Crop Post-Harvest Research Programme Zimbabwe

An Overview of Sorghum and Millet Production, and Utilisation in Zimbabwe's Semi-Arid Smallholder Sector

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DISCUSSION DOCUMENT

PERCEPTIONS ON SORGHUM AND MILLET PRODUCTION AND UTILISATION IN THE SADC REGION, AND FUTURE RESEARCH NEEDS

John Wood, Lynda Hammond and Tony Swetman
Process Quality Management Group, Food Security Department, Natural Resources Institute,UK

Introduction

Examination of recent technical literature and reports on research activities on sorghum and millet production and utilisation within Southern Africa indicates that investigations have fallen into four broad categories:

- Plant breeding - initially for yield improvements, but more recently to include other traits relating to ease of harvesting, early maturation, resistance to disease, and more recently appropriateness of varieties for end use.
- Sorghum and millets in grain import substitution programmes - including:

  Evaluation of the technical characteristics of sorghum and millets as replacements for imported wheat (composite flours) and wheat products;

  Sorghums and millets as sources of malt to replace imported barley for the brewing industry;
- The mechanical dehulling of sorghums and millets to produce white flours for the "quality upgrading" of flours and meals for a variety of food uses.
- The feasibility / desirability of including sorghum and millet in strategic grain reserves, national planning for self sufficiency, and opportunities for sorghum and millet in liberalised markets.

The purpose of this paper is not to present an overview of the findings of specific research, but rather to attempt to place the topics of research against the broad objective to improve the production of sorghum and millet. Research topics currently being carried out by organisations in a variety of countries represent pieces of the jigsaw, rather than the sequential components of an integrated programme with both lateral and vertical interactions. Some appear to have been conducted in isolation of the farming system in which these crops are grown (whether at rural or commercial level), and also without reference to the end user.

International research into sorghum in particular is directed at knowledge for both developed and developing country users. Mechanisms which drive sorghum (and millet) research within

the semi arid regions of the developing world are quite different from those that drive the research programmes on these same crops within northern climatic zones.

In the south, sorghum and millet are traditional drought-resistant subsistence crops. However, they have been subordinated by national grain strategies which demand and support the production of non-traditional cereals, from more temperate regions, in particular, maize. Essentially maize is an exotic to Africa, but its production or import was often subsidised in order to provide people with foods of perceived higher quality, and greater acceptability than sorghum and millet. As a result the small grains have become designated as the poor man's food.

In northern countries, sorghums can be considered to be exotics, (though perhaps less so for the southern states of America where sorghums have been traditional foods in Central America for many years). The purpose of growing sorghum has been to fill the gaps in grain demand in regions where other cereals are non-commercially viable, with a clearly defined end user - the livestock industry. Within this market sorghums are lower cost sources of energy and proteins for meat production than other grains.

Under these conditions sorghum is not a product of subsistence agriculture, but a product of market opportunities driven by consumer demand for meat. The crop is grown in systems which benefit from efficiencies of scale of grain production, available land for production, and the ready availability of inputs and technology (fertiliser, herbicides, mechanisation etc.).

The luxury of this position is not evident in most of the SADC region. There are few identifiable major markets demanding sorghum and millet as primary raw materials. The exceptions are Botswana and Namibia where local supply cannot meet demand for food varieties of sorghum and millet, and in South Africa and Zimbabwe where sorghum is grown for malting and brewing in commercial quantities. Botswana and Namibia are sufficiently semi-arid to make maize production impractical. The driving force for semi-arid production is the ability to produce a subsistence crop with minimal inputs. Inputs (seed, labour, fertiliser) are expensive, unavailable or both.

If maize grows better than sorghum in higher rainfall areas with the same inputs then it is not surprising that maize output has expanded. However, the subsidies which governments applied to maize, clearly unbalanced the natural supply and demand cycle for sorghum and millets. This preferential support for maize has only enhanced the perception of many rural and urban consumers that sorghum and millets are inferior, and should remain subsistence crops. They are perceived as grains to consume when all else fails. However, this is not true for all countries in the region. In Botswana there is minimal perception of sorghum as the poor man's grain, and there is a flourishing sorghum milling industry providing sorghum flour. Sorghum is the preferred grain and maize is the food provided by aid support.

Regaining a former status is always much harder than finding a foothold as the new and well-supported entrant. This has been true for sorghum and millets which now need a new and vital image if they are to succeed. Mechanisms must be found for marketing sorghum and millet as grains with inherent positive, not negative values.

Against this background it is necessary to review four basic questions relating to the current sorghum and millet sector and what could be done to promote their production and utilisation.

- *What are the interrelationships within the breeder to product chain for the production and utilisation of sorghum?*

- *What are the constraints / incentives to increased production of small grains by rural and commercial farmers?*

- *What are the constraints / incentives to increased utilisation of small grains by small-scale entrepreneurs, commercial brewers, feed millers and food processors?*

- *What are the national / regional economic/ price signals which appear to affect sorghum and millet production?*

The outcome from finding answers to these questions should be the identification of priority areas for research or intervention which would have most positive impact on the sorghum and millet sector in the SADC region. They must also be examined against the backdrop of the current production, policy and pricing structures of the sorghum sector.

Interrelationships within the breeder to product chain

It is probably fair to state that the economic environment under which sorghum and millet development is now responding is different to that when SACCAR's Sorghum and Millet Improvement Project and other similar projects were first conceived. New research must address the new economic environment and if possible address the economic position when the research is to come to fruition.

More recent economic and political pressures have resulted in the following actions:

- Considerable pressure being placed on SADC countries by international funding agencies to liberalise / privatise their grain markets, disband national grain marketing boards, remove subsidies on crop production to allow markets to reach their own trading levels.

- Strong recommendations from policy researchers to reduce the size of national grain reserves due to improvements in early warning systems. However with declining international grain stocks, the ability of the North to respond to emergency grain shortages in the South may be weakened.

These changes - some welcomed, others not - have had varying impact on the different players in the sorghum and millet sector.

Changes in climatic patterns will also play their part in influencing crop production practices. In the wake of the 1993-94 drought in Southern Africa and the resulting grain shortfall within the SADC region there has been a resurgence of interest in the place of sorghum and millets in national food security programmes. This interest is being reinforced by the anticpated El Nino effect which is expected to cause adverse weather patterns and crop damage in the region during the 1997/98 season. For example, in October 1997, Zimbabwe's Early Warning Unit advised that the country should re-examine its proposed export of 350,000 tonnes of maize since it would significantly deplete the current stock level of 502,000 tonnes to levels which are way below the ideal strategic grain reserve level of 500,000 tonnes..

The relationships within the sorghum and millet sector are complex and are illustrated in Fig 1.

The important users of grain from sorghum and millet breeding programmes are rural farmers, commercial farmers, grain marketing and storage organisations, the brewing, feed and food sectors. For commerciall users, grains are the priority, whereas for the rural farmer, his interests are in terms of food for the family and feed for livestock.

Rural farmers

In recent years agricultural researchers have become much more willing to learn from the traditional wisdom of communities passed from one generation to another. The traditions of sorghum and millet planting and harvesting, the risks which subsistence farmers must respond to and the selection of grain varieties, which in the farmers eyes, give him and his family the best return for the least risk. Certainly many farmers have welcomed new varieties because of, for example, their potential for higher yields, resistance to disease, and ease of harvesting. Others have retained that scepticism towards change for justifiable reasons. Older varieties have been kept by those who view sorghum as a multi-purpose crop. Maximising grain yield *per se* is only one of the criteria for selection. Others may include bird resistance; forage value for livestock; strength and height of the stover as thatching or fencing material; ease of processing and palatability.

Many rural farmers, either choose, or find themselves in a position where their food production and lifestyle is at subsistence level. Crops are grown to provide sufficient supplies for subsistence, with some margin to store against shortfalls in a subsequent season, but for many rural farmers the incentives to grow sorghum and millet as a cash crop have been few.

NRI studies in Zimbabwe have indicated that the minimum land holding in a semi-arid region (Natural Regions IV or V) for a family of 6 persons is about 2 ha. Of this, 1.6 ha is for small grain production for domestic consumption and 0.4 ha for sunflower or groundnut production for cash. A small area is often set aside for a vegetable garden. Maize may be grown, but yields are often very low.

For these families, market liberalisation of the grain trade and the reduction of activity of Zimbabwe's Grain Marketing Board, has had relatively little impact since they have remained outside of the market, except for the procurement of new hybrid seeds for planting. In many

communal areas the expanding population is causing encroachment of family plots into the communal grazing lands, thus reducing the potential for economic livestock rearing for milk, meat or draught power. The problem is compounded by the expansion in livestock numbers needed for working the land.

In contrast families with considerably more land than is necessary for family subsistence do not plant to the lands capacity. There may be several reasons for this:

- Not all the land may be productive
- Shortage of, or price of, seed and inputs (fertiliser / herbicides etc.)
- Potential loss by bird attack.
- Unavailability of labour for planting, weeding, harvest, threshing and storage.
- Shortage of storage capacity.
- Low capability of draught animals to prepare the land.
- Local customs and technical desirability to leave part of the land fallow.
- Insecure market, distance from market, and low prices for selling excess production.
- Grading systems which are perceived to be unfair or manipulated against the farmers.

The commercial users of sorghum or millet.

Maize, as the premium cereal in the SADC region has found ready markets in both the animal feed and food sub-sectors. Small scale entrepreneurs and large commercial processors both have a place in the market for maize meals, though some commercial millers have seen part of their market lost to rural and peri-urban entrepreneurs. These entrepreneurs have set up in business preparing similar products using friction dehullers and hammer mills as the key components of milling technology.

Animal feed
Maize finds its place in the animal feed market because of its nutritional characteristics, ready availability and price per nutrient in a formulation. Maize, for example, could be substituted by a blend of cassava and soya bean meal, but neither of these crops is available at the right price / availability / quality combination to seriously make an impact on maize utilisation.

However, it must be remembered that feed (and flour) millers are interested in the price per ton delivered to the mill gate and not the general market price. Rising transportation costs can have significant impact on the price of a commodity delivered to the processor, and crops such as sorghum and millet grown far from user industries may face transport costs considerably greater than for maize. Although this may be true for any given within-country grain market, there may be centres of demand across country borders, and the opportunity for export should not be missed. There has been particular evidence of this in southern Zambia where it has been more competitive for sorghum growers to sell to Botswana than to find a home market.

The feed industry will only utilise sorghum if the price/quality/availability relationship for sorghum is more favourable to the feed mill than the use of maize. The mill will also examine the relative costs of handling, storage and milling sorghum as an alternative to maize, though total substitution of one grain for the other is unlikely. The market price for sorghum ought to reflect its value as a competitive source of feed nutrients. While sorghum has similar feed value to maize for ruminants, for monogastric animals like pigs and poultry sorghum it is of lower nutritional value to maize (lower protein digestibility and metabolisable energy content).

The feed industry is potentially the largest consumer of small grains, and modern feed formulation software will indicate to the feed mill the price at which sorghum or millet could be brought into a formulation if it were available on the market. Thus the feed sector can set the floor price for small grains. For sorghum and millet to be used in feeds and foods therefore, production, harvesting, storage and transport costs etc. must be at a level which enables this floor price to be met, and sorghum and millet production to be profitable to the farmers.

Brewing
For brewing the price of sorghum for malting must be related to the cost and quality of barley malt and other grains which it seeks to replace. Again they are not equivalent products, but they can replace each other with appropriate adjustments to the process (see J Dewar). The use of sorghum for brewing more traditional lactic beers is slowly growing in Zimbabwe (Chibuku Breweries). In Zimbabwe and South Africa brewers have found it necessary to grow the crop under contract to ensure supply, since the established marketing channels do not secure grain of the desired characteristics.

Food
In the food sector, the small grains must not only compete with the the price / availability / quality combination referred to above for the feed sector, but also compete in terms of their organoleptic and functional properties. The latter determines which food products can be prepared from sorghums and millets while the former determines their commercial acceptance, and ultimately their market demand.

The widely differing properties of red, brown and white sorghums, and the reasons for their production have made criteria for breeding and selection-for-use rather complex. The rural farmer while preferring white sorghum for the domestic preparation of porridges, will often grow a red variety with known bird resistance (due to the presence of tannins), because therein lies his food security. For him, organoleptic properties may be secondary to security of harvest, although he may have a personal organoleptic preference for white sorghum meal.

In contrast, the sorghum miller is seeking to sell his product into the white roller meal market held by maize. It is for the urban housewife within her increasing cash based economy, to determine on a price / availability / organoleptic / functional property combination which is most suited to her family. Here, we must not underestimate the power of marketing in the form of advertising and packaging to sway the potential buyer, and the increasing availability of disposable income to purchase processed foods. Sorghum and millet must compete with

cereal products such as rice and pasta, though pearled sorghum products are finding acceptance as rice replacers in South Africa, and the use of sorghum and millet flours are being used in commercially prepared weaning foods in Botswana.

Unlike maize, there are sorghum varieties with sufficient diastatic activity released during malting to give selected varieties (usually red) a place in the brewing industry. Much of the early research on this topic was conducted in Nigeria in the 1980's following a ban on import of barley malt for the brewing industry. The technology has since been developed and modified in South Africa leading to a commercial demand for 400,000 tons of sorghum annually Some researchers have predicted that by the year 2020 South Africa will be a net importer of sorghum, rather than an exporter to neighbouring countries (personal communication Prof. John Taylor, University of Pretoria)

Composite flours

The composite flour programme came into existence to find ways in which indigenous cereals could be blended with wheat flour to produce wheat based products of acceptable quality while reducing the demand for wheat imports - i.e. a policy of import substitution. In response to this policy, much work has been done to find ways in which small grains like sorghum and millets, and other starch sources like cassava, can be added to wheat flours. The secondary argument has been that the inclusion of these alternative grains in wheat flour will promote their production.

However, from the perspective of raw material substitution there may be more sense in adding sorghum, millet or cassava to maize flour to produce blends of different characteristics. Maize, like sorghum, millet and cassava is a non-gluten commodity. However, since maize is considered an important staple in most Southern African countries, there has been no open promotion of its addition to wheat flour.

Driving forces

The driving force for any import substitution policy is a combination of technical characteristics of substituting materials and their price relative to others on the market. Since maize production is often subsidised and is of lower price on the market than sorghum and millet it is unlikely that these alternative cereals would find their way into a maize product unless they enhanced its eating quality.

The low availability of sorghum because of its association with subsistence agriculture, and pricing policies which mitigated against its demand did nothing to promote the use of the crop. These matters need reconsideration under a free market where sorghum must find its place in the market in relation to commodity value. Whether this value reflects its cost of production requires further evaluation.

Technology developments

The most important technology developments in sorghum and millet processing which has found adoption by small and medium grain processors is that of friction dehulling. Within these simple machines, the dry grains are abraded against the surface of carborundum-based grinding disks, the bran is removed by forced air and the dehulled grains collected for sale or further processing. Where introduced, dehullers have given urban and rural communities the ability to produce sorghum meals and flours of less than 85% extraction rate, with a grey-white appearance and preferred organoleptic qualities which can compete with maize products produced by commercial roller mills. However, what has been good for sorghum and millet has also been good for maize, and many dehullers, certainly in Zimbabwe are being used to dehull maize before hammer milling to a meal or flour.

Despite the proven benefits of the technology, its uptake has been limited by two key factors.

a) the dependence upon imported carborundum stones, their high cost and the absence of local stockists.

b) upon transfer of dehuller manufacturing capability from NGO to the private sector. In many cases the increase in price due to removal of NGO subsidies, addition of profit margins etc. has made dehuller purchase prohibitive.

These factors have resulted in the decline or stagnation of sales of dehullers. For example, unofficial data from the NGO, ENDA Zimbabwe indicated that while Zimbabwe has about 3000 hammer mills in operation for the grinding of grains to meal, there are only 250 dehullers installed and running. In Tanzania, dehuller construction and installation appears to have virtually ceased. In contrast, dehuller activity appears to be well accepted in Botswana where 113 dehullers are being used daily, some operating 24 hours per day. There is no dispute that dehulling technology works, but the conditions for its successful and continuous implementation are not easily achieved.

Private grain trader vs Grain Marketing Board

In response to liberalisation of the grain markets there have been significant changes to the practical operations of grain collections and markets. In Zimbabwe for example, many of the former activities of the Grain Marketing Board (GMB) are now handled by private traders. Producer prices are no longer set by complex formulae but by what the market can accept. Prior to privatisation there were suggestions that market liberalisation would result in a decline in maize production and sorghum production would be stimulated. However, sources within GMB have found that "the market for maize is inelastic, and that for sorghum is inpenetrable". Furthermore there is evidence that some commercial farmers are growing horticulture crops which are more profitable than maize.

Within rural areas, independent traders are steadily increasing their market share by buying cash crops such as sunflower seed direct from rural farms. Many farmers are willing to accept cash in hand, albeit at less than GMB prices, since GMB require seed delivery to district collection points, and can only make payment two months after purchase.

Market forces are clearly having an impact on markets for maize and sunflower, and will have similar impacts on any proposed expansion of sorghum production..

Market logistics

In broad terms the expansion of sorghum production is still at the "chicken and egg" stage. Without demand there is no production, and without production there is no demand. What is

needed are mechanisms which will create demand and stimulate production. Often the stimulus for increased crop production has come from the food demand from urban centres. This has led to the centralisation of processing industries around urban centres and the transportation of grains, for example, from rural to urban centres and the transportation of processed foods in the reverse direction. This mechanism remains non-competitive until there are competitive benefits to process in rural areas and to sell processed goods to rural communities and to urban centres whether in-country or across borders. For rural commodities like sorghum there may be little benefit in promoting processing in national urban centres since the costs of grain collection and transportation will be greater than that for maize, and the costs of sorghum production at rural level will also be greater than maize production at commercial level. It is important therefore that the relationships between costs of sorghum production, transportation, storage, processing, product packaging and marketing which will enable sorghum products produced in rural areas to be competive with maize based products produced in urban areas receives detailed examination. This should apply to all potential sorghum based products - animal feeds; meals, flours and flour-based products; brewery and industrial products.

Summarising the interactions within the sector

Having broadly reviewed the small grain sector within the SADC region, some pointers to answers to the earlier questions would be as follows:

What are the supply and demand interrelationships between the breeder to product chain?

These are illustrated in Fig 2. The supply chain is presented in Fig 1, but it is overlaid with indicators of constraints and incentives.

Currently there would appear to be more constraints to sorghum and millet expansion than incentives. Expansion can only be based on improved and sustainable demand.

What are the constraints / incentives to increased production of small grains by rural and commercial farmers?

Factors which could drive the commercial exploitation of sorghum and millet in the feed, food and brewing industries are different from those factors important to the rural farmer. It would seem that the rural farmer could benefit from the development of commercial sorghum processing, primarily by having an assured supply of quality sorghum seed available to meet demands of processors, and a local processing market into which production in excess of family requirements can be sold.

Constraints / Incentives to increasing the production of small grains

Rural Constraints	Commercial Constraints
• Poor seed supply • Low germination rate of seeds	• Sorghum cultivation more labour intensive than maize.

• Lack of draught power • Storage loss (40% loss -insects etc.) • Lack of credit • Small production areas • No fertiliser • Preference for local varieties (non-hybrids) • Poor threshing techniques. • Bird attack • Shortage of early maturing varieties • Insecure or no market for excess production. • Low prices • More labour intensive than maize (weeding)	• Bird attack • Market demand uncertain • Price mechanism not established. • Commercial stocks of proven varieties unavailable. • Low germination rate of seeds

What are the constraints / incentives to increased utilisation of small grains by small-scale entrepreneurs, commercial brewers, feed millers and food processors?

Sorghum Processor	Constraints	Incentives
Animal feed Food Brewing	• Insect contamination in stored material • Variety inconsistency • Variety characteristics uncertain • Supply shortages • Poor quality of imported grains • Declining interest in sorghum and millets.	Much of the technology for use of sorghum in animal feed, food and brewing processing is known. Information on known technologies needs wider dissemination, but to stimulate their adoption they require a stable grain supply system.

What are the national / regional economic/ price signals which appear to affect sorghum and millet production?

- Price and availability of seed for plating
- Preferential support through subsidies to specific crops
- Seasonal price fluctuation
- National stock levels held by traders; central strategic reserves; reserves held on farm
- Early warning climatic information

- Speed of price information reaching farmers
- Uncertainty of commercial value of small grains
- Differences of grain prices across borders
- Magnitude of current sorghum and millet market
- Market demand for small grains

Conclusions

While considerable research has been conducted towards improving the breeding and processing characteristics of small grains the market for these grains is, in most SADC countries very limited. Sorghum and millet are often considered to be secondary grains to maize, and of value only to subsistence farmers in drought stressed areas.

Expanded production of small grains utilising the benefits of research will only occur if there is a demand for them, primarily in the areas where they are grown, and where their use in processing of animal feeds and foods makes them competeitive with maize. It is argued therefore that to stimulate production, sorghum and millet must be able to cost-effectively and technically:

- replace or supplement maize in commercial food systems
- replace or supplement maize in animal feed systems
- replace or supplement imported barley malt in brewing systems
- replace or supplement imported wheat / flour in food systems
- have specific nutritional / functional / industrial properties that make it desirable in its own right.

At rural level, sorghum must:

- be equally or more cost effective to grow than maize.
- be equally or more resistant to storage loss by insects / fungi than maize
- be of equivalent or better nutritional quality and shelflife than maize.
- be valuable as a whole crop for food, feed, household according to the priorities of the grower.
- be easier to prepare as a food than maize.
- have the ideal functional properties for food product preparation.

Topics for study which will provide further impetus to sorghum and millet production and utilisation are summarised in the Appendix.

Appendix.

Future Research Requirements

Research is required to identify the extent to which the criteria for sorghum and millet expansion can be met. As a consequence, breeding programmes should:

- have an understanding of the intrinsic qualities of traditional varieties
- produce varieties with the characteristics required for each type of processing - food, feed and brewing,
- take account of qualities which encourage consumer acceptance.
- stimulate closer links with seed production programmes

New economic and technical knowledge is needed to give impetus to sorghum and millet expansion. It is suggested that future research should provide information on the following topics.

a) Sorghum and millet economics:

1. Identification, on a country by country basis, of the prices at which sorghum can be competitive with imported barley for beer production, with maize for feed production, and as a component of a composite flour for food use.

2. Land use: identification of the quantity of land available in each of the SADC countries which could be used for expansion of sorghum on the assumption that sorghum will not replace maize production on commercial farms. Determination of the quantity of seed and inputs necessary to cost-effectively utilise that land and identification of the most constraining factors to land development, including human and livestock resources.

3. Results of conduct cost / benefit analyses of rural sorghum production systems which would identify the conditions under which rural farmers would benefit from producing excess grain beyond their subsistence requirements. To include consideration of sorghum in the mixed crop system for subsistence security.

4. Identification of economic / agronomic conditions which would would enable rural co-operative / commercial farming of sorghum as a cash crop to be viable in semi-arid regions.

5. On the assumption that economic / technical studies confirm the potential viability for expanding demand for sorghum based foods at rural and urban levels, identification of how seed replication and distribution can be improved to ensure supply of seed to farmers, both rural and commercial.

6. An analysis of the logistics / feasibility criteria for establishing sorghum (and / or millet) processing industries in rural areas which could stimulate sorghum production as a cash crop, and to replace products transported from urban centres. Industries should also utilise other cash crops such as sunflower and groundnut grown in semi-arid regions.

b) Grain utilisation characteristics

1. Potential for use of sorghum in a composite flour with maize. Wheat flours are usually grists of different types of wheat (hard and soft) to yield flours of different properties for different products. The extent to which white sorghum can be blended with white maize without losing the organoleptic and functional properties of maize flours requires confirmation from both technical and economic perspectives. A composite product of good quality would enable maize-based products to be available throughout the year, rather than the current practice of consuming maize at the beginning of the season and sorghum at the end (which reflects differences in the storage characteristics of maize and sorghum). The acceptability of a good maize/sorhum flour may stimulate improved storage practices for maize, particularly at rural level.

2. Recognising that for many rural communities, sorghum or millet are the staple foods, to investigate the nutritional consequences of consuming the grains as products prepared from wholemeal or dehulled cereals. What are the best uses of sorghum by-products? Should bran be used for feed or food use? Methods for treatment of brans to enable them to be added back into human food rather than to animals or doscarded.

3. Since the early 1970s developed country nutritionists have been actively promoting the consumption of higher fibre breads, confectionery, breakfast cereals, and vegetables as dietary means to prevent cancer of the colon, diverticulitis, heart disease and other diseases associated with the consumption of over-refined foods. In response to public pressure the flour millers now produce a wide range of high fibre flours. However, much of the evidence for the impact of high fibre diets to prevent intestinal and other diseases originated in studies of the diets of peoples living in Southern Africa. What we are now seeing is the reversal of food habits in Africa towards the Western diet which could bring with it increases in the associated intestinal diseases. This is the negative side of promoting dehulling. The positive side of dehulling may be improvements in the calcium absorption in diets. Wholemeal flours are known to contain phytates in the bran fraction which chelate dietary calcium, and the removal of the bran may thus overcome this problem.

Calcium binding by phytates was well recognised in the UK during the second World War (1942) when food advisers to the Government advised " to change a nation's dietary from white to brown bread, and at the same time to reduce their milk and cheese supply (the main sources of calcium) would probably mean that nine out of ten children would begin to loose calcium. Rickets might increase in young children and growth become slower at all ages. As a result calcium carbonate was added to the flour to compensate for that chelated by phytate.

This warning received confirmation in Eire in 1943 when, after three years of 100% wholemeal flour in Dublin, the incidence of rickets in children had risen from a practically

negligible level to 50%. Vitamin deficiencies (especially Vitamin D) may have played some part in these events, but the Irish investigators concluded that the high incidence in rickets in Dublin children during 1942-43 was probably caused by the high phytate content of the wholemeal flour then in general use.

The converse side of the nutritional arguement is that bran and germ removal from flour, while improving the shelf-life of the flour due to removal of much of the cereal oil, resulted in the removal of most of the B vitamins from the grain. Milling to 70% extraction reduces nutrient levels relative to that in whole wheat: fat by 45%; fibre by 90%; riboflavin by 60%: thiamine by 75%, nicotinamide by 85%, calcium by 50% ; iron by 60% and phosphorus by 75%.

Since grains provide much of the total nutrients in SADC grain based diets, it is important that the potential impact of grain dehulling (whether small grains or maize) on the dietary intake of essential vitamins, and calcium is understood and where appropriate, recommendations for supplementation and management of diets prepared and disseminated.

4. Improved designs for low-cost threshing technologies over the flail or stick for use within household or village communities. Large power driven machines are available, but they are unavailable to most rural communities and can be costly.

5. Define the analytical methodologies which can be used to characterise the functional and nutritional properties of sorghum - for food feed and brewing use within the SADC region. Methodologies for brewing have been established for South Africa, and are being discussed and agreed across the brewing industries in SADC. Methodologies for feed and food quality in relation to product types have not been fully identified.

6. How extensive is mycotoxin contamination of small grains and maize, particularly during periods of drought stress followed by periods of short rains? Given that the Sorghum and Millet Improvement Project (SMIP) is directed at improving small grain production, could this production be refused by potential commercial buyers because of mycotoxin contamination? Furthermore since it is known that other foods from semi-arid farming systems (such as groundnut and sunflower) are also known to be susuceptible to mycotoxin contamination due to drought stress conditions, rural people are likely to be ingesting considerably higher levels of mycotoxins than urban people. There is anecdotal evidence that many people in Mozambique die from liver cancer. Is their any link with mycotoxin intake? The ability of dehulling technology to reduce mycotoxin intake, and options for using mycotoxin contaminated brans requires investigation. Feeding mycotoxin contaminated brans to livestock is not recommended. Ultimately growers will need advice on how to prevent mycotoxin development in growing crops, and what is the economic value of this prevention.

7. Nutritional qualities. Can sorghum and millet offer anything to the growing "health food" market. There are anecdotal claims for some of the millets to provide relief from diabetes, be benficial for lactating mothers, and be more digestible for children. Can these claims be substantiated? If they are substantiated, is their a specialist market for millets which would stimulate their production as a cash crop?

Supplementary notes:

Effect of substituting white sorghum for maize on the price of mealie meal.
(at October 1997)

Grain grist	Producer price / market buying price Z$
Maize	950
Sorghum	808
M 75% + S 25%	914 (4% less than maize)
M 50% + S 50%	879 (8% less than maize)
	Is this worth doing? Would a family ask for such a product at this price?

In one survey of maize in 1991 in urban Harare 62% of respondents said that they would buy straight run maize meal (wholemeal) if it was 12% lower in price than roller meal.

(Ref: T. Takavarasha, Agricultural pricing policy in Zimbabw in: Food Security Research in Southern Africa : Policy Implications Eds. JB Wyckoff and M Rukuni, Dept. Ag. Econ. and Extension, University of Zimbabwe, March 1992).

Would this be similar for sorghum meals? Is cash saving a higher priority than eating quality?

Questions tobe asked concerning food developments:

Is it technically feasible?

Is it desirable ? (will it enhance the physical, nutritional, microbiological, organoleptic characteristics)

Will the product be acceptable? (to what group of customers, at what price , from of presentation / packaging ?)

Is it sustainable? (can quality, inputs and outputs be guaranteed?) What are the risks?

Small grain processing costs in rural regions of Zimbabwe (April 1997)

Charges are based on a 20 litre (approx) tin of grain. If average bulk density of grain is 0.75 kg/litre, then weight of grain being processed is approx 15 kg per batch.

Process	Mutoko District Z$ / 15 kg	Buhera District 1 Z$ / 15kg	Buhera District 2 Z$ / 15kg	Chivi District Z$ / 15 kg	Means Z$ / 15kg
Grinding	4.0	4.0	4.5	2.0	3.7
Dehulling	4.0	2.5	3.5	4.0	3.5
Dehulling and grinding	6.5	6.5	7.0	6.0	6.5
Double grinding	7.5**				
Bran selling price per tin (5kg)	10.0	6.0	2.0	7.0	6.3 (Z$ 1.26/kg)

** one miller double ground sorghum to give a softer flour.

Costs for producing meals and flours. Grinding by hammer mill through a 1mm screen.

Process / product	Estimated producer cost of grain (Z$ / kg)	Process charges per tin (approx 15kg) (Z$)	Extraction rate (%)	Process charge per kg product (Z$)	Cost of grain component (Z$ / kg)	Cost per kg final product (without packaging) (Z$ / kg)
Grinding	0.9	3.7	100	0.25	0.9	1.15
Dehulling	0.9	3.5	80	0.29**	1.13	1.42
Grinding and dehulling	0.9	6.5	80	0.54	1.13	1.67
Bran (0.3 x density of maize)		6.3 per 5kg				1.26
Commercial roller maize meal						1.9 (including packaging)
Commercial refined meal						2.65 (including packaging)

** (Cost per kg grain / 0.8)

Commercial roller and refined meals sold in 20 kg bags.

Rurally processed dehulled meal of about 80% extraction is approximately 88% of the price of commercially produced roller meal of about 85% extraction rate.

Income for the service miller for the processing of dehulled and ground grain

Service charge for dehulling and grinding @ Z$ 6.5 per 15 kg grain
Income from sale of bran @ Z$6.3 / 5kg (equivalent to Z$3.78 / 3kg bran (20% of grain))
Total = Z$ 10.28 per 15kg grain or Z$ 0.68 / kg grain.

In October 1997. GMB prices for buying sorghum were estimated to be Z$920 per ton (source TDC UOZIM) in July /August GMB selling price for maize @ Z$1320 / ton and for sorghum @ 975 / ton. October prices: maize @ Z$ 1420 / ton and sorghum @ Z$ 1250 /ton.

i.e sorghum price is currently approx 88% of the price of sorghum (if it is available). There is no differential between the price of red and white sorghum.