AQ

DRAFT REPORT

R&ISS

agritex

University of Zimbabwe

INTERMEDIATE TECHNOLOGY

odi

Cranfield UNIVERSITY

NRI

Crop Post-Harvest Research Programme Zimbabwe

Opportunities for Improving the Utilisation of Small Grains and Oilseeds in Rural Areas of Zimbabwe

Funded by the UK Department for International Development under the Renewable Natural Resources Research Strategy 1995 –2005.

Opportunities for Improving the Utilisation of Small Grains and Oilseeds in Rural Areas of Zimbabwe

Proposals Based on a Survey of Mutoko, Buhera and Chivi Districts, Zimbabwe, 11-15 November 1996

Wood J.[1], *Thomson M.*[1], *Masendeke A.*[2] *and Ruhode T.*[3]

1. *Natural Resources Institute, Chatham, UK*
2. *Intermediate Technology Development Group, Harare, Zimbabwe*
3. *Development Technology Centre, University of Zimbabwe, Harare, Zimbabwe*

University of Zimbabwe

INTERMEDIATE TECHNOLOGY

December 1997
Project A0549

c:\mydocuments\a0549\sgrain oil insert

Contents

1. INTRODUCTION

1.1 Small grains and oilseeds are primary crops grown by most subsistence and rural farmers in the semi-arid regions of Zimbabwe. This report summarises current crop production levels and processing technologies available in rural areas in order to identify constraints to their utilisation and propose topics for research under the DFID Crop Post Harvest Programme.

2. SUMMARY OF CROP PRODUCTION SYSTEMS IN SEMI-ARID REGIONS

2.1 Mutoko, Buhera and Chivi districts are broadly representative of the semi-arid regions III, IV and V in Zimbabwe which account for about 60% of the country's geographical area, and possess two thirds of the national population of 12 million. They are the least populated areas of Zimbabwe. Population densities from the 1991 census indicate 30 persons per sq. km. in region IV and 21 persons per sq. km. in Region V (approximately 4 - 5 families per sq. km). About 75% of the small holder farming areas (communal lands) and two thirds of Zimbabwe's population are located in these dry areas (Eicher and Rukini 1994). Population growth and the tradition of land division to following generations has resulted in diminishing family landholdings with increasing pressure to produce staple, food secure crops.

2.2 The typical communal family consists of 6-7 people living within the household with a further 2-3 non-resident adult members. Of the 6-7 resident members, over 50% are children either at school or of pre-school age. There are a few households with elderly persons over 60 years old. This leaves three people per household available for work on the family farm or for domestic activities for the family. Communal farming is not uniform in character whether in terms of physical, economic or demographic factors. The wide range of non-resident heads of households inevitably affects the levels of annual income and expenditure.

2.3 A 'typical' rural, semi-arid region, communal area farm is situated 10-30 km from the nearest small town or business centre. Landholdings range from 0.5 to 4 ha; areas of 1-1.5 ha predominating. In the Mutoko resettlement areas all land holdings are 6 ha per household, and the heavier soils suit cotton production.

2.4 The main crops are maize (where rainfall is sufficient) and sorghums and millets in the very dry areas. Sorghums and millets are for home consumption though some red sorghum is grown as a cash crop for sale to a commercial brewer (Chibuku). Most farmers allocate 10 to 20% of their land to other crops - the most important of these being sunflower and groundnuts (Table 1). There are no domestic uses for sunflower, the seed being grown as a cash crop. Groundnuts may be used as an oil substitute for culinary purposes, or pounded to a paste ('peanut butter') for children or sold for cash.

2.5 Grain yields are the lowest in the country for most crops. Where rainfall and soils are sufficient to support maize, this remains the preferred crop, while in the very dry areas sorghum and pearl millet predominate. (Mazvimazi, 1996)

Table 1 Summary of the typical crop distribution patters (% by area) by district.

Crop	Mutoko % per farm	Mutoko resettlement area % per farm	Buhera Zone III % per farm	Buhera Zones IV,V % per farm	Chivi % per farm	Typical yields (kg / ha) Good season	Drought season
maize	60	55	65	25	56	905	215
ground-nuts	15	10		10	19	400	100
sunflower	15	10		10		900	300
millets	5				6	650	250
sorghums	4	4	50	50	19	700	200
cotton		20					
others: (lentils cowpeas, bambara etc.)	1	1	5	5			

Notes: Source: Agritex district officers.
Sorghums tend to be planted in the ratio 1 red to 4 white.
Pearl millet is the preferred, though finger millet is also grown in Chivi district.

3. SMALL GRAINS PROCESSING - CURRENT SITUATION

Importance of small grains in the communal lands

3.1 On a scattered landholding of 2 ha a family will plant, for example, about 1.4 - 1.6 ha to grains for domestic consumption, but even with modest yields the farm is only able to produce about 70% -80 % of the grain needed to meet recommended FAO calorie requirements for the family. Hence there is growing pressure to minimise all grain losses during harvesting, storage and utilisation. Other crops (mainly oilseeds and vegetables) are necessary to generate cash for the household and to broaden the diet.

Threshing and storage

3.2 Farmers in regions III, IV and V employ different methods of grain storage depending on the environment and ethnic background. In general, however, both sorghum and millet may be harvested early with high moisture to reduce bird damage that would otherwise occur when the grain was fully mature. The grain is stored in a heap on the panicle either under a shelter or in the sun. Fungal growth is common in the heaps during drying. When the grain has dried, it is threshed from the grain heads using sticks or by cattle trampling. This is inefficient and causes loss of valuable grain.

3.3 Mechanical threshing in rural areas is unknown, though the Institute for Agricultural Engineering have experimented with a petrol driven commercial thresher which could be towed by vehicle or animal cart from farm to farm within a District. However, the likely high demand for such a service only during the harvest season suggests that without high investment by an external service company, this service may not be sustainable.

3.4 Improved threshing technologies, which will reduce losses after harvest, while reducing labour inputs, are necessary for grain separation and cleaning prior to use or storage. However, for small scale threshing to be effective, it will be necessary to store grain on the panicles for threshing as and when required. This may necessitate a change to traditional storage practices.

Grain transport and marketing

3.5 Liberalisation of the grain market has given the opportunity for private traders to compete with the Grain Marketing Board (GMB) for the purchase of all types of grains from farmers. Although GMB do not provide transport of commodities from farm to depot, private transport is available to collect grain from farms and deliver it to depots for sale or processing. The rate within an approximate 70 km radius was Z$5 per 55 kg bag irrespective of distance. Lorries can carry about 500 bags by collecting only 5 bags or so from each farm, hence there is a high transport cost in completing a full load. Animal drawn scotch carts tend to be used for distance up to 10 km.

Maize prices:

3.6 GMB were offering Z$ 60 per 55 kg bag ($1.09 /kg) and payment within 21 days. However, payment is invariably late and may take up to 3 months. Under these conditions many farmers are accepting $45 per bag ($0.82 /kg) as immediate cash payment from private buyers. The final price will be dependent upon the grade, but it does include the $5 charge for the bag.

3.7 Some farmers obtain seed maize from the GMB loan scheme, but they are often reluctant to sell the harvested grain to GMB in the following season because the amount owing will be deducted before final payment is made. As a consequence, farmers are prepared to accept a lower payment per bag from private traders.

Sorghum and millet prices:

3.8 GMB prices for white sorghum and millet were $900 per ton whereas Chibuku Brewery were offering $1200 for red sorghum on contract. However, farmers were required to deliver their grain to Harare or other major centre.

Dehulling

3.9 There are many varieties of sorghum and millet, all of which have a bran coat (pericarp). The bran gives a coarse texture to meals prepared from whole grains and is traditionally removed from the grain kernel by the arduous process of pounding. Some varieties of sorghum - the red sorghums - have an unpalatable highly pigmented tannin-containing testa layer just beneath the pericarp. The astringency of the tannins gives red sorghum considerable resistance to bird attack, but makes it unpalatable for meal production. Tannins can complex with grain proteins to lower their digestibility, stain the meal pink/brown and give a bitter taste to the meal. Traditionally the red sorghums are used for brewing where the tannins give colour and flavour to the beers. The less bird resistant white varieties are grown for food use.

Manual dehulling
3.10 The manual pounding of small grains for the removal of the bran coat is energy and time consuming. Small grains are dehulled by pounding at the rate of about 20 litres (16 kg) per batch which is sufficient for a family of 12 for 3 days. Time taken for this activity depends upon the skill and persistence of the operator, and the variety of grain, but it will take more than an hour just to dehull about 15 kg of grain. To pound this quantity of dehulled grain to a meal will take a further 3-5 hours. Pounding is said to be the hardest work of all for rural women. Some women still use stones for grinding.

Motorised dehulling
3.11 During the last 10 years motor powered friction dehullers with a throughput capacity of approximately 400 kg per day (120 tons /year) have been introduced within the SADC region. In Zimbabwe for example, frictional dehullers have been installed at more than 100 hammer mill locations within the country. However with approximately 2,600 hammer mills in semi-arid regions IV and V of Zimbabwe, it is clear that for many rural people, dehulling technology is unknown or unavailable because their farms are beyond the accepted walking distance for taking grains for processing.

3.12 The introduction of dehullers has been considered effective in areas where there are adequate quantities of sorghum and millet. The NGO ENDA Zimbabwe has been the primary proponent of the dehuller in Zimbabwe, and has provided good support to business entrepreneurs on their use and maintenance.

3.13 Many dehullers were sold to entrepreneurs at a subsidy in order to evaluate the technology. However, the transfer of dehuller production from NGO to commercial manufacturer has resulted in a doubling in machine price and a significant decline in demand.

3.14 Discussions with rural women using dehuller services indicated that they will walk up to 4 km each way to a hammer mill and 6 km to a dehuller, carrying about 16 kg of grain on their heads once or twice per week, depending on the size of the family. Some women walk much further distances. Larger quantities are moved by donkey, cart or wheelbarrow. Others brought their grain for processing by bus.

The charges made for dehulling and grinding are fairly consistent as indicated in Table 2.

3.15 Dehullers tend to be most in demand when crop yields are good. Business is slower in drought periods when food is in short supply and the demand is for 100% meal. Although developed for dehulling of small grains, dehullers have been very effective at de-braning maize prior to hammer milling to meal.

The extent of bran removal during dehulling is variable from 15-25% depending on the variety of grain, the state of repair of the dehuller and the dwell time of the process.

3.16 All of the dehullers work on a volume basis, and none appeared to have calculated the cost effectiveness of the process for converting grain to meal.

At the time of the visit the prices of commercially milled maize mealy meals in business centre towns were:

Roller meal (80% extraction) $35 / 20 kg bag = $1.75 /kg (Mutoko)
Roller meal (80% extraction) $ 40 / 20 kg bag = $ 2.0 /kg (Buhera)
Refined meal (70% extraction) $50 / 20 kg bag = $2.5 / kg (Mutoko)

The equivalent cost of rural processing of sorghum to meal of 80% extraction is estimated to be $1.51/ kg (See Appendix 1)

3.17 Since customers tend to equate the quality of dehulled and milled small grains with roller maize meal, they perceive that rural processing gives a product which is lower in price than the equivalent maize product. In reality the calculations indicate the efficiencies of large scale milling in that the mill has paid transport costs on maize purchased from commercial farm or store to mill, processed the maize, packaged and transported it to rural areas and given a margin to the rural store holder and possibly an intermediate wholesaler at a price which is competitive to what rural processors can achieve with no transportation, wholesale or retail costs.

3.18 Nevertheless, for those women within travelling distance of a dehuller, and with cash to hand, there was a preference for well-dehulled and milled grains in place of hand pounded and stone ground meal. However, for the majority of the rural population in sorghum and millet regions, dehulling by machine is not possible, and dehulling by pounding is therefore the norm. Where available, mechanical dehulling has given options for improved flour quality to growers of sorghum and millets, but for the majority of families without access to this technology, alternative, less labour intensive, household level dehulling technologies would be beneficial.

Table 2: Variability in dehulling and milling charges by processor.

	Kowo Township Mutoko	Buhera Region IV business centre	Buhera District Region V business centre	Chivi District business centre
Unit type	Dehuller + hammer mill driven from single diesel engine	Dehuller + hammer mill driven from single diesel engine	Dehuller + hammer mill driven from single diesel engine	Dehuller and hammer mill driven from single electric motor.
Comment	Operating for 2 years without disc breakage. About 1 in 6 batches are dehulled.	With new stones the dehuller can dehull 20 litres in 2.5 mins. With worn stones 8-10 mins.	Dehulling takes approx. 3 minutes for maize and 2 minutes for pearl millet per 20 litre tin.	Owned by 7 women.
Product milled	Maize	Small grains 70% Maize 30%	Pearl millet 75% Sorghum 18% Maize 7%	Maize 60% Sorghum 30% Pearl Millet 40%
Mill screen size	No1.	No 1	No 1	
Hammer mill only	$4 per tin (approx. 20 litres)	$4.0 per tin	$4.5 per tin	$2.0 per tin
Dehull only	4$ per tin	$2.5 per tin	3.5 per tin	$4 per tin
Dehull + hammer milling	$6.50 per tin Bran retained by miller	$6.5 per tin Customers can take or leave bran.	$7.0 per tin Bran retained by miller	$6.0 per tin Customers can take or leave bran. Most leave it.
Notes	Maize bran sold to poultry and pig units @ $10/tin Whole sorghum is milled twice.	Bran sold at $6 /tin	Bran sold at $2 /tin to pig producers	Bran sold for $7 per tin to poultry producers.

Mycotoxins

3.19 It is not feasible to consider processing technologies for grain without reference to the organoleptic and mycological quality of the original grain. The first defines quality in terms of its use, the second in terms of its impact on health. Drought stressed grains are known to be susceptible to fungal attack and the development of fungal toxins (Lisker and Lillehoj, 1991). The risks of toxin ingestion by people consuming such grains, and who may be of marginal nutritional status should be evaluated. The impact of grain processing technologies and in particular, dehulling, which could have an impact on levels of fungal toxin ingestion requires detailed investigation.

Bran for livestock feed

3.20 Within the context of maximising the utilisation of nutritional sources within the household, the potential for using sorghum and millet brans in simple, rural diets for poultry also requires investigation. This work will complement poultry feeding studies conducted under projects C0633 and O0053. The use of grain and grain by-products are discussed in more detail in Section 5.

Potential nutritional deficiencies through dehulling

3.21 The dehulling of cereal grains has both positive and negative aspects which need to be balanced. The dehulling of grains removes the fibrous bran and grain germ which results in the production of a white flour with improved shelf life and organolepic properties. In contrast, debraning may significantly decrease the vitamin B complex content of meals, and the fibre level in the diet. The reduction in fibre intake can have a long-term effect on intestinal function, and may induce diseases such as cancer of the colon and diverticultis. These are considered as dietary diseases caused by the consumption of refined foods which are low in dietary fibre. Opportunities for adding back bran into the diet and /or enhancing milled flours with sources of B vitamins requires investigation.

4. OILSEEDS PROCESSING - CURRENT SITUATION

4.1 Groundnut and sunflower seed are important crops within the farming system (Table 1). Sunflower is grown as a cash crop for oil extraction by commercial processors, while groundnuts are for domestic consumption and /or sale as whole nuts, or as rurally processed peanut butter.

Sunflower seed

4.2 Before market liberalisation almost all of the national sunflower crop was marketed through the Grain Marketing Board (GMB). Rural farmers sold their crop to GMB for cash, while retaining sufficient open pollinated seed in stock for the next season's planting. The culinary oil market was therefore controlled by GMB and the commercial oilseed crushers. However, under the liberalised market, rural processors have had the option of selling to GMB, direct to processors or to intermediate traders, or to retain seed on farm for domestic crushing. Hybrid seeds with high levels of oil are slowly becoming available for planting though shortages in supply are common place.

4.3 Sunflower hybrids SV1 and SV2 are being introduced but many farms have mixed varieties in the field. Farmers do not necessarily buy new hybrid seed each year, hence by replanting seed there is a regression in oil content with each replanting.

Cooking oil

4.4 All rural households use cooking oil and the purchase of commercially refined oil from township shops can absorb a high proportion of rural household expenditure. In a recent national household survey 92% of respondents claimed that they could not afford to buy their full requirement of cooking oil. Consumption patterns for vegetable oils are not known, but local NGOs indicated that consumption of 1.5 -2 litres of oil per month per family (say 24 litres per annum) would not be an unreasonable estimate.

Options for obtaining culinary oil

4.5 Currently there are three options available to rural people for obtaining oil for human consumption. These are:

- sale of seed to commercial crushers and purchase refined oil from the village store
- purchase ram pressed oil from the village market
- home grown or purchased seed taken to a ram press for oil extraction according to service fee
- purchase a ram press and crush home grown seeds and those of neighbours

Apparent cost savings to the rural household by oil extraction by the ram press for the production of culinary oil are presented in Appendix 2. The technologies available for oil extraction are discussed below.

Technologies available for oil extraction

4.6 Since 1989 a local NGO (Zimbabwe Oilseed Project) has been promoting a small manually operated lever press (ram press) for use at village level. In 1996 the ram press was sold for Z$2,500 (£150), but even at this price the technology was beyond the purchasing capacity of almost all rural families. Ram press owners tend to be business entrepreneurs offering an oil crushing service, or small co-operatives or women's groups crushing their own seeds to generate oil for sale in local markets. Some women's groups have up to 80 members each contributing to the purchase and running of a single press and marketing the oil.

4.7 Each press can process 5-10 kg seed per hour, each 10 kg of seed yielding 1-2 kg of oil depending on seed variety and design of press. Although the ram press has given options for the use of seeds in many communities, it is fairly arduous to use and extracts around 50 - 60% of the oil from unimproved seed (containing 20-25% oil) or hybrid seed (containing 40-45% oil). The remaining oil within the fibrous and proteinaceous press cake is fed to livestock, though the real feeding value of the oilcakes is still under investigation.

4.8 Ram press owners sell their product just below the village shop retail price which is a sufficient market incentive for local sale. In November 1996 ram press oil was being sold at Z$15.3 per litre. Commercially refined oil was available in township stores at Z$17 per litre. Some entrepreneurs buy clean new plastic bottles and labels from suppliers, whereas many buy old bottles from children, wash them and fill with oil. Some women bring their own bottles or containers. The apparent savings to the rural household by oil extraction by ram press for the production of culinary oil are presented in Appendix 2.

4.9 However despite the existence of approximately 3000 ram presses in the country (equivalent to approximately 1 press per 2,700 members of the rural population, though the number operating is uncertain) there are many rural households with no knowledge of this technology. These families have no access to alternative domestic oil extraction technology, and must sell their seed to traders and purchase refined oils from township stores which may be many kilometres from their village.

4.10 Although the ram press has given considerable freedom to those with access to the technology to obtain oil from their own seed, there is apparent potential for realising a greater income (or conversely a greater saving) for the rural family if improved, alternative low cost technologies were available for use at the domestic level. The technology must produce a greater output of oil with a quality equivalent to, or better than, mechanically expressed oil.

Groundnuts

4.11 In areas where groundnuts are available, women roast and then pound the shelled nuts into a paste or peanut butter that is used as an alternative to oil for cooking relish. The recent agricultural price liberalisation has encouraged an increase in groundnut production and increased the volume that is available for sale. The University of Zimbabwe Development Technology Centre has begun preliminary field testing a manually operated peanut butter making machine that is affordable in rural areas. Initial trials have been encouraging in terms of both technology adoption and marketability of the produce with requests from women's groups for access to further machines.

4.12 The sale of peanut butter to nearby rural centres and further afield offers great potential as an income generating activity, though good hygienic manufacturing practices must be introduced and maintained.

4.13 In rural communities, groundnuts are probably the major source of high quality protein, and peanut butter has a key place in the diets of children. Under Zimbabwe food legislation, groundnuts for export sale or for use in foods must be tested for aflatoxins. Pre-harvest contamination is associated with drought stress in groundnuts, maize and possibly sunflower. However, post-harvest contamination is also possible if harvest coincides with rains, and could be the major factor for mycotoxin development even in semi-arid regions. A survey of potential levels of aflatoxins in regions IV and V groundnuts and peanut butter is essential if strategies to combat the problem are to be realised.

4.14 Although groundnuts can be pressed for oil using a ram press the extraction rate is lower than that for sunflower, and the nuts have a ready market for sale.

5. LIVESTOCK IN THE SEMI-ARID REGIONS

5.1 A detailed study of the livestock sector was beyond the remit of this rapid survey. However, within the rural communities cattle play an important part in the cropping system due to their dual purpose; for draught power and as a supplier of milk. Some homesteads may keep a few scavenging poultry. The availability of grazing and forage material for cattle varies with the season with the most critical shortages occurring at the end of the dry season and the early part of the rainy season. Effective fodder conservation and the use of home produced by-products from oilseeds and grains could improve milk output, the nutritional status of the stock, and their effectiveness as draught animals.

5.2 Non-stover feeds for ruminants are also essential ingredients of poultry rations for meat or egg production. If ingredients are in short supply, they may be better utilised in a well-managed poultry unit than being fed to cattle.

5.3 New information on the potential use for these raw materials will increase the number of options available to rural farmers concerning cash generating opportunities and improving the nutritional status and food variety available to the household.

5.4 It is recommended that livestock studies are considered against the findings of first stage dairy and poultry trials being conducted by NRI in collaboration with Henderson Research Station, Mazoe (Project O0053).

6. PROPOSALS FOR NEW RESEARCH

a) SMALL GRAINS

Proposed Research Activities

1. A review of the human work input by rural women to undertake traditional technologies of threshing and dehulling by pounding; and an evaluation of the magnitude and opportunity cost of work saved through the use of friction dehulling technologies currently available in Zimbabwe.

2. The design and testing of prototype technologies (non-motorised) for small grain threshing, and an evaluation by rural women on the effectiveness of prototype technologies to meet their perceived or real needs. To be conducted jointly between the design and build specialists at NRI and UOZ.

3. Laboratory investigations into the ways by which the pericarp and testa layers are bonded to the grain kernel and thus to elucidate potential enzymic mechanisms for pericarp and testa removal at rural level. To include:

- Laboratory and field investigations into the effectiveness of commercial enzyme systems on grain dehulling, and their evaluation by rural women.

- Laboratory investigations of sources of enzymes of potential availability to rural farmers, the mechanisms for their production, extraction and use. These studies will call upon the indigenous knowledge of local people and include health and safety aspects of extraction and use of crude enzymic extracts.

4. Investigations of the extent of mycotoxin contamination of rural grains and their potential impact on consumer health. In particular to investigate levels of mycotoxins in small grains grown at harvest (with normal and drought stress histories), after post harvest handling, and at the time of utilisation. Also to study the partition of mycotoxins between the bran and grain kernel when the grain is dehulled by friction or enzymic methods.

5. Investigations of the nutritional impact of dehulling on the dietary intake of B vitamins, vitamin E and essential fatty acids present in the bran and germ of grains.

Outputs

1. An analysis of current processing technologies for small grains and their impact on women's food processing work-load reviewed; their limitations to alleviating arduous work identified.

2. Innovative, low cost, non-motorised, threshing technologies developed for use by rural farmers. Technologies are for small grains but with adaptability for other on-farm crops requiring separation from a grain head - e.g. sunflower and groundnut

3. Knowledge of the mechanisms whereby the grain pericarp and testa are bonded, and the mechanisms for their separation. Guidelines on the technology for, and safety measures to be adopted, for the enzymic dehulling of sorghum and millets.

4. Indicators of the possible extent of mycotoxin ingestion by rural people from small grains and the potential for reducing the risks of ingesting fungal toxins present in small grains through the use of dehulling technologies.

5. Knowledge of the potential nutritional deficiencies which could occur through the introduction of technologies for improving the organoleptic qualities of small grains.

b) OILSEEDS

Proposed Research Activities

1. A qualitative and quantitative field survey of dietary habits involving oilseeds, farming patterns and market opportunities for rurally grown oilseeds and processed oils. The survey will build on the wide experience of UOZ and ITDG in conducting rural surveys.

2. Investigations of the principles of sunflower dehulling as applied commercially and the adaptation of these principles into a pilot scale dehuller. To be conducted jointly between the design and build specialists at NRI and UOZ.

3. Laboratory studies of the conditions under which cellulolytic and proteolytic enzymes break down the cellular structure of indigenous and hybrid oilseeds to release oil, and methods for protein recovery for use as human food. To include:

- Laboratory and field investigations of indigenous sources of enzymes of potential availability to rural farmers, the mechanisms for their production, extraction and use. These studies will call upon the indigenous knowledge of local people, the use of a diverse range of biological materials and include health and safety aspects of extraction and use of crude enzymic extracts.

- Laboratory and field investigations into the effectiveness of such enzyme systems on sunflower oil extraction and protein recovery and their evaluation by rural women.

- Laboratory and field studies on the quality and shelf-life of enzyme extracted sunflower oil.

4. Mycotoxin studies

- Field and laboratory investigations into the mycotoxin contamination of sunflower in drought prone, and non-drought regions and the effect of dehulling and oil extraction on mycotoxin ingestion.

- Investigations into the magnitude of mycotoxin levels in groundnut kernels harvested in drought-prone and non-drought regions, in peanut butter produced by rural processors for sale, and storage trials of peanut butter produced and stored, and sold under current practices.

5. With a preoccupation for the use of sunflower for oil extraction, the nutritional benefits of sunflower protein for the human population have been overlooked. In Zimbabwe there appear to have been few or no indigenous traditions for the use of these seeds as foods. Since the mechanical extraction of oil normally requires the presence of the pigmented fibre fraction to improve the efficiency of oil release, the press cakes tend to be high in fibre, black in colour and unpalatable as human food. There is therefore, a need to develop simple non-motorised dehulling technology

would yield a fresh, white seed, low in fibre which could be consumed as a valuable food *per se*.

Outputs

1. Recommendations on the use of oilseed oils and proteins in the diets of rural populations in semi-arid regions.

2. The design of a simple non-motorised sunflower dehuller for use by individual families with capacity to dehull 10 kg of seed in one hour i.e. to provide seed containing 2-4 kg of oil, depending on variety.

3. Enzymic / biotechnology methods adapted for use in rural semi-arid communities which will maximise oil recovery and yield good quality protein for human diet supplementation.

4. Knowledge of the levels of mycotoxins in groundnuts produced in drought-prone regions, including:

- how these levels may change during production and storage of rurally produced peanut butter,
- the partition of mycotoxins in sunflower seed during dehulling, oil extraction and protein recovery.
- knowledge of the criteria for processing peanut butter, and recommendations for good storage practice for retaining quality during storage and sale.
- recommendations on processing and storage of sunflower and groundnut to minimise mycotoxin contamination in products.

5. Simple technology for the rural dehulling of sunflower seed and knowledge of the use of sunflower kernels to improve the nutritional status of rural people.

c. LIVESTOCK

Proposed Research Activities

These are presented against the concept of improving on-farm utilisation of home grown crops which are sustainable under semi-arid production systems.

1. Utilisation of whole crop and crop by-products for sustainable livestock product output. For ruminants and poultry these should include the evaluation of feeding systems based on all or some of the following:

whole crops/ stovers / processing by products/ whole grains / whole oilseeds.

These could be conducted firstly as desk exercises, and later by confirmatory field trials against know economic, market and price constraints.

Outputs

1. Knowledge of practices for the most cost effective crop utilisation system(s) for livestock production under different levels of animal product output.

2. Options on the livestock carrying capacity, and possibilities for income generation by farms in relation to their crop production potential.

3. Knowledge of the criteria by which rural farmers prioritise crop production between food, livestock and cash generation under different climatic or economic constraints.

Contribution of Outputs

The outputs will give rural people, and women in particular, choices for the processing of their grains and oilseeds and the use of their time and work effort in supporting the needs of the family. The outputs will also give new insight to rural peoples, planners and NGOs into the nutritional status of village communities and the opportunities to a) improve nutrition through grain processing and village poultry production from grain and oilseed by-product utilisation; b) increase the income generating opportunities for the family; c) enhance the nutritional status of rural diets.

Beneficiaries

The target beneficiaries are rural women many of whom provide the major labour inputs into grain and oilseed harvesting and processing, and looking after household livestock, while male members of the household are seeking alternative work outside of the village community. The technologies will be designed for individual or village group use.

The project does not seek to undermine the benefits which are being provided to communities through business centre friction dehullers or ram press entrepreneurs, but to build on the known demand for technologies to alleviate the work burden of rural women.

However it is also recognised that technologies which are proven to work at rural level may also have application at larger scales of processing, or livestock production, and thus be of benefit to all scales of grain and oilseed production and processing under semi-arid conditions.

Target Institutions

The main potential collaborating institutions are ITDG Zimbabwe, the Development Technology Centre (DTC) at the University of Zimbabwe, and Henderson Research Station, Mazoe, Zimbabwe. Excellent relationships have already been established and both institutions have participated in the compilation of this concept note. Other institutions will be involved in target districts, including DRSS, AGRITEX (the Government extension service), the Zimbabwe Women's Bureau (ZMB) and other

NGOs. An interesting possibility is through the AGENT programme operated by CARE - 50 agents have been identified in rural areas (forecast to rise to 400 by the end of 1997) to act as suppliers of agricultural inputs to farmers, and could be used to test the acceptability of new technologies and livestock production practices.

Risks and Assumptions

1. Women are open to studies of their working practices without inhibition, and will wish to feel part of the research programme.

2. That technologies can be developed, which may not be as efficient as large scale ones, but are cost effective for use by an individual family or small rural community,

3. That sources of safe, enzyme culture systems can be identified or developed for use as 'starter cultures' which do not have deleterious impact on the nutritional or organoleptic quality of the grain kernel or oilseed.

4. That there are no cultural problems associated with biotechnology systems; that the work effort involved in the new technology and the costs of using it are lower than for current technologies, and the quality of the final product is equal or better than the traditional product..

4. That rural livestock farmers are willing to use their livestock to evaluate the nutritional and economic performance of grain and oilseed by-products and be prepared to use recommended cattle and poultry husbandry and feeding systems.

5. That rural families will be willing to provide (with compensation) their food crops for research, and analysis from harvest to utilisation.

7. REFERENCES

Bruinsma D (1996) Review of food processing practices and opportunities in Africa - cereals, root and tuber crops. CTA Technical Centre for Agricultural and Rural Co-operation.

Lisker, N and Lillehoj EB (1991) Prevention of mycotoxin contamination at the preharvest stage.

Mazvimavi, K (1996) An overview of sorghum and millet production and utilisation in Zimbabwe's semi-arid smallholder sector.

Masendeke, A (1996) Oilseeds in Zimbabwe - a review of current knowledge and issues, ITDG.

8. APPENDICES

Appendix 1.

Apparent savings to the rural household by dehulling and hammer milling small grains for the production of porridge meals.

Conversion factors:
1 tin is approx 20 litres
Bulk density of maize is about 720 g/litre; sorghum and millet about 850 g/litre; bran fraction about 210 g/litre.
Hence 20 litres of grain is approx 16kg and 20 litres of bran approx 4.2 kg.

Converting charges from volume to weight:

Hammer milling costs average $3.6 per 16 kg =	$0.23 /kg
Dehulling costs average $3.5 per 16 kg =	$0.22 /kg
Dehulling + milling (after dehulling) $6.5 per 16 kg =	$0.41 / kg
Average selling price of bran = $6.25/ 20 litres (4.2kg) =	$1.5/ kg
Average value of sorghum = $820 / ton =	$0.82/kg

If 1 kg grain = 0.8 kg dehulled grain + 0.2 kg bran
then the consumer is being charged $0.41per 0.8 kg meal = $0.51/kg meal. She is also giving away $0.3 worth of bran (0.2 x $1.5/kg) to the miller.

If the domestic grain has a value of $0.9 per kg and 1.25 kg grain are needed to produce 1kg meal, then the dehull and hammer mill meal of 80% extraction has a value of $ (1.25 x 0.82) + (1.25 x 0.41) = $1.54 / kg.

At the time of the visit the prices of maize mealy meals were:

- Roller meal (80% extraction) $35 / 20 kg bag = $1.75 /kg (MUTOKO)
- Roller meal (80% extraction) $ 40 / 20 kg bag = $ 2.0 /kg (Buhera)
- Refined meal (70% extraction) $50 / 20 kg bag = $2.5 / kg (Mutoko)

Since customers tend to equate the quality of dehulled and milled small grains with roller maize meal, they perceive that rural processing gives a product which is lower in price than the maize equivalent. In reality the calculations indicate the efficiencies of large scale milling in that the mill has paid transport costs on maize purchased from commercial farm or store to mill, processed the maize, packaged and transported it to rural areas and given a margin to the rural store holder and possibly an intermediate wholesaler at a price similar to what rural processors can achieve with no transportation, wholesale or retail costs.

Appendix 2

Apparent savings to the rural household by oil extraction by the ram press for the production of culinary oil.

1. Sale of seed and purchase of bottled oil:

The yield of sunflower seed from a typical 0.2 ha land allocation from the family plot would yield approximately 120 kg of seed, which if sold to the traders or the Grain Marketing Board would generate an income of 120 kg x Z$1.75/kg = Z$210 per annum. This quantity of seed contains approximately the annual requirements of oil for the family. Since the rural family is unable to extract the oil domestically, then the expenditure for obtaining an equivalent amount of oil would be 24 litres x Z$ 15.3 /litre = Z$ 367 per annum. i.e. an expenditure of Z$ 157 per annum more than the income form the sale of seed.

Since the Grain Marketing Board and traders offer the same price for open pollinated (20% oil content) and hybrid seeds (40% oil content) there is no stimulus for the rural farmer to grow the higher yielding varieties, even if they were available on demand, unless they wished to extract the oil for sale or home consumption.

2. Oil obtained through the service crushing by a ram press owner.

If the seed were taken to a ram press for oil extraction, the charges for extracting the oil from home grown seed would be 120 kg x crushing charge of Z$ 0.83 /kg = Z$ 100. The cake is retained by the ram press operator. Since the ram press owners are extracting only 50% of the oil, then 120 kg of farmers seed would yield approximately 12 litres of oil. The balance of oil for the year (say 12 litres) would require to be purchased on the open market at 12 litres x Z$ 15.3 / litre = Z$184. The total expenditure for obtaining the annual requirements for cooking oil would therefore be Z$ 284, or $ 74 more than the income generated from the sale of the seed.

Into this calculation must be brought the value of the ram press cake for sale as a livestock feed, or for use in the household as a livestock feed.