Research and Development Issues in Grain Postharvest Problems in Africa

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GASGA - the Group for Assistance on Systems relating to Grain After-harvest - is a voluntary association of organizations primarily linked with donor operations.

These organizations all have major involvement in most, if not all, off the following:

- the provision of professional advice)
- the conduct of field projects;
- the training of developing country personnel;
- and the conduct of research and its application in relation to the problems of the postharvest sector of the production of grain and other major food commodities in developing countries.

The association is essentially technical; it is international in character, but informal and limited in membership, so that its deliberations, aimed at the specific objectives indicated below, can take place readily.

GASGA consists of the following organizations:

- Australian Centre for International Agricultural Research, Canberra, Australia (ACIAR)
- Centre de Cooperation International en Recherche Agronomique pour le Developpement, Montpellier, France (CEEMAT/CIRAD)
- Deutsche Gesellschaft fur Technische Zusammenarbeit GmbH, Eschborn, Federal Republic of Germany

(GTZ)
- Food and Agriculture Organization of the United Nations, Rome, Italy (FAO)
- Food and Feed Grain Institute, Kansas State University, Manhattan, Kansas, USA (KSU)
- International Development Research Centre, Ottawa, Canada (IDRC)
- Koninklijk Instituut voor de Tropen, Amsterdam, The Netherlands (KIT)
- Overseas Development Natural Resources Institute, Chatham, England (ODNRI)

GASGA aims to stimulate improvement in the technical help given to developing countries in the postharvest handling, processing, storage and transport of grain, and to harmonise activities so that the most effective use is made of members" resources. GASGA seeks to identify and suggest ways of meeting needs for research, development, training and information in this subject field, in the light of existing or planned operations by GASGA members and other organizations.

The Group is also prepared to answer requests for technical advice put to it by developing countries.

GASGA also seeks to facilitate the appropriate dissemination of information about technical developments and activities in the postharvest sector to donors, developing countries, and other interested organizations. The last group includes, for instance, the International Agricultural Research Centres whose commodity-oriented preharvest programs need links with postharvest activities and requirements.

The GASGA Executive meets annually to review progress in its activities and discuss proposals for future work.

Since the 19th Executive Meeting, held at Feldafing, West Germany, a technical seminar has been held in association with the annual meetings and the papers presented at the seminar published in the GASGA Executive Seminar Series.

The Role of Small Grains in Food Security in Marainal Rainfall Areas of Zimbabwe

S.C. Muchena Ministry of Lands, Agriculture and Rural Resettlement Zimbabwe

Agriculture in Zimbabwe falls into two major sectors, the commercial, comprising 4800 large scale farmers who, (including some smaller scale commercial farmers) occupy 39 % of the available agricultural land. In addition their labour and dependents (a total of 1,7 million people) live here. The remaining agricultural land is occupied by approximately 800000 communal farmers and the bulk of the rural population, of approximately four million.

Land in Zimbabwe falls into one of five agroecological zones, originally delineated by Vincent and Thomas in 1961, designated Natural Regions I to V in descending order. A major criterion for the differentiation between natural regions is the amount and distribution of the rainfall through the unimodal rains. Region III receives between 650 and 800 mm of rainfall a year, but temperatures are high and fairly severe mid season droughts are common.

You will see, from the following table that the majority of communal land falls into Regions III, IV and V which, bearing in mind the above comments on these agroecological zones and the proportion of the population who win their living from the soil in communal areas, indicates the importance of agricultural production systems which are relatively drought tolerant, to the property of Zimbabwe.

Distribution of Agricultural Land by Natural Region Percentages

Proportion of Land

Natural Region	Commercial Farming %	Communal Area %
I	3	1
II	27	8
III	22	17
IV	26	45
V	22	29
	100 Equals 39 % of Agricultural Land.	100 Equals 61 % of Agricultural Land.

ICRISAT has characterised land which receives less than 600 mm of rainfall, unevenly distributed, as semiarid. Ninety one percent of communal areas in Zimbabwe fall into this category and enjoy the associated depression in their crop yields.

Such effects are especially felt if they impinge on flowering of crops, particularly maize, where non synchronous pollen shed will cause total crop failure.

In recent times there has been a trend in Zimbabwe, and indeed in most SADCC Member States, away from the traditional intercropping and rotating of up to six or ten crops (including drought tolerant cereals) towards hybrid maize production. This reduction of crop diversity has had a pronounced effect on the farmers

ability to survive adverse conditions by increasing the risk of total crop loss. The availability of improved hybrid maize varieties and the chance of exellent yields in good circumstances has lead to maize encroaching into areas traditionally producing sorghum and millet. Table 2 below exemplifies the last ten years of a much greater trend by looking at cropping patterns in Chibi communal area from 1974 to 1985.

Crop	1974/75			1984/85		
	Area Ave.ha	Total ha(%)	Farmers Growing(%)	Area Ave.ha	Total ha (%)	Farmers Growing (%)
Maize	1.15	42.3	93	1.27	59.3	100
Groundnuts	0.46	17.1	74	0.28	12.9	69
Sorghum	0.31	11.3	43	0.09	4.2	30
B R Millet	0.30	11.3	37	0.07	3.4	15
F Millet	0.29	10.6	61	0.25	11.6	70
Roundnuts (Bambara)	0.12	4.4	46	0.14	6.4	78
Other	0.05	3.1	36	0.05	2.3	36
Total	2.68	100.1		2.15	100.1	

A major effect of the trend towards maize planting in communal areas has been to reduce household food security. Bearing in mind the fact that the majority of communal areas are in Natural Regions III, IV and V with their lower and less well distributed rainfall, farmers obtain good yields in good years but nothing in poor years. Meanwhile those farmers continuing to plant small grains would receive less yield in good years, while

they get something in poor years. Their food security is greater.

In support of farmers' preference for taking the greater risk of planting hybrid maize there are the following factors;

I. **it is substantially less susceptible to bird damage**
II. **it is relativley more palatable and digestible**
III. **it is more versatile in terms of utilization**
IV. **it has enjoyed well developed pre and post production infrastructure.**

On the other hand the small grains are relativley poor yielding. They had not received much attention in terms of genetic improvement. In fact, I initiated the first ever pearl millet improvement programme in Zimbabwe in 1977, and the materials introduced and selected are only just beginning to trickle into the farmers fields in Zimbabwe.

In addition, small grains are often severely subject to bird damage, (losses of up to 50 % are not uncommon), and require more preconsumption processing than maize. The majority have a fibrous and highly coloured pericarp which causes off colours and tastes if they are included in flour. Perversely, those varieties with the greatest problems of this nature are also least prone to bird damage. Birds don't like off tastes either. Processing small grains to remove the hull by traditional pestle and mortar methods involves between two and five hours labour per 20 kgs, depending on variety and other factors.

If we look at the rainfall pattern in Zimbabwe since 1980 you will see that there are farmers who have only one good year this decade. Considering my earlier comments on the population distribution and agroecological zoning in Zimbabwe the message for the improvement and dissemination of small grain production is loud and clear.

1980/81	Very good rainfall
1981/82	drought
1982/83	drought
1983/84	drought
1984/85	fair
1985/86	fair
1986	drought

Government policy recognises the significance of food security such that Zimbabwe brought sorghum and millet into the formal marketing system for the first time in 1985. This meant that, for the first time, there was a guaranteed market price for these grains and the mechanism for selling them to the Grain Marketing Boards was available for these commodities. In consequence the Ministry of land, Agriculture and Rural Resettlement is now faced with small grain stocks of 190 000 tonnes costing Z$ 5 million per annum to hold.

While the existence of the stockpile of small grains and the much greater stocks of maize testify to the self sufficiency of Zimbabwe in cereal production, there are still geographical areas where people do not produce enough, or earn enough to have access to adequate food. Thus, while the country was in surplus to a considerable extent it was necessary for Government to provide drought relief feeding for 500000 people in Region IV and V areas last year. While national food self sufficiency has been attained household food security, (the availability of and access to adequate food), remains a major concern. It could be argued that a fair proportion of the expenditure incurred for the drought relief exercise, which has been undertaken to a greater or lesser extent almost every year for several years, could be saved were people in those drought prone areas able to improve their food security. The planting of crops more likely to produce reasonable yields, such as sorghum and millet is one thrust which could help.

Since Independence government has taken several initiatives to improve household food security amongst peasant Farmers. The Department of Research and Specialist Services, in conjunction with ICRISAT in their SADCC regional programme, has enhanced its research into producing drought tolerant, disease resistant and higher yielding sorghum and millet varieties. This work has been rewarded by the release of several superior varieties of both sorghum and millet.

To address the laborious traditional processing requirement of small grains Government has begun a collaborative project with the Canadian International Development Agency through a non government organization, ENDA Zimbabwe, to introduce the dry abrasive dehulling technology by RIIC with IDRC assistance in Botswana, which you will hear described in a subsequent paper by Ozzie Schmidt.

Our project will build upon the experience and information gained by introducing four test dehullers, and will see a further forty machines installed in suitable areas, the aim being to establish a self sustaining small grain milling industry. The intention is to thereby, enhance utilization of small grains, and to improve both national and household food security.

Considerable valuable work has been undertaken in recent years on in-field water harvesting techniques aimed at making better use of what precipitation is available, while not adding unduly to the tillage costs involved.

While I have described, briefly, the work, and outcomes of the work which has been undertaken with small grains in Zimbabwe, it is my belief that there is considerable additional work needed in the home economics area to bring small grains, and small grain products, to greater prominence in the daily diet of Zimbabweans.

We have done some work with blended flours but there is considerably more scope for additional product development which will increase the market for small grains. If the market for small grains can be widened then greater incentives can be offered to farmers in the areas most suited to production of small grains to

redouble their efforts. If we can achieve this objective we will, at once, be improving the food security of people in marginal rainfall areas and broadening the spectrum of foods which Zimbabweans eat and enjoy through bringing otherwise marginal land into more productive use. As the Nigerians say, 'one should laugh with the teeth he has, even if they are few'.

Zimbabwe: Altitude and annual rainfall

Zimbabwe: Land tenure and natural regions

Zimbabwe: Natural regions

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Sorghum and Millet Processing and Utilisation in the Southern Africa Development Coordination Conference Area

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Introduction

The pricipal staples consumed in the Southern Africa Development Coordination Conference (SADCC) region are cereals, a region in which 63,7 million people live deriving their main sustenance from a gross land area of 477,1 million hectares. Of the gross land area 385 million hectares find some agricultural use (see Table 1 below) and of that agricultural area roughly 40 %, or 185 million hectares, receive less than 600 mm of rainfall. If we assume that 80 % of the population are directly (Table 2) employed using agriculture as their means of employment (50,6 million) and that the more arid areas support less than a straight proportional share of the population, say 20 % of the rural population, we are talking about more than 10 million people.

Table 1- Land Use in the SADCC countries, 1980

Arable and Permanent Cropland(a)							
Country	**Total Arrea**	**Land Area**	**Arable Land(b)**	**Permanent Cropland**	**Permanent Pasture**	**Forest**	**Other**
Angola	124,670	124,670	3,500	550	29,000	54,200	37,970
Botswana	60,037	58,537	1,330	-	43,794	962	112,451
Lesotho	3,035	3,035	361	-	2,000	-	674
Malawi	11,848	9,408	2,273	18	1,840	4,983	311
Mozambique	80,159	78,409	3,080	230	44,000	16,050	15,279
Swaziland	1,736	1,720	164	3	1,224	106	226
Tanzania	94,509	88,604	5,030	1,000	35,000	42,750	5,824
Zambia	75,261	74,071	4,998	7	35,000	20,940	13,134

Zimbabwe	39,058	38,667	2,524	59	4,856	23,810	7,477
Total	490,313	477,121	23,260	1,867	196,714	163,801	93,346

Source: Food and Agriculture Organization of the United Nations, Production Yearbook, vol. 36 (Rome: 1982), quoted in Southern African Development Coordination Conference, Agricultural Research Resource Assessment in the SADCC Countries, vol. 1, Regional Analysis and Strategy, (Gaborone, Botswana: SADCC, 1985), pp. 2-5.

a. **In FAO statistics, arable land refers to land under temporary crops with multiple crop ped areas counted only once, plus temporary meadows for mowing or pasture, land under market and kitchen gardens, and land tempo rarily fallow or lying idle. Land under per manent crops refers to land cultivated with crops that occupy the land for long periods such as coffee, rubber, and cocoa. It includes fruit and nut trees but excludes trees grown for wood or timber.**
b. **This figure includes permanent cropland.**

Table 2 - Population and GDP, total and per capita, SADCC countries, 1982

Country	Population (a) (millions)	Total GDP (b) (US$millions)	GDP Per Capita (US $)
Angola	8.0	5,700 (c)	713 (c)
Botswana	0.9	722	802
Lesotho	1.4	300	214
Malawi	6.5	1,320	203
Mozambique	12.9	4,465 (d)	356

Swaziland	0.7	429	613
Tanzania	19.8	4,530	229
Zambia	6.0	3,830	638
Zimbabwe	7.5	5,900	787
Total	63.7	27,196	427

Source: Joseph Hanlon, SADCC: Progress, Projects, and Prospects, The Economist Intelligence Unit Special Report No. 182 (London: The Economist, 1984), p. 13.

a. **1982 midyear estimates.**
b. **GDP at current factor cost.**
c. **1981.**
d. **1981 market prices.**

You have heard from the previous speaker, Sam Muchena, the rationale for improving the utilisation and production of small grains in Zimbabwe. Extrapolating this, albeit very crudely and conservatively, above gives some idea of the impact that the success of such policies could have on the food security of the SADCC region. It is my task today to consider the processing aspects of the utilisation of sorghum and millet and their interaction with the food security of the SADCC region.

There are three main small grains grown in SADCC; sorghum (*Sorghum bicolor* (L) Moench), pearl millet, (*Pennisetum typhoides*) and finger millet (Eleusine coracana), in descending order of significance. More than 3500 varieties of sorghum alone have been identified giving varying food values and demonstrating the ability of the crop to grow in a wide range of agroecological niches.

Small grains are used in the SADCC Member States as human food, pricipally ground into meal and used as

one of several forms of porridge; and as feed for animal production, both the grain and the stover. In addition the stalks are used in some areas as building materials or for fuel and the leaves are consumed as forage. The processes and their products will be considered in more detail further on.

Nutritional Composition

Are the small grains sorghum and millet nutritious ? Whole small grains average 350 calories per 100 grammes, largely due to carbohydrate and oil components. The protein content ranges from 8 to 14 %, although higher protein varieties have been developed, which quantity of protein is comparable to that contained in other grains such as wheat, maize and rice. Calcium and iron are strongly present in finger millet grain ranging from 220 to 850 mg per 100 grammes and 7 to 15 mg per 100 grammes, respectively, both minerals being important in human nutrition. Oil, ranging from 2 - 6 % in sorghum and millet is of good quality being po!yunsaturated with associated health benefits in reducing cholesterol levels in humans.

Protein and energy malnutrition are presently considered to affect 25 % of the SADCC regional population under five years of age, not helped by the low quality of the protein available in sorghum and millet, largely due to low levels of the limiting amino acid lysine. In traditional practice this limitation was overcome by the consumption of legumes or oilseeds with small grains. Protein availability during digestion is variety dependant ranging from 42 % in the cooked low tannin varieties to 14 % in high tannin varieties as demonstrated in our rat studies. Paradoxically, cooking sorghum reduces protein digestibility to 47 % among young children (Maclean et al 1981). Fortunately germination and fermentation, which are traditionally widely used with these grains, generally improve protein availability.

Processing Technologies

The structure of sorghum and millet grains is such that they generally have a tannin rich testa which tannin affects the availability of nutrients in the grain and accords unpleasant tastes in some products.

Traditionally the testa, or hull, has been removed by pounding the grain in a pestle and mortar, either wet or dry, either pretreated or not. Once an acceptable amount of the testa has been removed the grain is winnowed and then ground into meal.

These traditional processes are restraining of utilisation by dint of the great labour involved to do them properly. Ozzie Schmidt, the next speaker will detail a particular innovation developed by the RIIC in Botswana with IDRC assistance to remove this constraint.

Fermentation of whole grain is widely practiced to produce either alcoholic or non alcoholic beverages. This process suffers from variability of the product when it is undertaken in rural household conditions. Dehulled grains are also widely allowed to sour by encouraging facto bacillic fermentation which imparts a desired taste to porridges.

Some grain is also germinated before further processing which assists in improving the digestibility of the contained nutrients. Again this form of process suffers from variable results and could benefit from work to make it more efficient at the rural household level.

Small grain food products

A selection of the food products derived from sorghum and millet grain is show in the table below in rank

order of their significance in the regional food system.

Table 3 - Poods made from Sorghum and Millets in the SADCC Region

Type of Food	Preparation Method	Moisture % in Final Product
Thin Porridge	Boil Flour in water	About 90
Stiff Porridge and dumplings.	Same	65 - 80
Snacks	Puffed, popped or parched	15 - 20
Non alcoholic beverages	Flour with or without malt and hot water and soured overnight.	Over 94
Alcoholic Beverages	Mashed malt & water into wort and yeast fermented	Over 96
Sorghum "rice"	Boiled in water	40 -50
Composite products with cassava, maize, wheat and rice.	Cooked like porridge, baked or grilled.	Variable
Baked unfermented and fermented bread	baking or cooking on hot grill	Below 50

It is plain that porridges of one type or another are the dominant use to which sorghum and millet meals are put. Thin porridges are made by adding 10% flour to 90% water and boiling for between 15 and 20 minutes the product being eaten by children who find its consistency easier to consume, and by adults, usually at breakfast, with fresh or sour milk, butter or ghee, groundnut flour, sugar, honey or lime juice as additives. Such a dish, porridge plus one or more of the additives, is reasonably nutritious, especially the protein balance. Souring the porridge by the addition of a small quantity of starter which has been fermented for up to forty eight hours by lactobacillic action is widely reported from Botswana, Tanzania, Zimbabwe, Zambia and Swaziland. As part of the work which I am currently engaged on, I am documenting as many of these products as possible in an endeavour to direct further research work at their potential for enhancing sorghum and millet utilisation. Soured porridges can be either thin or thick in consistency.

Thick porridges, soured or not, are made by adding approximately 40% flour into boiling water and stirring until the desired consistency is attained. The porridge is then cooled and eaten with a relish of meat, vegetables, legumes or sour milk to enhance its palatability as well as its nutritional value.

Germination of small grains before their grinding into meal has been shown to have beneficial effects in reducing the bulk density of food, increasing its energy density. Thus, three times the germinated flour can be mixed into the same volume of porridge as that of ungerminated grain flour. This process is being promoted in Tanzania and Zambia especially, for use in weaning foods while there are plans to introduce it into Botswana and Zambia. The likely impact of this technique on the nutritional status of weaning children is estimated to be great in an area where 25% ot those under five years of age are malnourished.

Fermentation of sorghum and millet whole grains into alcoholic and non alcoholic beverages is the largest industrial use to which these are put in the region. It is also widely practiced in rural households and villages. On the one hand brewing has the advantage of raising the value added to the grain, and on the other it provides a beverage of far greater nutritional value than that of clear beeer and has the advantage that the

residue can be included into wheat bread to raise the dietary fibre content.

Nutritionally 100 cc of 2% alcohol opaque beer contains 35 calories and significant amounts of calcium, iron and the B group of vitamins.

Competition with other more convenient food products

Compared with small grains, maize, rice and wheat have advantages of perceived greater covenience as they have become industrially available in convenience forms, especially within the urban areas of the region. What forces can be brought to bear to reverse this situation, especially considering that large parts of the arable land in the region are not agroecologically suited to producing maize, wheat or rice ?

Composite flours made of mixtures of sorghum, millet, maize, cassava and sweet potato are not uncommon, usually in an endeavour to extend the food available or to improve the texture and taste. Why are they not commercially available ?

Wheat based products have an advantage over sorghum and millet as the energy required to grind the latter to a suitable particle size is up to 15% greater. Once this particle size is achieved between 15 and 20% can be added without loss of consumer preferred tastes and textures. Why is it not widely done ?

Locally prepared weaning foods made by germination of the grain before milling face strong competition from industrially produced weaning foods supported by vigorous promotion and marketing which have even penetrated rural markets. The processes involved in rural or household production are often beyond the means of the householder requiring utensils, additives such as sugar and temperature regulation. None of these is individually incapable of being overcome but the combined weight of such demands often militates

against adopting the innovation.

Research and development

Essentially, science is not directing enough effort to bringing sorghum and millet into beneficial use in the food systems of more people in areas which are best suited to their production. Plant breeders continue to look only for yield and to pay scant attention to consumer preferred attributes of tastes, texture, colour and so on.

Hulse et al (1980) in reviewing the research done on sorghum assessed 90% of all research work on this grain crop as being directed towards poultry, livestock and other non food uses. Feeding animals and then eating the animals leads to considerable losses due to inefficient conversion of one food type into another. A redirection of such efforts into human, direct usage of sorghum might have advantages ?

Recently work has begun at Carlsberg in Denmark and Sweden on physical and chemical properties of sorghum as a human food, as well as at the Texas A & M University and at ICRISAT in India (1982). However, this partly suffers from being basic research while what is surely neglected is applied research directly addressing third world needs.

Reorientating research and development

To improve the impact of research on third world nutritional and agricultural problems there is a need to consciously and vigorously redirect efforts away from basic to applied work. More, it is important that applied

work is undertaken on a collaborative basis with third world researchers to ensure that the problems studied are those mostly likely to yield best results for the most hungry or malnourished people. Cost benefit analysis should be a standard tool in research planning and evaluation with great care taken to specify where the costs are met from and who derives the benefits. An aspect of benefit of collaborative research, often ignored because of the added difficulties of contact and research resource deficiencies in developing countries, is the contribution which such work can, but does not always, make to enabling developing countries to achieve a critical mass of scientific ability to be able to undertake research independently.

Compared to rice and wheat for instance, research on the chemistry and qualities of small grains is in its infancy. A thorough review of the research resources being deployed in small grain areas is necessary followed by a clear ranking of needs and redirection of resources to meet those needs.

Large among these needs I would put the assessment and development of some of the existing techniques for improving the palatability and nutritional contributions of small grains which I have alluded to earlier.

There are said to be products available from outside the region, from west Africa, Sudan, Ethiopia and India which are unknown to the SADCC region. An evaluation of their potential for our region is a possible short cut to widening the market for small grains, and should be urgently researched.

A major issue in need of attention is the production of varieties which are bird resistant and yet which have low tannin contents, or which contain in such a way that it is easily removed before cooking.

The reduction of susceptibility to aflatoxins would make sorghum and millet more readily usable by more people.

Conclusion

In a sketchy way I have endeavoured to review the complex and interrelated areas of nutritional quality and processing of sorghum and millet and their potential contributions to food security in the SADCC region. In conclusion I would urge the direction of as many resources as can possibly be so directed to the thoughtful development of sorghum and millet and the thoughtful dissemination of the technologies already available, or being produced by research. A superb technique is of no value if it is not capable of adoption by those in need of its benefits. In such cases there is cost and no benefit, except perhaps to the researchers gaining employment and higher qualifications from the work. It is my sincere hope that ALASKA will strongly advocate efforts to develop and promote small grains processes and products to improve the nutritional status of the SADCC region.

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The Place of Dehulling in African Food Systems

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Introduction

My colleagues have presented an overview of the drought resistant grains in Zimbabwe, and have indicated in which ways the foods from these grains are important to those people who depend on them. I would like to complement these presentations with a review of the problems and successes associated with introducing small scale dehulling machinery to primarily rural targets.

As you know, IDRC has contributed research support to a 15 year process of development of the machinery, its pilot testing in the domain of the intended beneficiaries, and the wider dissemination of the machinery to the dry areas of Sub-Saharan Africa. This process, which at first sight appears to be heavily hardware oriented, is leading us to a better understanding of the interactions among the many facets of the sorghum and millet food system. As more disciplines, and more of Africa's intellectual resources are being invited to focus effectively on sorghum and millets, we hope to reach a critical mass of effort intended to increase the production and utilization of these small grains.

The problem

In Africa sorghums and millets are grown primarily by smallholder subsistence farmers and are mostly consumed by the producer and her/his family. These grains are well adapted to the semiarid regions, form the staple food for large rural populations, are still preferred by a substantial percentage of the population, have suffered from policy neglect, and are often viewed by the urban elite as a "poor man's crop".

The 22.3 million tons of sorghums and millets harvested in 1981 in Africa constituted 28% of cereal production in that continent, with maize, wheat and rice accounting for 42%, 11 % and 10,7% respectively. Nonetheless, Africa's second most important cereal crop (sorghum and millets) constitutes a very small proportion of the cereals bought and distributed by official grain marketing agencies. The official unimportance assigned to these crops is reflected in the fact that the national production data reported by the FAO do not distinguish between bulrush and finger millet.

Shortly after IDRC's inception in 1970, its Division of Agriculture, Food and Nutrition Sciences selected the semi-arid tropics and their neglected crops as one of its areas of concentration. The cereals sorghums and millets became one focus of research support to national agricultural research systems.

It soon became apparent that one constraint to farmer adoption of improved varieties of these small grains lay, not on the production side of the food system, but on the pOSt production side. Women and children traditonally spent many hours handstamping sorghum and bulrush millets to remove the outer layers (dehulling or decorticating) in order to make them palatable.

The evolution of dehuller designs

The initial technical objective was to develop a simple mechanical device, suitable to the needs of the producer/consumer of sorghums and millets as well as of grain legumes. We can now point to the existence of an number of variants on a basic design, which consist of a metal shaft on which an number of grinding stones, or abrasive discs, are evenly spaced about 2 cm apart. This rotor is enclosed by a semi-circular sheet metal barrel with a flat top. The barrel is partly filled with grain, and abrasive discs, spinning at 1500-2000 rpm, rub against the individual kernels in the agitated mass of grain. The affect is a progressive abrasion of the outer layers of the grains or grain legumes. The length of time during which the grain iS retained affects how much of the material is removed as abraded fines.

The first effective design was the modification of an existing barley thresher by the National Research Council of Canada's Prairie Regional Laboratory (PRL). The PRL dehuller demonstrated its technical effectiveness on the sorghums, millets, and cowpeas which were commonly grown in Maiduguri in 197476. It was tried in Senegal in 1977 as part of an larger post harvest project, but was not found to be very useful at the time. The same design, by contrast, proved very successful in Botswana 19761978, and provided the basis for further improvement.

The Rural Industries Innovation Centre (RIIC) in Botswana scaled down the size of the PRL dehuller and incorportated a trap door at the botton of the barrel, enabling the dehuller to deal with batches as small as 5 kg. In continuous flow operation it is capable of up to 5 tonnes per eight-hour shift. Its economic break-even point lies in the vicinity of 1,52 tonnes per day. Figure 4 shows an exploded drawing of the RIIC type of design.

The PRL, later renamed the Plant Biotechnology Institute, also designed a small version, the MINIPAL, for its laboratory needs. It is capable of dehulling batches of up to 5 kg, but possesses no aspirating system for the automatic removal of the abraded fines.

The Catholic Relief Services in Gambia has over the last three years adapted the MINI-PAL to village conditions, making it more rugged, and is making this design widely available in the country. In 1985

EndaZimbabwe, a non-governmental organization, lengthened the barrel of the MINI-PAL and added a trap door for easier emptying of the batches. Enda has sought to match the barrel capacity to the common 20 litre "bucket" (containing 18 kg of sorghum or 20 kg of millet) in which women bring their grain to the mill. The Senegalese parastatal company, SISMAR, ist developing its own variant, intended to match the conditions of that and neighbou-ring countries.

It should be emphasized that much of the design work and all of the pilot testing and introduction of technology work has been and is being done by applied researchers in African countries.

Experiences from hardware introduction

The absence of dehulling machinery is a constraint

This statement remains a workable initial hypothesis for many sub-Saharan countries, but has to be qualified by further subordinate hypotheses. We will also see that the generation of an hardware technology can be a necessary, but not sufficient, condition for solving the primary problem of increasing production and utilization of the drought resistant grains. I would like to highlight the expenences in three countries before proceeding to a more general analysis.

Botswana

In response to vigorous demand from potential investors, the RIIC moved quickly from its prototype design to a dissemination of the dehulling machinery. Between 1979 and 1983 around twenty small scale milling systems were installed in rural and pert-urban locations in Botswana The systems included a dehuller, hammermill and an engine to drive both. There had not been a strong tradition of service grinding in

Botswana, and most of the new owners of the mills had little experience with technical operations of such equipment. Many also were not very experienced in business.

By 1987 there are now 26 such small scale dehulling and milling systems, incorporating some 37 dehullers, in existence in Botswana. The early systems operated as service mills, processing the grain brought by individual customers. However, the more aggressive among the owners soon began to buy up grain in bulk, and packaged the processed flour in attractively printed bags, for sale to the urban centres. A lively competition for outlets arose among these commercial millers, complete with individulized brand names seeking to induce brand loyalty in the urban consumer. The annual droughts sin ce 1882 have put a virtual end to service milling, since individual farm household have little or no harvested grain. The present status of this small scale sorghum milling industry is that about one third of the installations remain viable, while two thirds are virtually idle.

While the RIIC had intended the small scale systems to respond primarily to the rural labour bottleneck, the industry evolved quickly from service milling to small commercial milling enterprises selling a packaged processed product.

Some of the lessons learned from the rapid penetration of the new dehulling technology in Botswana are:

- **economies of scale apply to the marketing and distribution of the processed product, but not to the processing itself**
- **while some early studies demonstrated that an investment in a service mill would be very profitable, with high internal rates of return, subsequent events produced a different result. Of ficialdom did not actively anticipate potential competitor between mills, and did not anticipate a condition of over supply of installations. The national principle of rapid economic growth seems to have overruled the policy of small scale industrialization.**
- **the known climatic fact that droughts recur was not sufficiently considered by the credit agencies which**

lent money for the purchase of milling systems on the basis of the micro-studies of profitability.

- **producer price policy is intended to be an incentive to increase sorghum production, but this fifth year of continuing drought is nullifying that aim. Further, the Botswana Agricultural Marketing Board, the sole importer of sorghum, is maintaining a very high re-sale price, partly in order to recover financial losses from previous years. The net result appears to be that consumers are purchasing more imported maize products, and that the change in food preferenc from sorghum to maize is effectively being encouraged, to the possible detriment of the agricultural sector.**
- **the process of introduction of technology inevitably impinges on policy issues, and is dependent on effective policy practice by several different Ministries and Parastatals.**

In Tanzania, the Small Industries Development Organization (SIDO) has introduced Botswana-type processing installations to four pilot sites in ujamaa villages in the dry areas. The oldest installation has operated for more than two years, the youngest for just under a year. The level of use fo the dehullers is much below capacity, although the hammermills are being kept extremely busy in all four places. The reasons for this underutilization of the dehullers are not fully known. Experience being accrued indicates that there can be several reasons for introducing dehullers:

- **in the Regions of Dodoma and Singida it is likely that much of the drought resistent cereal harvest is indeed hand dehulled and hand ground traditionally. The prevailing sorghum varieties are white, and contain little or no tannin.**
- **the Regions closer to the Rift Valley, Tabora, Shinyanga and Mwanza, are very bird-prone, and the prevailing sorghum varieties are brown and contain substantial levels of tannin. These varieties are very soft, however, and pulverize very readily. Thus, there is no tradition of manual dehulling. Here there is a nutritional reason for introducing dehullers, but new techniques of village interaction will need to be**

found if dehullers are to be accepted.

- **work at Sokoine University of Agriculture on sorghum utilization has to be more closely tied to these two different realities.**
- **with SIDA funds and the determination of the then Minister of Industry, ten RIIC dehullers were purchased from Botswana two years ago. All have found willing buyers, and this might appear to indicate a wider demand for dehullers in the country. However, it is not clear whether the buyers, in a country chronically short of foreign exchange, were more interested in the diesel engines of dehuller utilization, before one can really conclude that there is a demonstraded demand.**
- **in Dezember 1986 a two-volume "Proposals for a Drought Resistant Cereals Strategy" was issued by the Food Strategy Unit in the Ministry of Agriculture and Livestock Development. This was followed recently by proposals for four specific action projects intended to implement the proposed strategy, one focussing on an accelerated effort by SIDO to disseminate the dehullers more vigorously. It appears that the dehullers may be the victims of their own publicity.**

Zimbabwe

Since mid-1984 the non-governmental agency, Silveira House, has been monitoring a Botswanastyle installation in a sparsely populated location in the eastern, dry district of Mutoko. Sevaral Ministers and senior government officials visited the site, were impressed by the dehuller's performance, and felt that its wider deployment would strengthen rural response to the official campaign to grow increased amounts of sorghum and millets. (The introduction of official prices in 1985 had a dramatic effect on farmer response).

It was apparent that the policymakers had a need for more dehullers in the dry areas. Was there a corresponding need expressed by the rural dwellers ? Between May 1985 and December 1986 EndaZimbabwe, another non-governmental agency, conducted some quick applied research in the south-eastern areas to test the hypothesis that dehullers were indeed needed and would fit the rural realities

encountered. The survey, which included demostrations with a MINI-PAL dehuller, indicted the need for dehullers, but of a smaller size than the RIIC design.

In late 1985 and early 1986 Enda-Zimbabwe placed four MINI-ENDA prototypes with existing rural hammermills in the south-east of the country, and monitored their utilization by the communities. While the locations lie within the localized drought zone of the 1986 harvest causing in a serious grain shortage locally, the results do confirm that home processing is a widely perceived problem for which a small dehuller seems to be a solution. In early 1986 Enda-Zimbabwe began formulating a development project aiming at the wider scale dissemination of dehulling technology into the dry areas. The project, to be funded by CIDA, will aim to achieve the following outcomes in four years time:

- **forty small-scale milling systems distributed throughout the country, owned and successfully operated by rural or pert-urban groups or individuals;**
- **a functioning cradit system to enable future potential investors of mills to purchase the hardware;**
- **selected members of the metalworking industry fully capable of building a quality product of two sizes of dehuller;**
- **an interministerial committee to monitor project progress, and to intervene with policy so that the intended users of the technology, and the intended beneficiaries, are indeed reached;**

Thus Enda-Zimbabwe, as the executor of the project, will play the role of the midwife to bring into being a self-sustainting process of technology delivery.

There are some very important things which we do not yet know, and which must be learned quickly in order to reduce the risks which are apparent with this large development project (many of the same questions are emerging from the Tanzanian experience as well):

- **the small farmer in the dry areas clearly integrates drought-anticipation into her/his planting decision**

about the amount of land allocated to maize and to the drought-resistant grains. What are those decision mechanisms?

- **after the harvest, what is the housewife's strategy for using maize and the small grains as food ? We know that there is a tendency for the hybrid maize to be eaten first, because it does not store as well as do sorghum and millets. Does this also indicate a strong preference for maize as food, and does the woman barter her small grains for maize as long as it is available?**
- **are the drought resistant grains viewed by the rural dweller to be primarily food, or primarily the basis for beer brewing? Does this attitude change between drought years and years of good rainfall ? How much nutritive value is in the opaque beers, and should science be viewing these beers as food rather than as alcoholic drinks?**
- **are the dehullers the most important technology which needs to be introduced to the rural areas? Should an altered farming systems package be introduced at the same time?**

We are in the process of encouraging Zimbabweans to formulate some research, to run parallel to the dissemination activity, to explore the following:

- **how can the process of technology introduction be improved?**
- **what policy Issues, requiring attention, are being identified as the project progresses?**
- **intensive studies to provide insight into household "behaviour" and to show the impact of the technology on selected rural locations.**

Technology generation in response to identified needs

Figure 3 seeks to put technology generation in its proper relationship to effective problem identification. Any solution, in order to be useful to the intended beneficiary, has to be technically sound, economically viable, and socially acceptable. Thus the problem being addressed by technology generation has to be defined in all three of these dimensions, and continually re-checked in subsequent field testing, before proceding to wider

dissemination.

We often neglect to consult the intended beneficiaries, and make too many assumptions about the social performance criteria Agricultural research systems have learned this lesson, and are stressing Farming Systems Research in their resource allocations. We, in the area of food after harvest, need to develop our own analogue to FSR and put it into practice.

Effect of the Hardware Technology on the Sorghum and Millet Food Systems

Let us list some key attributes of these grains, both advantages and disadvantages, before considering the effect of dehullers on the food system.

From the producers' point of view:

- **they suit the agroclimatic realities of the dry areas (more drought resistent,. Require lower inputs for a moderate yield); unless and until major changes are made to land use patterns (a long term and expensive task), they have a better chance than do other cereals of contributing to household food security;**
- **the high-tannin varieties of sorghum and the polyphenols in bulrush millets are able to prevent depletion of the field crop in the bird prone areas;**
- **home processing is time and energy consuming;**
- **there is no sustained demand surplus production; the grains are often unsaleable, and thus not a reliable source of cash for the household;**
- **there is strong competition from other corals which have a better established total infrastructure: maize in Eastern and Southern Africa; rice in West Africa; wheat in the urban areas**

From the (urban) consumers' point of view:

- **processed forms, primarily flour, from sorghum and millets are not available in shops; few urban housewives will choose to handprocess the grain when they can buy maize flour, wheat flour, and ready to cook rice instead;**
- **the stiff porridge from maize flour does not have the heavy stomach feel associated particularly with sorghum;**
- **wheat flour and rice require a shorter home cooking time than do flours from maize, sorghum or bulrush millet.**

The effect of intervening with dehullers can be represented in two diagrams. Figure 1 shows that the provision of dehullers (if they are needed) to the rural areas at primarily the quality of rural life. Some new jobs may be created, and the presence of the mills may act as a focus to atract other agroprocessing activities. But an increase in production is unlikely.

Figure 2 indicates that demand for surplus production will have to come from the domain of the urban consumer. Enda-Zimbabwe is at present making small amounts of sorghum and millet flour available to urban shops, and are finding no difficulty in selling all the supply. They are likely tapping the food preference of those who have recently moved to the towns from the rural areas. However, it will be necessary to adapt imaginative and aggressive marketing techniques from the North, in order to bring about a susbstantial sustained demand for primary or secondary products from the drought resistant grains.

As the experience of the Kenya Industrial Research and Development Institute (KIRDI) shows, active policy support is very necessary for a successful marketing initiative. With financial support from the EEC and strong technical involvement by TDRI, KIRDI has been trying to introduce whole dehulled sorghum into Kenya's urban markets. Technical feasibility was established relatively quickly. But the absence of a grading sy stem among sorghum varieties, lack of enforcement of quality standards at the buying point, no clear buying policy nor a fixed resale price published by the National Cereals and Produce Board, combine to provide KIRDI and

TDRI with major hurdles in their project.

Conclusion

Machine dehulling has a potentially prominent place in African Food Systems. It can help to solve the following problems:

- **to free woman and child labour for leisure or other tasks;**
- **to make high tannin cultivars more palatable and nutritious;**
- **To generate urban demand for sustained surplus production.**

The ultimate success of machine dehulling, however, depends on many Actors. The objective of increasing the production and utilization fo the drought resistant grains implies that we are seeking to change the food systems of these grains. Any strategy to bring about a change has to view to production and the post production sectors (including dehullers) as interrelated components of a total food systems. Many sub-Saharan countries do focus on agricultural production, but have no strategy for the post production sector.

We intend to continue to discover in what ways dehullers can contribute to change in the small grains systems. In addition we can indentify three priority tasks, two of which relate to the strengthening of linkages, and one to policy:

We can set out to strengthen feed back from the eater to the commodity improvement team. More work is needed to define and standardize food quality parameters of the dishes commonly being eaten; these have to be related to grain quality parameters of the varieties commonly being grown.

Linkages between the processor and the commodity improvement team need to be created and maintained. We need a definitive inventory of the wide range of cultivars being planted and eaten now. For instance,

what percentage of the volumes harvested and eaten contain tannin, and are not traiditionally dehulled? What percentage are now traditionally dehulled? What are the processing characteristics of both kinds?

We have seen that national policies, and their vigorous practice or neglect, can foster or hinder directed change. We can initiate discussions, by supplying case studies, among makers of policy on the following, often disparate, fields: food, agriculture, and household food security; technology choice and industrialization (small scale versus large scale), food industry (centralized or distributive), employment creation (rural versus urban focus).

Figure 1: Effect on food system by introduction of rurally-located dehulling machinery

Figure 2: The mature food system for sorghums and bulrush millets

Figure 3: Flowchart of the applied research process for technology development in response to user needs.

Figure 4: Exploded drawing RIIC style dehuller

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Relevance of marketing conditions to improve foodgrain production

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1. Introduction

In explaining its objectives GASGA emphasizes that equally important to increased production is to ensure preservation of what is grown until such time as it is needed for ultimate local consumption or for export. Indeed, for the consumer it does not matter whether scarce supply is due to high losses or respective failures of production.

Preservation through adequate storage and/or transformation of the raw product is one of the main functions of marketing systems including all institutions or economic agents from production to consumption level. Consequently, the functioning of agricultural marketing systems plays an important role with regard to constrain post harvest losses. But marketing systems are even more important. They determine among others, to what extent government price policies become effective for farmers or, ultimately, what prices farmers get when selling their marketable surplus. Thus, marketing systems in conjunction with respective government policies determine the economic incentive to change production patterns and to increase production or not.

The creation of a respective favourable marketing environment is, therefore, one of the necessary conditions to achieve e.g. the objective of increasing basic foodgrain production. Unless farmers have confidence that prices will bear some minimum relation to cost, they will hesitate before incurring additional work or expenses to increase their output or raise its quality. This is particularly true in view of the fact, that a growing urban or non-agricultural population asks for an increased market production beyond subsistence requirements which under the condition of given land ressources can be achieved to a growing extent only by intensifying production with respective inputs of time and money.

Growthrates of foodgrain production in African countries during the last 2 1/2 decades in many cases ranked below population growthrates, in some case they were even negative. Consequently foodgrain import, requirements rose from about 4. Mio metric tons (1974) to more than 10. Mio. metric tons (1982/83). Apart from unfavourable climatic conditions, poor institutional and financial support to production activities (new technologies, input supply, extension, credit etc.) inadequate market or marketing conditions are seen as one of the major contributing factors to this development. The crucial issues in this context concern particularly foodgrain, price policies, market intervention by parastatals and food aid policies as well as its management.

2. Foodgrain Price Policies

For many years foodgrain price policies were biased towards the urban sector in many African countries. Because of the status of foodgrain as a wage good and the high share of basic food in the household budget of low-income consumers foodgrain prices were fixed at a low level in order to satisfy the urban clientele. This in turn was reflected in corresponding low farmgate prices which usually did not allow to cover production costs. Farmers in such a situation tend to confine themselves to subsistence production.

However, it should be noticed, that market prices or prices in parallel market often exceeded official producer prices due to the specific supply/demand situation. In such a situation official prices are of theoretic value only since the market situation provides enough incentives to farmers. Nevertheless, considering that production decisions are taken long time before the marketing season, not knowing the market prices in advance, the impact of announced official producer prices cannot be neglected.

Concomitantly with the consumer oriented low price policy governments usually persue the policy to keep foodgrain prices stable throughout the year and uniform in all regions irrespective of transport costs. Stable prices aim at protecting consumers from seasonal and erratic price fluctuations. Panterritorial prices are

usually kept in order not to be blamed of being biased toward certain regions or tribes/ethnics respectively and/or to prevent undesired migrations.

These policies have major implications for the marketing system and production. If announced prices are effectively implemented, the incentive for the private sector to engage itself, in storage and/or interregional trade for balancing supply and demand between surplus and deficit regions is rather limited, if not absent. At the same time prices in surplus areas are unnecessarily depressed because surplus is not absorbed fast enough by the public marketing institutions. This again limits the incentives for producers in these regions. Similarly, prices in deficit regions are kept artificially low through subsidy on transfer costs, which again limits production in these areas (provided, prices in parallel markets do not reflect real transfer costs) and thus increases the necessity for interregional transfers and consequently marketing costs.

Another important issue with regard to foodgrain price policies is the relation of foodgrain prices to those of export crops and the relative prices of locally grown and important gratin.

Criticism is put forward that relative prices have favoured export crops. In this context, however, comparative advantages of export crop production should not be neglected.

More seriously seems to be the issue of import price policies favouring imported cereals (e.g. rice/wheat) at the expense of local grains. Since world market grain prices are artificially low at present, an liberalized import policy endangers domestic food production with dangerous long run effects.

3. Market Intervention through Public Marketing Organizations (Marketing Boards)

Effective implementation of foodgrain price policies requires a corresponding government institution able to

carry out all necessary market regulating operations, e.g. procurement, storage, transport, sales and distribution etc.

For these purposes socalled parastatal grain marketing boards have been set up. Partly, in West Africa these boards are full government services without financial autonomy whereas in other cases they have a more or less autonomous status. In addition to its market regulating function, e.g. guaranteeing announced producer minimum support and stable consumer prices, they partly are charged with maintaining a food security reserve, managing food and and supply remote areas otherwise not supplied sufficiently. In the past, very often monopoly powers had been assigned to various marketing boards. However, recently most of the monopoly powers have been given up within the strategy to liberalize grain marketing operations.

Irrespective of their status, all marketing boards are faced with severe problems in fulffilling their market regulation functions and therefore are increasingly criticized. The main criticism is as follows:

a. **The marketing boards are not able to stabilize or control farmgate prices and consumer prices effectively.**
b. **Operational efficiency is low, i.e. the private sector could perform most of the functions involved more efficiently (storage, transportations etc.).**
c. **Buffer stock policy is generally too costly. Market regulation through export/import operations would be more efficient.**
d. **The effects of interventions through marketing boards are detrimental to the objectives persued.**

ad a: Low effectiveness of market intervention

Price movements in (parallel) rural and urban markets have often shown large deviations between official and market prices, supporting obviously the above argument, at least at the first glance. However, the

problem requires a more detailed analysis to come to a more differentiated conclusion. In general it can be said that the marketing boards themselves for the most part are not responsible for the failures, most problems accrue to unrealistic price structures decided by superior authorities, insufficient financial ressources given to the boards and unnecessary market control regulations (e.g. movement restrictions). There is, on the other hand, ample evidence that marketing boards provided with required ressources were able e.g. to establish floor prices for the benefit of farmers.

Consequently, marketing boards should not be considered as priori unable to regulate grain markets effectively.

ad b: Low operational efficiency

There is hardly any dissent that the private sector, ceteris paribus, is able to operate more efficiently than a parastatal organization with high overheads and a heavy administrative set-up. However, it should be taken into consideration, that grain marketing boards perform social, redistributive and productive functions which cannot necessarily be expected from private sector operations looking for the highest return on investment, especially in critical supply/demand situations. Possible social opportunity costs are usually not considered.

Apart from this, long term storage contributing to the high costs incurred by marketing boards, is up to now seldomly carried out by the private sector in African countries. The respective opportunity cost of the capital required is very high because of the capital constraints faced by the developing countries. The question is, whether private sector long term storage, requiring the same storage facilities, the same capital input etc. would be significantly less expensive than public long term storage under present African conditions.

ad c: Bufferstock export/import policy

Because of the high risks and costs of a bufferstock policy performed by most grain marketing boards cer tain donors as well as the World Bank favour an export/ import strategy to regulate the market. Such a strategy assumes that export possibilities exist m case of surplus situation and sufficient foreign exchange and/or food aid to cover foodgrain deficits. The present experience in West Africa, however, demonstrates that export possibilities for coarse grains grown and consumed in that region are rather limited since production follows more or less the same pattern leading to surplus in almost all countries at the same time. Moreover, exports at current world market prices would also require heavy subsidies. Therefore, exports do not seem to be a viabal alternative for regulating the internal market in all situations.

On the other hand, imports and food aid may well help tO stabilize consumer prices at a desired level in times of scarce internal supply. Moreover, restricting imports in times of abundant internal supply would help to ease the situation. Moreover, restricting imports together with a respective price policy may also help to maintain domestic consumption habits in favour of locally grown and consumed coarse grains or may help to promote its consumption at the cost of imported grains such as rice and wheat. To increase the convenience of food preparation through respective processing seems to be a very important factor in this context. For examples it may be referred to millet flour and "maize rice" in Senegal.

ad d: Detrimental effects of market intervention

As already indicated above with regard to the price policy, price stabilization and panterritorial pricing may reduce the incentive for increased production and optimal allocation of ressources. The degree to which this occurs depends, however, largely on the price margins fixed for or induced by market interventions. The bigger the margin between public buying and selling prices the higher will be the incentive for private sector

participation in grain marketing and the lower the market distortions. On the other hand the smaller the public margin and the more control on private marketing the greater will be the market distortion with detrimental effects on production.

Effects of market intervention may also not be consistent with the redistributive objectives. This is especially the case if low income consumers do not have sufficient access to official sourses at guaranteed prices (e.g. Mali) but have to supply themselves at higher prices in parallel market. Similiarly, negative income distribution effects occur at producer level, if especially the bigger farmers profit more from market intervention than smallholders.

Summarizing, it can be concluded that criticism of grain marketing boards does not seem to be justified in general terms. Considering that the private sector does not necessarily perform the regulating function assigned to boards the latter may well contribute or even necessary to create the marketing environment required for increased grain production. However, that does not mean that marketing boards need to replace the private sector.

There is ample evidence that the private marketing sector is not generally exploitative or ineffective as often alleged and which would justify to exclude traders from grain marketing. The question therefore is not to replace them or not, but, to regulate their operations. In a competitive environment and with sufficient ressources there is no need for governments to intervene extensively and directly upto the farm level which for a parastatal, as pointed out above, is a very costly exercise. Therefore, each situation has to be carefully examined, as to what extent marketing boards need to intervene in the market by direct transactions or, respectively, to what extent the performance of marketing transactions can be left to the private sector.

Whenever possible, government should refrain from direct involvement in marketing transaction in order to reduce marketing costs and save scarce ressources. The answer in this respect depends largely on the situation with regard to the physical and marketing infrastructure, market structure (local, monopolies,

collusion etc.), market transparency among farmers and traders, degree of farmers organisation, access of farmers and traders to credit etc. These factors largely determine the degree of competition and absorbing capacity of the private marketing subsystem as well as the "countervailing power" or dependence of farmers, which ultimately determines the price they get for their marketed surplus.

4. Food Aid Policies and Managament

Food aid, for long time has been criticized for leading to severe market distortions, depressing local grain prices changing consumption habits etc. to the detriment of local production. This criticism refers mainly to a particular form of food aid and its management, i.e. bulk supply which is distributed free of charge or heavily subsidized irrespective of local specific market situation. This practice was quite common in the past. Nowadays the major donors try to avoid these effects. In principle this is possible if certain conditions are met, e.g.if

- **the cereal provided corresponds to local consumption habits**
- **food aid substitutes commercial imports and thus does not increase local supply**
- **free of charge or subsidized distribution is well targeted to vulnerable groups or through food-forwork projects and does not exceed the real needs.**
- **prices for food aid/imported cereals do not discourage local production.**

A lot of progress has been made in this respect. However, there are still problems which are difficult to control. The major ones are as follows:

- **food aid has a budget effect by generating counterpart funds. In view of the difficult financial situation of receipient governments these funds are usually most welcome and often required to finance ongoing**

projects. This may have two effects. Firstly, food aid requirements are inflated to generate the necessary funds. Secondly, financial problems arise in local surplus situations, since food aid is only partly convertible into financial aid. Some donors even do not provide for substituting food aid by financial (food) aid. Since food aid counterpart funds are among others used for local purchases contributing to establish floor prices for farmers, the required support is just then lacking when urgently needed, i.e. in surplus situations. This card be currently observed very well in the Sahel countries.

- **legal and administrative procedures of donor countries make it difficult to adjust food aid supply to actual requirements and market situations. USAID and dependent NGO's, for example, due to legal provisions (PL 480) are not in a position to purchase cereals locally for food-for-work or other social projects. This leads to a situation in which despite abundance of local supply cereal food aid supply from outside is continued. Furthermore, due to administrative procedures, food aid arrivals occur when the local supply situation has already changed. Thus, Mali in 1986 still received 94,000 MT of food aid (the "cash market" is estimated to be around 350,000-400,000 MT), when actually no food aid was required. This certainly contributed to depressing local prices and problems of OPAM, the Malian marketing board, to sell its local stocks for generating funds and to clear storage capacities for the next harvest.**

5. Summary and Conclusions

In the previous paragraphs an attempt was made to review the crucial issues which demonstrate the relevance of marketing conditions for improved foodgrain production and the implications for the post harvest system. It was pointed out that a price policy consistent with the objective of increasing food production is crucial to this end but becomes only effective if implemented effectively. The latter needs a very careful design of market intervention and coordination with import/export and food aid policies. Otherwise market destortions may lead exactly to opposite results as stated in the objectives.

Market intervention and in consequence the implementation of price policies can only be effective if prices are set right and the physical and financial means as well as the required personnel is provided for. Since market interventions to support farm and stabilize consumer prices are costly (storage, export subsidies etc.) and financial ressources are limited the capacity and skills of the private sector to perform marketing functions (storage, interregional trade/transport etc.) at lower costs should be utilized as far as possible. technical, financial, institutional as well as infrastructural assistance to increase this capacity at all levels (including farm level) contributes to the aim of effective and efficient market intervention or regulation respectively.

The extent to which the private sector participates in marketing depends, apart from respective regulations and controls, again largely on the price policies and its implementation. Narrow subsidized margins between official producer and consumer prices tend to exclude private participants increasing the burden for the public sector with possible detrimental effects for farmers and consumers and vice versa. With widening the margin within a policy of increasingly liberalizing grain marketing as initiated in many countries under the assistance of the World Bank and various donors the demands on the private sector with regard to post harvest management is growing. This, obviously, has also important implications for GASGA and its activities.

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Concepts of food grain stock policy

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An Indonesian case study

DJB Calverley, ODNRI

At the beginning of this decade Indonesia made a major policy decision to become self-sufficient in rice and stop impoting rice. Government involvement in rice marketing and price control was carried out by BULOG, a parastatal organisation with considerable autonomy. As a result of price incentives, rice production increased sharply. BULOG was called on to intervene to support producer prices but it had little opportunity to dispose of surplus stocks through price stabilisation operations at the upper level. It did have the role of supplying about 1,5 million tonnes annually to, so called, budget groups; hospitals, schools, civil servants, etc., but this was insufficient to dispose of its annual procurement. Consequently as production increased so did its stocks, at times to over 4 million tonnes. ODNRI was asked to advice on the minimum stock levels needed for BULOG to meet its commitments, and what were the costs incurred of producing and holding these stocks.

The problem, basically, was one of achieving a high degree of food security at minimum cost. Food Security was defined as:

Having food (rice) available to meet the demands of those who need it, anywhere, at any time and at resonable cost.

The definition implies a sense of dynamism, of having continually to address the problem of food supplies. A failure of food security was considered to occur if stocks became exhausted anywhere in Indonesia at any time. This was a very limiting consideration of failure, since in most instances short term exhaustion could be anticipated and prevented by emergency action.

The study considered the national aggregated stock requirements, and those in each of Indonesia's 27 provinces. Some provinces were identified as being regularly in rice surplus, others in rice deficit. A simulation

model was developed which hat 5 major components.

1. **A set of economic models of BULOG's marketing activities of procurement and distribution of paddy and rice in each of the provinces.**
2. **A model of the provincial stock levels and changes based on a set of re-order levels for deficit provinces from those in surplus.**
3. **A model for calculating the probability of failure of BULOG's operations in provinces which are normally in deficit.**
4. **A model for calculating the likelihood of BULOG purchasing adequate aggregate national stocks from provinces normally in rice surplus (or from exports).**
5. **A model of aggregate BULOG storage costs.**

It was assumed that BULOG's stock levels follow a conventional pattern; stock levels rising due to procurement immediately after harvest, and later falling to meet disbursement to budget groups and for price support operations. The net change of stocks on a monthly basis being the difference between outgoing and procurement. When the stocks in deficit provinces reached stated minimum levels, re-order rules were established for ordering more rice from provinces in surplus. The period of minimum stocks occurs immediately before procurement begins. Adequate provincial and national stocks should be carried over to prevent exhaustion of stocks at this critical period, and this level of stocks is regarded as the minimum needed by BULOG.

An analysis of the provincial marketing operations, on the basis of the standard deviations of rice production about the trend production, made it possible to estimate the probability of cumulative stock changes and whether these would be outside the limits of acceptability. Since it was a political decision that there should be no imports of rice, stock changes were required, as far as possible, never to result in an aggregate national deficit. From these probabilities could be calculated the degree of confidence that system failure will be

prevented, i.e. the degree of confidence that food security can be sustained.

Clearly the nearer domestic rice production approaches the national demand, the smaller will be the carry over stock levels needed for any required level of food security. It was found that a 2 million tonne carry over in 1983 would give 69% confidence that the system would not fail; with the higher trend production in 1985/86, 1,5 million tonnes of carry over, with the increased BULOG procurement gave 97% confidence.

Two further important points are illustrated in Figure 1. First at low levels of confidence, small increases in stock levels have significant effects on improving food security. Beyond about the 90% confidence limits, very substantial increases in stocks increase food security by very small margins. In 1985/86 increasing the stock level from 1.5 million tonnes to 5 million tonnes increased confidence levels from about 95 to 98%. Second is the high annual cost of procuring and holding stocks. Market operations in supporting specified producer and consumer prices and in carrying over 1,5 million tonnes in 1985/86 would cost about US $180 million. This is in contrast to the Indonesian Government's rule of thumb guideline of 5 million tonnes which would cost some US $600 million.

The model is a simulation of BULOG's operations. It was a first attempt to quantify a dynamic concept of a food stocks policy and as such it is very specific to Indonesia Considerable work is still needed to refine and simplify the model, make it more user-friendly and adapt it for a wider application. This is presently on-go ing.

Meanwhile it remains an important tool in its own right. With it, stock level requirements can be calculated regularly as circumstances change, policy decisions can be more critically analysed, and the consequences of policy changes more sharply focussed. When, therefore, ODNRI was asked to predict optimal levels of rice production to minimise BULOG's accumulation of stocks, this was done by adapting the simulation model to examine the impact of policy variables (paddy prices, input prices) which previously were taken as fixed, and the opportunities offered by relaxing other constraints, particularly the possibility for linking food security strategies to agricultural food production policies where imports and exports can be considered as

complementary to stock holding operations.

There can be no question of directly transferring the existing model to, say, an African country but the deterioration in food security presently evident in many African countries, demands that concepts and techniques of managing staple food stocks be applied to a much needed policy development in matters of food security. The institutional context and the database are much weaker in Africa than in Indonesia. Nevertheless, there is scope in African countries for the application of a model similar to that developed in Indonesia. New and recent initiatives towards regional cooperation in food security need support and offer scope for an application of a model on a regional basis.

Food security and the cost of holding stocks

Utilization of small grains in the SADCC-region - Report on a workshop

G.K. Tuengerthal, B. Bohnstedt

1. Foreword

At the 19th annual meeting of GASGA, held in Germanyin 1987, several papers were presented which highlighted the importance of small grains (millet, sorghum) in East Africa and outlined a number of problems, especially in marketing, which hinder the promotion and increased consumption of these crops.

It was the common feeling that the problems and their interrelation have not been fully understood so far. It was therefore decided to organise a regional workshop in order to look into the various problems of small

grains in the SADCC region (Southern African Development and Coordination Council) and possibly to issue recommendations on how to overcome existing obstacles.

The workshop was organised by members of GASGA and was held from 17th to 21st October 1987 at the Matopos Research Station of ICRISAT, Matopos, Zimbabwe. The participants of the workshop would like to thank ICRISAT for their organisational support and hospitality.

2. Method applied

The workshop was conducted with the aid of the ojectives-oriented project planning method (ZOPP). This method is based on the logical-framework approach, which is widely used in the development community.

ZOPP is a systematic approach to planning projects and their objectives. Starting with the identification of the core problem (which the project is intended to help solve) and the specification of other factors causally linked with this in the project environment, objectives are identified which will have to be achieved in order to solve the specified problems.

These objectives are used to establish alternative solutions, which are investigated in feasibility studies. The project and its objectives are then developed for the most suitable approach. A clear, logical and unambiguous statement is prepared showing why the project should be implemented, what other factors-may endanger the success of the project, what state implemeltation of the project should bring about and how data should be collected in order to identify achievement of objectives. The planning for the project and objectives resulting from this process may be presented in a project planning matrix.

The method consists of three inter-supportive components:

- **the procedure, which is the guideline for work in the planing group;**
- **the team approach as the framework for studying multisectoral problems;**
- **the visualisation technique, which is used to document the contributions by the individual participants and the results of discussions.**

A three-day-workshop does not provide sufficient time to deliberate extensively on each of the steps, especially in cases where participants have no experience with the method. Nevertheless all workshops members agreed that using the method had made it much easier to structure a goal-oriented discussion, reach a group consensus and agree on final recommendations.

3. Participation Analysis

The first stage in the ZOPP planning procedure aimed at clarifying the interests and relationships underlying the problems. The terms in which a problem is perceived or stated depend on the interests involved or the point of view. In many situations the participation analysis is a provisional substitute for direct participation of partners or target groups in the planning process. It is an attempt to identify more closely with the situation of the participants, in order to acquire a different perspective and develop a better understanding of the problem.

From the documentation (cf. Annex 1) it is apparent that the production and consumption of small grains affects an extraordinarily wide range of groups and organisations in one way or another. In addition to alarge part of the public sector, especially the grain marketing boards and the Ministers of Agriculture, the private sector (production, processing and marketing) is heavily influenced by any change in the consumption of small grains. The workshop members realised that some of the groups (middleman traders, branches of processing industry, policy makers) may be apposed to projects boosting small grauns production and consumption.

4. Problem Analysis

This involves the separation and linking of cause and effect. Taking the core problem as a starting point, the attempt is made to investigate and present the causality underlying the problem complex in the environment. It is not enough to stay at the level of symptoms or superfi cial phenomena the effort must be made to pursue the problems to their roots.

The workshop identified "insufficient production of food and cash crops in harsh environments" as the core problem (cf. Annex 2). Below the core problem the causes which lead to this problem are listed.

Above the core problems its effects are described. If this "problem tree" is elaborated properly, the causes and effects of one level should be necessary and sufficient to explain those of the next level. In some cases a cause may also be an effect. This may be valid e.g. for "Too many cheap grain imports from overseas". The most important and possibly central consequence of the core problem was considered to be "sustained survival in dry areas endangered".

5. Objectives Analysis

This comprises the analysis of relationships between inputs and objectives on the basis of reformulation of problems as objectives. Questions to be considered here are:

- **whether the objectives as formulated are morally or politically acceptable and**
- **whether the intensity and scale of the objectives as formulated and the relationships between inputs and**

objectives appear plausible.

Defined potential objectives (target states expressed as completed actions) and their breakdown and interrelationships are presented in terms of means and ends in a causal model. The "objectives tree" permits the presentation of not only monocausal structures but also more complex relationships through multiple entries for objectives, arrows showing relationships or numerical input/output points.

Proceeding from the core problem the workshop agreed on the objective "sustained production of food with marketable surplus in harsh areas" and converted the problem tree to a hierarchy of objectives (cf. Annex 3). The result showed that two different project types could be considered in order to reach the objective, a "crop and product development approach" and a "production system development approach". The participants were perfectly aware that general policy decisions such as e.g. protection of small grains against cheap grin imports will have a substantial influence on all possible progress in this field. It was accepted that marketing is clearly one of the most relevant contributors to a wider use of small grains and that every effort must be made to widen marketing possibilities.

In the course of the objectives analysis it became apparent that a pure R & D effort will not be sufficient to overcome existing obstacles. It was pointed out by some members that worldwide R & D has already provided answers to many if not most production, processing and marketing issues, but that either the lack of international R & D cooperation or adverse national agricultural policy decisions delay the utilization of such already established knowledge.

In this context the workshop returned to the discussion of small grains use in the SADCC region, outlining relations between producers and consumers (cf. Annex 4). This led to the conclusion that the market for small grains should be split into two areas, one covering the food sector and the other industrial utilization. This in turn may be divided into different sub-markets, since the desired properties of sorghum for malting differ from required for starch production, to mention only two examples.

6. Project Planning Matrix

The project planning matrix presents in matrix form the main project elements and objectives (i.e. project purpose and overall goal) emerging from the ZOPP process. The matrix has four levels, "overall goal", "project purpose", "results" and "activities", and four columns, "summary of objectives and activities", "objectively verifiable indicators", "means of "verification" and "important assumptions".

Due to lack of time the workshop concentrated on the results and activities and on important assumptions. On the basis of the extensive problems and objectives analysis the workshop decided to choose "sustained production of food with marketable surplus in harsh areas ensured" as the overall goal and "expanded utilization of small grains achieved" as project purpose (cf. Annex 5).

The workshop took great care to scrutinise important assumptions. The list of assumptions indicates the concern about the necessity of integrating any small grains project in an overall agricultural policy, e.g. "good policy allows economic production", or "prices encourage farmers to plant new varieties" etc.

7. Final recommendations

After establishing the project planning matrix the workshop members split up into sub-groups to discuss priority issues-in the following areas: institution building, marketing and R & D (c f. Annex 6). Due to the R & D background of most workshop members, researchoriented priorities were prominent in the ensuing list. After a renewed and sometimes most controversial discussion, a list of final recommendations (cf. Annex 7) was agreed upon. These recommendations cover the areas of policy, R & D and marketing.

[Participation analysis - Annex 1]

[Problem analysis - Annex 2]

[Objectives analyses - Annex 3]

[Diagram of small grains uses - Annex 4]

Project Planning Matrix - Annex 5

Goals Results Activities		Objectively Verifiable Indicators	Means of Verification	Assumptions
Goal	sustained production of food with marketable surplus In harsh areas ensured			
				- production of small grains restricted to harsh areas -dwellers do not emigrate harsh area to towns

Project Purpose	expanded utilisation of small grains achived			- credit transport infrastructure exist - sustainable production systems developed - technical advice/support on production and pavailableost-production
	1. High-yielding varieties with desired characteristics available 1.1 Provide the extension			**- prices encourage farmers to plant new varieties** **- support structures and working** **- volumes of high-yielding**

Results/ Activities	service the relevant plant production information 1.2 Multiply appropriate varieties 1.3 Design and carry out breeding programes for required varieties 1.4 Research and define desired and undesirable characteristics			**seeds planted and harvest** **- sustained demand exists** **- small grains used come from surplus production (robbing Peter for Paul)** **- small grain products remain competitive for the industry**
	2. Industry sells wider range of products out of small grains 2.1 Identify marketable products 2.2 Rand marketable products 2.3 Identify grain characteristics for the products 2.4 Install co-operation with breeders to test and develop new grains with identified			R 1 - breeding programme is successful - private and/or institutional

	traitsmarket 2.5 Develop marketable products 2.6 Execute testing of "new" products 2.7 Evaluate relation between cost prices and sales prices			seed multipliers are interested in taking over new varieties
				R 2 + 4
	3. Improved village level technologies developed and practised 3.1 Determine importance of sell grains in the production and food system 3.2 Identify priority areas for improving bottlenecks in			- marketable products can be identified - institutional capability exists including research and product development - sufficient scientific capability operation exist - products are acceptable and competitive in

	processing 3.3 Generate sound, affordable and socially acceptable solutions 3.4 Check new problems created by your candidate solution in the existing small grain food system 3.5 Try new solutions on a limited scale with families/community 3.6 Design and execute dissemination programmes			quality and price - good policy allows economic production (tax pricing exercising grain standard import, policy) - network for co-ordination possible - market conditions allow economic production - lack of marketable products is the only reason for not marketing
				R 3
	4. Greater utilization of small			- small grains

	grains in animal feed 4.1 Execute testing of grains a) as they are b) as prepared for feed (hens, pigs, cows) 4.2 Study possible uses (poultry, pigs, cattle 4.3 Evaluate market for feed of a) grains b) rations 4.4 Co-operate with feed millers 4.5 Study of by-products availability 4.6 Execute of by-products testing 4.7 Incorporate by-products in feed mills 4.8 Execute trials for use of by-products in feed 4.9 Stimulate growers 4.10 Co-ordinate all involved or likely to be (Min. of Ind., Min. of Agric, R$D Sector, Industry, Farmers, GM8, Traders)			are really relevant to villagers - bottlenecks are removable - key bottlenecks lie with processing and preparation - solution which meet technical, social and economic criteria can be found - comparative advantage of small grains vs. maize is being adjusted - enabling policy climate

[Annex 6]

Final recommendations - Annex 7

I Policy	II Research and development	III Direct marketing
1. Expand power of national bodies to create a small grain task force.	1. Develop acceptable grain from high yielding cultivars with graeter conveniences in food preparation.	1. Identify existing products, establish the demand for them and start diffusing them now with emphasis on rural areas.
Tasks: • formulate programme • coordinate work • lobby politicians • lobby industry	2. Identify and priorities industrialised marketable products as a prerequisite to product development.	2. Allow and improve intervillage trade to enable increased small grain utilisation and reduce undesirable surplus at GMB.
2.SADCC (REGIONAL): Form or strengthen a body to link breeders, technologists, consumers, manufacturers.	3. Perform imaginative investigation into animal feed use.	3. Start diffusion of blended products at low levels. e.g. composite meals and flours. Intensify research in

		collaboration with millers, bakers, breeders until final breakthrough.
3.DONORS GASGA to lobby donor agencies and governments on the importance of small grains; to coordinate prioritisation of small grain projects		

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