resulted in higher stem yields, more tillers and taller main stems than late

planting (November, December). Similar results were reported by Inman-Bamber (1980), Ferraris (1988) and Almodares *et al,(*1994). Planting as early as October in Botswana is often not possible due to late rains and lack of ploughing and planting facilities. Establishing suitable planting dates for early and late maturing landraces in Botswana still needs attention.

Unfortunately planting early did not improve juice quality, contrary to observations by Ferraris & Charles-Edwards (1986b), Petrini *et al,* (1993) and Almodares *et al,* (1994). This negative relationship between stem yield and juice quality requires more research in order to optimise yield and quality.

Application of nitrogen resulted in higher stem yields and sucrose content than the unfertilized control. Similar results were reported by several researchers (Jordan-Karim, 1979; Jackson & Arthur, 1980; Ferraris, 1988 and Bennett,1982). In the results of this study the rate of 60kg N ha^{-1} was identified as a suitable rate for sweet sorghum production in pure stands under the experimental conditions. In the past several fertilizer trials in Botswana have failed to convince farmers to adopt the use of fertilizers. Small scale farmers would accept use of organic manures (kraal, poultry) and application rates still need to be calibrated in on-farm demonstration trials.

A 30 cm intra-row spacing in sweet sorghum resulted in high stem yield per plant and sucrose content and it was recommended for sweet sorghum production in pure stands. For farmers who have already adopted row planting, this recommendation should be readily acceptable because maize and grain sorghum are planted at the same spacing. Uniform spacing is an important strategy for improving stem yields because it directly

affects stem size.

On the bases of the results obtained from this study, farmers can improve yield and quality of sweet sorghum by adopting some of the strategies investigated. For example a plot of one hectare planted immediately after the first rains in rows of 90 cm by 30 cm intra-row spacing and topdressed with 60 kg N ha^{-1} can result in a yield of 37 000 plants. In the case where a late maturing landrace is used, 37 000 tall and thick main stems could be harvested and sold at an estimated price of P2.00 (Botswana currency P1.00 equivalent to R1.25) per stem. This compares favourably with practically all other cropping alternatives available to small scale farmers in rural areas. Sweet sorghum is an agronomic viable cash crop for small scale farmers. However, a detailed economic analyses taking into consideration the variation in stalk quality is required before specific recommendations can be made to growers. Price elasticity in the supply-demand functions will determine the economic viability of this crop.

This investigation into practices to improve yield and quality of sweet sorghum produced a number of interesting results which should contribute towards establishing sweet sorghum as a cash crop for small scale farmers:

- Identification of the fact that harvesting of seed before mass maturity resulted in poor quality.
- Promising landraces have been collected and characterised.
- juice analyses provided new information on quality characteristics of sweet sorghum landraces presently grown.
- Progress has been made to quantify the effect of planting date, spacing and nitrogen nutrition.

However, a number of aspects deserve further attention:

1. The study was conducted using landraces collected from farmers, and these landraces are genetically heterogenous. Selection and multiplication of genetically uniform landraces will reduce experimental variation. It would also provide improved genotypes to farmers.
2. It was observed that the seed quality of seedlots collected from farmers was generally poor. Investigations into factors causing poor seed quality can alleviate the situation. Cultivar selection and seed multiplication by the Department of Agriculture (Seed Multiplication Unit) can contribute greatly towards improved seed planting material.
3. Only ten of the landraces in the collection were botanically characterised, and of these only a few were represented in the field trials. A large source of unexplored genotypes awaits evaluation.
4. It has been observed that physical removal of panicles and florets is not feasible although yield and juice quality were improved. The effect of male sterility and selection of genotypes with small panicles in improving stem yield and juice quality of sweet sorghum deserves attention.
5. Technology transfer in order to change attitudes of small scale farmers regarding production practices of this traditionally neglected crop, needs attention.