

# FOOD SECURITY FOR SOUTHERN AFRICA



*Edited by*  
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University of Zimbabwe UZ/MSU Food Security Project

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## CHAPTER THIRTEEN

### RESEARCH ON SORGHUM AND WHEAT FLOUR COMPOSITES

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M.I. Gomez, M. Mutambenengwe and H. Moyo

#### BACKGROUND

The development of improved maize varieties and processing technology has gradually enabled maize to replace sorghum in low rain areas of Zimbabwe and other SADCC states. Sorghum and millet production and utilization technologies have remained at traditional levels of low efficiency and productivity. The increased dependence on maize has been coupled with a concurrent increase in the demand for wheat and wheat products. With the exception of Malawi and Zimbabwe, the rest of the SADCC states are net importers of maize. Currently every SADCC state is an importer of wheat.

Apart from the shift from traditional cereals of sorghum and millet to maize, wheat and rice, the SADCC countries face common problems arising from drought. The dryland regions (400 to 600mm rainfall) which collectively account for about 17% of the total SADCC land area (Table 1). The unimodal rainfall pattern limits production to one growing season for rainfed crops. The erratic distribution of rainfall, is a critical determinant of agricultural productivity of the region. Increasingly, agricultural policies are being geared to address the problems of recurrent drought and low rainfall.

In Zimbabwe, in an effort to improve and expand sorghum and millet production, the government raised producer prices about 80 percent since independence in 1980. The combination of higher producer prices and favourable weather in 1985 and 1986 has led to a large increase in the marketed surplus of sorghum as shown in Table 2.

Table 1: SADCC States: Percent of Land Area in the 400 to 600 mm Rainfall Zone, 1980).

Country	Percent of Land Area in 400-600 mm rainfall zone
Angola	5
Botswana	65
Lesotho	14
Malawi	3
Mozambique	13
Swaziland	15
Tanzania	19
Zambia	1
Zimbabwe	23
Average	17.6

Source: World Bank, (1981).

Table 2: Zimbabwe: Sorghum Marketed by Type of Farm, 1981-86

Harvest Year	Large-scale Farmers	Small Scale Communal and Resettlements (000 tonnes)	Total Marketed
1981	24.5	7.9	32.4
1982	16.9	2.2	19.1
1983	4.9	0.5	14.0
1984	15.5	5.2	20.7
1985	51.9	29.6	81.5
1986 *	66.0	66.6	132.6

Source: Grain Marketing Board

\* CSO, First Official Crop Estimate, 1986-87

However, the bulk of the sorghum in GMB warehouses in Zimbabwe is red sorghum that is used in the brewing industry. White sorghum is preferred by communal households and it has a potential for blending with wheat to make composite flour.

The traditional uses of sorghum are two-fold: the malting of sorghum grain for brewing of opaque beer and the use of sorghum meal in the traditional staple 'sadza'. The breeding, selection and agronomic research have been hitherto directed almost entirely to the brewing-type of red

sorghums which are produced primarily by large scale commercial farmers. But the malting and brewing demand was only about 20 - 30 000 tonnes out of the 84 000 tonnes of red sorghum purchased by the Grain Marketing Board (GMB) in 1986.

Since the bulk of sorghum is produced in semi-arid and drier regions of the country which are most prone to drought and maize crop failure, it is desirable in terms of long-term food security to increase the production and of white sorghum for rural consumption. However, such a decision pre-supposes the availability of technologies for expanded utilization of the crop both for 'food' and possibly industrial applications. A logical approach to product development and diversification would be to direct research and development to the substitution of sorghum for imported cereals such as wheat, rice or maize.

#### WHEAT SUPPLY AND DEMAND

Zimbabwe currently imports about 40 - 50 000 tonnes of wheat per annum representing about 15 to 20 percent of normal domestic consumption of 250,000 tonnes. If the current rationing of flour to millers were lifted in Zimbabwe, the annual wheat consumption would increase from 250,000 to 350 000 tonnes. Since wheat is essentially an irrigated crop in Zimbabwe, the expansion of area is limited by the availability of water resources and investment in new or expanded irrigation schemes. Despite an increase in yields to a national average of 4.5 metric tons/hectare, the prospect of increasing wheat production seems remote, although research is being carried out on summer wheat production.

Studies on bread consumption patterns in urban and communal areas indicate that Wedza communal lands consumers buy at least one loaf a month. In Chiweshe more than half the



households sampled consumed bread more than once a day (Berg, 1982). In high density suburbs, low income families were found to spend 7.2 percent of their total food expenditure on bread (CSO, 1980). The demand for wheat is expected to continue to rise to double the present level by the end of the century.

#### SORGHUM UTILIZATION

The sorghum research programme of the Food Science group at the University of Zimbabwe was initiated in 1985 in response to a demand for solutions to reducing the mounting sorghum surplus. The research objectives and agenda on sorghum utilization were designed to:

- improve and increase sorghum consumption as partial replacement of wheat imports and eventually to develop technologies capable of producing bread or bread alternatives from non-wheat flour.
- substitute sorghum for maize in traditional diets in low rainfall areas.

Current research by UZ food scientists is based on a two pronged approach to increasing sorghum utilization:

- Development of small mechanical dehulling and milling technologies to replace the traditional processing techniques.
- Development of industrial technologies for the large-scale utilisation of sorghum in commercial food products such as bread and bread substitutes.

#### DEHULLING OF SORGHUM

A major constraint on sorghum consumption is the tedious, labour-intensive nature of the traditional dehulling and grinding operations. Studies in Sengal showed that it takes two women about 1.5 hours to decorticate the daily household requirements of sorghum grain (2.5 kg) and a

further 2-2.5 hours to process the grain to flour (Chinsman, 1984).

The Department of Agricultural Research and Specialist Services and some non-governmental organisations became interested in rural sorghum dehulling technologies in 1984-85 . Although pilot dehulling units were operating at several rural sites, inadequate information was available on the technical performance of the machines. In collaboration with one of the field projects, a study was undertaken to evaluate the PRI/IDRC models of mechanical mini-dehullers.

The dehullers were evaluated to determine the optimum batch size and processing time in relation to optimum level of extraction, the effects of dehulling on removal of tanins and the acceptability of sorghum porridge. The optimum batch size was 8-10kg and a residence time of 8 minutes was required to obtain sufficient extraction (82 - 85 percent) for removal of bran and tanins and to produce a flour of good consumer acceptance in 'sadza' preparation. Mechanical dehulling under these conditions removed 33 - 46 percent of the tanins and significantly improved the acceptability of sadza for both red and white grain types relative to traditionally hulled and milled flour. The white grain was preferred over red in sadza preparations while the reverse was true for the thin porridge 'Bota'. The high level of acceptability of these traditional food products prepared from dehulled and hammer-milled flour indicates there is a market potential for a dehulled milled and packaged sorghum flour from both red and white types.

#### COMPOSITE FLOUR TECHNOLOGY

Composite flour technology (CFT) is based on the blending of various cereal flours or cereal and non-cereal flours (legumes, root crops) for economic, nutritional or functional advantage. Since gluten starch interactions are



responsible for most of the functional properties of wheat in bread making, the replacement of wheat at whatever level with non-gluten materials such as sorghum or cassava starch results in a reduction of the functional and organoleptic properties. Sorghum-wheat composite flour technology has been developed in several countries, including Ethiopia, Sudan and Senegal and applied to a range of food products (Zewide 1984; Bach, 1979 and Perten, 1984). The extent to which sorghum varieties could be incorporated into bread flour mixtures in Zimbabwe without a significant effect on baking properties and acceptability had to be investigated using local varieties. For the purposes of this study, a PRL/IDRC minidehuller of 8-10 kg capacity was used in conjunction with a hammer mill and laboratory sifter. Four sorghum varieties were blended with wheat flour to make bread:

<u>Variety</u>		<u>Type</u>
SV <sub>1</sub> and SV <sub>2</sub>	-	White improved
Nyamidzi	-	White traditional
Red Swazi	-	Red improved

These varieties were incorporated at 5, 10, 15, 20 and 25 percent levels in white wheat flour/sorghum composites in a straight dough bread formulation. The dough characteristics and baking properties were evaluated by objective mixograph and specific volume measurements. Acceptability of the bread samples was carried out by sensory evaluation using laboratory and consumer panels. Acceptability scores of composite flour bread were comparable to those of the 100 percent wheat flour controls in sorghum:wheat composites up to 15 percent level of replacement. SV<sub>1</sub> composites were as acceptable as the controls up to 20 percent levels of replacement.

The red sorghums were unacceptable due to a purplish-pink discoloration of the loaf in white wheat flour composites at all levels though it had comparative acceptability as the 100 percent whole wheat bread at 15 percent level in

whole wheat flour composites. The specific volumes supported the sensory results, showing no significant reduction in loaf volume up to 15 percent level. Similarly tests of dough strength demonstrated significant differences from the control only at higher levels of 20 and 25 percent.

The SV<sub>1</sub> and Nyamidzi white sorghum breads were subjected to shelf-life studies based on sensory evaluation and objective measurements of moisture content and compressibility. Sequential tests using a trained panel of consumers were carried out on composite and control (100 percent wheat flour) bread samples from Day 1 through Day 5. The 15 percent composites were indistinguishable from the controls and acceptable up to Day 5 when stored in plastic bags at room temperature even though moisture content and compressibility values decreased over this period. The sorghum breads were resistant to mould growth for a larger period (10 days) than wheat flour controls which started moulding at day 7.

#### PRACTICAL IMPLICATIONS FOR TECHNOLOGY DEVELOPMENT

Laboratory and pilot scale trials clearly demonstrate that the mechanical mini-dehuller coupled with a hammer mill and sieving system are capable of producing a white sorghum flour of adequate extraction (80-85 percent) and quality for incorporation in composite flour up to a level of 15 percent. Some varieties such as SV<sub>1</sub> showed higher extraction (90 percent) and are capable of incorporation up to 20 percent. The extraction rates obtained using the mechanical dehulling/milling systems as compared to the traditional system show an increase of about 20 percent and reflect not only higher energy efficiency but also lower processing losses.

However, the small-scale dehullers have a limited capacity (1-4 tonnes/month) and are capable of servicing only house-

hold or village needs when coupled with a hammer mill. The straight run flour from a mini dehuller-hammer mill unit is only suitable for 'sadza' or as brewing grits in combination with sorghum malt. The viability of the mini dehullers is therefore very limited.

Large-scale utilisation of sorghum as a milled product of varying granularities for a variety of end-uses ranging from sadza flour to bread flour, semolina and confectionary flour is constrained by the lack of industrial-commercial hulling and milling capacity. Sorghum and millets have very different milling properties from those of wheat (Perten, 1976). Semi-commercial scale milling systems for sorghum have been developed in Sudan and Senegal (Perten, 1983) and several commercial models of dehullers (Schulle, Buhler) are now on the market. However, an integrated commercial scale hulling and milling technology capable of producing a range of milled products for varied end-user is yet to be developed.

The identification of possible and potential end-user and market testing of sorghum products is a process that generates a chain reaction of development activity. These tests should stimulate the further development of industrial processing technologies. These tests should also provide sorghum breeders with a shopping list of desirable functional and quality factors of grain to match the specific end-uses of sorghum. The work on DVT and the pressures to increase sorghum utilization have stimulated sufficient interest among local millers in Zimbabwe to generate a modest level of investment in dehulling equipment. However, it will take further investment of capital and experimentation before the whole hulling-milling system for sorghum could be developed to a commercially viable level. At the same time, the viability of CFT would have to be convincingly demonstrated to millers through "scale-up" of pilot-scale trials to

industrial test-baking and test-marketing in conjunction with one of the medium scale bakeries.

Provided industrial processing technology could be developed even at the current selling price of GMB sorghum (Z\$230 per tonne) and the price differential between sorghum and wheat (\$340 per tonne) composite flour technology offers the millers a substantial annual savings of about Z\$3.9 million if sorghum were to be incorporated at 15 percent level in composite flour. The use of sorghum in bread which is price-controlled also gives the bakers a financial advantage in being able to reserve rationed wheat flour for higher-priced confectionary products. Over and above the domestic savings, the annual foreign exchange savings in reducing current wheat imports by 15 percent would amount to nearly Z\$12 million.

In the major sorghum producing countries of Africa such as Sudan and Ethiopia, sorghum and millet have remained as subsistence crops. Processing technologies have also remained at the traditional or at an intermediate level of mechanization. The transition of these crops from subsistence to cash crop status has not been accompanied by the corresponding advances in large-scale processing technology. The development of technologies for serving both rural and urban needs are of strategic significance for Food Security in low rainfall areas in Africa. This discussion of sorghum illustrates the void that presently exists in post-production technologies. Unless, improved technologies are rapidly developed in conjunction with breeding programs, rural households in low rainfall areas will become increasingly dependent on maize - a higher yielding but more unstable crop.

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