COLLABORATIVE PROJECT TO INVESTIGATE CONSUMER PREFERENCES FOR SELECTED SORGHUM AND MILLET PRODUCTS IN THE SADCC REGION OF AFRICA

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Research on sorghum and millets has focused mainly on agronomic and breeding aspects with little on consumer preference. The above project was undertaken to address this deficiency. Surveys were conducted in selected sorghum and millet production, marketing, processing and utilization areas in Tanzania. Visits outside the country were made to gather experiences.

It was found that sorghum and millets were grown without using agrochemicals thus resulting in low yields that were also caused by birds. Storage was a constraint to sorghum but not to finger millet. The improved varieties were higher yielding but more susceptible to storage pests and less appealing to consumers than the local varieties. The storage and bird problems are among the least attended constraints to sorghum. There was limited use of insecticides in storing sorghum. Processing facilities for dehulling sorghum were limited and relied mostly on the use of pestle and mortar, particularly in rural areas. Threshing was tedious and encouraged contamination with sand. Due to its slow digestion, pastoralists and farmers preferred consumption of pearl millet. Finger millet was good supplier of calcium and iron levels and thus appropriate for weaning. Marketing of sorghum in the production areas was a big problem. To increase utilization of sorghum and millets hardness, use of agrochemicals, availability of processing equipment, organized marketing and product development need to be addressed.

INTRODUCTION

Literature has cited food situation becoming increasingly worse way back in 1979 [1]. To date, this situation has not improved. Efforts to address food shortage in the country were made even earlier, particularly in 1977 when Tanzania experienced a drought. This was the time when improvement in production and utilization of sorghum were seen as a solution to the problem, especially in the semi-arid parts of Tanzania. A new mechanical flour milling system was popularized, i.e., the Prairie Regional Laboratory (PRL) dehuller and the Prairie Regional Laboratory/Rural Industries Innovation Centre (PRL/RIIC) dehuller[2]. These technologies were introduced to some regions in the country. The technologies failed to make a sustainable impact partly because of high cost and maintenance problems. However, today, with some modifications, some of these are still functional. One of the biggest drawbacks to the success of this dehulling was acquisition of carborandum stones that

got worn out after long time use. The Collaborative Project to Investigate Consumer Preferences for Selected Sorghum and Millet Products in the SADCC Region of Africa by then was seen as a way of identifying bottlenecks to sorghum production and utilization. The project implementation was seen as a way of enhancing food security as it would make these cereals more appealing to the consumers and make people living in semi-arid regions of the country, plant and eat more sorghum/millets. This will also as carter for the urban workers who are usually non-growers competing for the scarce maize in the country. Whereas wheat is eaten in most common forms like whole, porridge, leavened bread, unleavened bread, beer and spirits, snacks and breakfast cereal and as starch or glucose, sorghum is commonly used as porridge, leavened and unleavened bread and as beer and spirits. Pearl millet and other small millets are consumed as porridge, unleavened bread and beer and spirits [6]. There are no reasons for not widening the utilization options of sorghum and the millets.

The main objective of this study was to enhance food security in the region through promotion of drought tolerant crops such as sorghum and millets. The specific objectives were to find and characterize relative preferences for various cereals among different groups of consumers; identify key constraints to use of sorghum and millets in the different groups of consumers including ethnic, rural and urban groups. An additional objective was to identify sorghum varieties most suitable for meeting the technological requirements and organoleptic preferences of users; improve physico-chemical and functional characteristics of milled sorghum and millet products. Based on the findings, the grain would be developed and promoted by finding new opportunities for their use and identify commercial linkages and develop and promote new technologies. In this paper only some of the objectives have been addressed.

MATERIALS AND METHODS

Surveys

This study was mostly survey work in Tanzanian rural and urban places, where sorghum was being produced, consumed, processed or traded. In addition, the sorghum-marketing channel was traced right from the village to the ultimate consumers. The end users, namely households, food (Villages and National Milling Corporation), feed (Tanmix and Interchick Ltd.) and brewing (Darbrew Ltd.) industries were all involved in the study to establish their preferences for sorghum and millets use in their industries. Constraints experienced and future prospects were documented so that whoever was producing for a specific household or industry knew exactly what the end user wanted. The surveys employed Participatory Rural Appraisal (PRA) technique, where 10 to 15 people participated in the interview but for the urban and processors studies between 2 and 5 people directly involved in the processing of the grains were involved to generate the information presented and discussed in this paper. For comparison, some parts outside Tanzania, where sorghum was being produced and consumed were surveyed. They included Botswana where similar project activities were being implemented, South Africa and KIRDI (Kenya Industrial Research and Development Institute) where sorghum was being processed industrially.

Laboratory analyseS

Moisture content was determined by oven drying method at 105°C overnight. Protein determination was by Kjeldahl's technique (Nx6.25), using Kjeltec system. Crude fat was determined by extracting oven-dried sample (5 g) with hexane using Soxhlet continuous extraction for eight hours. Ash content was done by ashing the sample in a muffle furnace at 550°C to a constant weight. Crude fibre determination was done using the Fibretec technique. In all except ether extract determination, 1 g sample was used and all determinations were conducted in duplicate. In all the analysis the methods cited were AOAC (1990)[3]. Hardness, 1000 grain mass (g) visual score, dehulling losses, water absorption capacity and endosperm texture were determined as detailed in the ICRISAT Technical Manual No. 2 [4].

RESULTS

Types of villages and extent of production of coarse grains

The six villages (Table 1) were quite diverse in suitability of production of different coarse grains (sorghum, pearl millet and finger millet).

Main cereals cultivated in the survey villages and major forms of use

Maize, sorghum, pearl millet, finger millet and rice were common cereals produced in Dodoma villages and the main forms of use were as food, beer or for cash (Table 2). Maize, pearl millet and white sorghum were main cereals in the Dodoma villages, but extent varied with type of soils in the village.

Characteristics of cereal crops as judged by farmers

As seen in Table 3, the cereals differed greatly in terms of yield, tolerance to poor sandy soils; drought, pest and disease resistance. There was also variation in ability to thresh, storability, ease of processing, palatability, ease of marketing and price relative to maize, the common cereal in the country.

District	Village	Characteristic production levels
Dodoma Urban	Mahomanyika	Low sorghum/millet
	Hombolo Makulu	High sorghum
Dodoma Rural	Chipanga A	High sorghum and millet
	Mpalanga	High millet
Kondoa	Mondo	High finger millet, pearl millet, average sorghum
	Bumbuta	High pearl millet,some sorghum and finger millet
Urban		
Dodoma	Dodoma Market	Sorghum and millet sale
Dar es Salaam	Dar es Salaam Market	Sorghum and millet sale
	Pemba Island Market	Sorghum consumption outlet
		Sorghum in animal feeds
	Interchick	Sorghum in animal feeds
	Tanmix	Sorghum in brewing (*kibuku*)
	Darbrew Ltd	

Table 1 Surveyed villages in Dodoma region, trade and processors

Village	Main cereals	Use
Mahomanyika	Maize (main)	Cash, food
	White sorghum	Food
	Pearl millet	Food
	Finger millet	Cash
Hombolo Makulu	White sorghum (main)	Food
	Pearl millet	Food
	Maize	Food and cash
Chipanga	White sorghum (main)	Food, brewing
	Pearl millet	Food, brewing
	Rice	Cash
	Maize	Food, cash
Mpangala	Pearl millet (main)	Food, brewing
	White sorghum	Food, brewing
	Maize	Food, cash
Bumbuta	Pearl millet (main)	Food, brewing
	White sorghum	Food
	Red sorghum	Brewing, food
	Finger millet	Cash
	Maize	Food, cash
Mondo	Pearl millet (main)	Food, brewing
	Maize	Food, cash
	White sorghum	Food
	Finger millet	Cash

Table 2 Main cereals cultivated in the survey area and major forms of use

Characteristic	Pearl millet	Local white sorghum[a]	Improved sorghum (Tegemeo)	Local red sorghum[b]	Finger millet	Maize
Yield	Low but reliable	Low but reliable	Higher than traditional varieties	Low but reliable	Low	Higher in good years
Tolerance to poor sandy soil	Good	Fair	Fair	Fair	Fair	Poor
Drought tolerance	Good	Good	Good	Good	Fair	Poor
Pest resistance	Susceptible to birds	Susceptible to birds	Susceptible to birds and insect pests	Good	Good	Susceptible insect pests
Disease resistance	Good	Good	Poor especially in wet years	Good	Good	Medium
Threshing	Difficult	Easy	Easy	Easy	Difficult	-
Storability	Good	Good	Very poor	Good	Very good	Poor
Ease of processing	-	-	Poor	-	-	-
Palatability	Good hunger food	Good	Poor	Poor	Good and nutritious	Good
Ease of marketing	Poor	Poor	Poor	Poor	Good	Good
Price relative to maize	Same or a bit lower	Same or a bit lower	Same or a bit lower	Much lower	Much higher	

[a] Lugugu and Langalanga varieties [b]Udo, Ilolo, Ichicha, Ikorobo varieties

Table 3 Characteristics of cereal crops as judged by farmers

Results of urban center studies

Constraints to utilization of sorghum in the food, feed and brewing industry were mainly related to erratic supply, inadequate amounts, tannin content, colour and sand contamination (Table 4).

Physical characteristics of local and improved Tanzanian sorghums

Table 5 compares the improved sorghum varieties (Tegemeo, Pato and Macia) and local ones (Lugugu, Udo and Langalanga). The ranges for these characteristics for the improved and local varieties, respectively were: Hardness 8.55-13.27, 4.65-13.73; 1000 grain mass 21.1-28.6,16.5-23.0 and Visual score 2.3-2.8,1.0-4.2. Dehulling loss (%) was 9.7-10.1, 7.13-17.53 and Water holding capacity 9.6-11.45, 6.10-17.05. The improved varieties were either mostly corneous or had intermediate texture whereas the local varieties were all intermediate in endosperm texture.

Name of industry	Location	Category of industry	Constraints to sorghum use	What preferred from sorghum
National Milling Corporation (NMC)	Dar es Salaam	Food	-Erratic supply of sorghum - Inadequate quantities -Red/brown varieties unliked	-Reliable supply of sorghum -Adequate quantities and -white/cream colour
Interchick and Tanmix	Dar es Salaam	Feed (mostly chick meal)	-High tannin varieties not preferred -Erratic -Supply not preferred - Inadequate amount	-Supply low tannin types Ensure reliable supply -Supply required amount
Darbrew Ltd	Dar es Salaam	Brewing	-Erratic supply -Inadequate amount -Sand contamination	

Table 4 Results of urban center studies

Variety	Hardness	1000 grain mass (g)	Visual score	Dehulling loss[5]	Water absorption[5] (%)	Endosperm texture[5]
Improved						
Tegemeo	8.55	28.6	2.6	9.7	11.45	Intermediate
Pato	9.22	31.8	2.3	10.10	9.60	Mostly
Macia	13.27	21.1	2.8	-	-	corneous
						-
Local						
Lugugu	13.73	21.9	4.2	7.13	6.10	Intermediate
Udo	4.65	16.5	1.0	17.53	17.05	Intermediate
Langalanga	8.56	23.0	2.9	9.40	15.0	Intermediate

Table 5 Physical characteristics of Tanzanian local and improved sorghum

Proximate compositions of some local and improved sorghum varieties

The proximate composition of the improved and local sorghum varieties is not so variable for crude fat, protein, fibre and ash, when the results in Table 6 are expressed on dry weight basis.

Variety	Moisture	Crude fat	Crude protein	Ash	Crude fibre
Improved varieties					
Tegemeo	7.20	3.60	8.82	1.30	3.25
Macia	8.50	2.80	7.21	1.17	2.88
Pato	10.01	2.20	9.65	1.43	2.91
Local varieties					
Lugugu	8.70	2.40	7.42	1.42	2.71
Mbangala	9.50	2.20	9.24	1.27	2.71
Sandala	9.50	2.20	8.12	1.57	3.16

Table 6 Proximate compositions of some local and improved sorghum varieties (%)

DISCUSSION

Survey

Table 1 revealed that although Dodoma was generally sandy, soil type varied with locatiom. This fact made some villages suitable for one cereal but not the other. The relatively more fertile villages favoured maize production and had therefore less sorghum, for example Mahomanyika village. The relatively dry villages were more suited to drought-tolerant crops like sorghum and pearl millet. In spite of this variation in crop type, still sorghum and millet were important crops in the Dodoma villages.

The main crops grown in the survey villages were sorghum, maize and pearl millet (Table 2). In some villages like Mondo and Bumbuta, finger millet was an important cereal. All of these crops were grown for food, and/or cash but others like finger millet were for cash, e.g., in Mondo and Bumbuta villages. Brewing was another important use given to these cereals, particularly white sorghum and pearl millet. Rice was mostly produced for cash. As depicted from Table 2 any of these cereals could be the main crop and thus a major food or source of household income, through sale of the cereal or beer prepared from it.

As judged by the farmers (Table 3), the pearl millet, local sorghums (red and white), finger millet and maize differed in their characteristics. For example, the local sorghums, pearl millet and finger millet yielded lower than improved sorghum and maize yields were highest. Despite low yields, only local sorghum and millet varieties gave reliable yields. Maize was grown with a lot of suspicion of crop failure. Also, maize was not tolerable to poor sandy soils of Dodoma but the other cereals were

tolerant and pearl millet was the most favoured according to the farmers. Drought tolerance was a common characteristic of the coarse grains but maize was not drought tolerant. With the exception of finger millet and red sorghums, the other cereals were quite susceptible to pest damage (insects and/or birds). Local sorghums were more resistant to pests than the improved. Only improved varieties and maize showed poor resistance to diseases. Threshing problems were outstanding in finger millet and pearl millet despite the advantages cited over the other cereals. The improved varieties also showed poor processing in the traditional processing due to relatively high dehulling losses. The red local sorghums and the improved varieties were less palatable but could be used for brewing. Only maize and finger millet could be easily marketed thus exposing marketing as a bottleneck to marketing sorghum. Finger millet fetched higher prices than maize because it was highly demanded and had an advantage of keeping longer without facing damage by insect pests, mostly because of the small size.

Pearl millet was mostly used in the households. Finger millet was mostly traded and had no storage problem. However, the most commonly traded of the coarse grains was sorghum. Constraints to its industrial utilization in the food, feed and brewing industry (Table 4) were mainly related to erratic supply that caused uncertainty in its supply, inadequate amounts available for industrial processing, high tannin content of some varieties, especially the brown sorghums, colour in foods and sand contamination that lowered quality of food prepared with sand-contaminated sorghum.

The proximate composition of the improved and local sorghum varieties is not so variable for crude fat, protein, fibre and ash, when the results in Table 6 are expressed on dry weight basis. With the exception of Udo variety that was the softest (hardness 4.65) the remaining varieties were looked similar 8.55-13.27 for the improved compared to 8.56-13.73. Therefore their hardness was comparable and is confirmed endosperm classification results that grouped most of them under intermediate texture. Grain size between the local and improved varieties was also comparable with the exception of Pato that had highest grain size (31.8 g) and Udo the lowest (16.5). Visual score assigned the lowest score to Udo that was brown colour. The other varieties were similar except lugugu that scored 4.2 as visual score. Dehulling scores were highest for Udo variety that is not dehulled for food but is instead used for brewing. Dehulling losses of the other varieties were similar except for Lugugu that was lowest. This could be among the major reasons for preference of this variety for food that it dehulls well. Water absorption was highest in Udo explaining its preference in brewing, as it has to absorb close to 20% water for the diastatic enzymes be effective in degrading the starch in the grain in malt production.

Generally, the survey in the villages exposed several facts regarding sorghum and millets when the local varieties were compared with the improved ones. Up to the time of survey the local varieties were still dominating. It was interesting to note that even though there was nobody advocating production and utilization of the local varieties, such varieties survived this competition with the improved ones, to excel as winners in this battle. With the exception of Serena (improved variety) introduced to address the bird problem, that has almost disappeared, the improved varieties were all

white and this is a quality desired by consumers. They also had large size that was again preferred by consumers.

However, as argued by farmers, improved varieties are disliked because, first they cannot keep their viability so that they can be used as seed for the next crop. Second, they cannot be stored long so that they can ensure household food security as insect pests, particularly *Sitophilus spp* attack them easily, Third, due to some of them having a big proportion of floury endosperm, dehulling losses are higher than those of the local varieties. This makes farmers reluctant to accept varieties with poor dehulling qualities. The traditional/local varieties have a large proportion of corneous endosperm that increases their resistance to pest attack. Fifth, although they yield low, traditional varieties are more palatable than the improved varieties. From the village survey in Dodoma, sorghum and pearl millet were still subsistence crops unlike rice, finger millet and maize that were outstanding in participation in local and distant trade. Despite this, some sorghum was being traded in Dodoma and Dar es Salaam regions and even in Pemba island.

Processing of these grains still relied on the rudimentary technology of pestle and mortar unlike maize and rice that had processing facilities within the vicinity of the consuming villages. Despite this limitation, sorghum was still important and popular in urban centers and were believed by farmers to be good in feeding diabetics. Sorghum and pearl millet were popular in rural areas for nomads and farming communities due to their slow digestion that made people eat once a day and travel long distances without feeling hungry. Finger millet was an outstanding cash crop in its area of production and also because of its nutritional excellence it was popular in weaning foods. In these foods, it supplied a lot of Ca and Fe plus the B group vitamins.

External visits exposed different ways of threshing and processing sorghum in other parts of Africa. In Kenya, for example *Supa Mtama* developed about two decades back was essentially supplying in the market dehulled sorghum that could be used in dehulled sorghum products like *kande* (sorghum cooked with beans) or could be milled into flour for porridges. Consumption of fermented sorghum for use in porridges, like *bogobe* in Botswana is something that could be copied in communities used to consumption of fermented flour products. Industrial processing of sorghum in Kenya and South Africa was something that could easily be copied in Tanzania when conditions allow and when there is an entrepreneur to produce for the community. Packaging of sorghum and millets and millets is one aspect that is lacking in Tanzania except in isolated cases. If introduced, coupled with appropriate package sizes, it could ensure convenient handling of sorghum even in super markets within and outside the country.

CONCLUSIONS

Research on sorghum will always be ongoing and unless the results are utilized, the story will be the same year after year. For Tanzania, to make progress in sorghum production and utilization, several problems highlighted in this paper need to be addressed. First, use of agrochemicals during preharvest and postharvest periods are

necessary and need emphasis. Second, the bird problem has been neglected and is not therefore, seen as a problem needing immediate attention, particularly by the breeders who have succeeded in improving yield of compact-headed sorghums that are easily attacked by birds. Sorghums with loose heads like the local varieties could offer a solution. Third, to the ultimate Tanzanian consumer, for food use, white or cream colour and palatability are paramount. Yield comes later. Fourth, storage pests are a big constraint to sorghum production and if addressed could make more people grow and eat more sorghum and the millets. It thus calls for immediate intervention. Fifth, if time-saving dehulling facilities are made available to rural households, sorghum consumption and thus production could be increased. Sixth, the problem of sand contamination of sorghum originates from threshing on the ground. This could be easily avoided by introducing use of mechanical threshers that could improve greatly the quality of sorghum-based foods. Seventh, The potential of finger millet need to be exploited, especially in communities that are nutrient deficient. Eighth, reliable markets are essential for promoting sorghum. These can only be operational if there is proper networking at national and international levels. Lastly, there are limited utilization options of these crops in the consuming communities, a problem that could be rectified through product development. Adapting already successful technologies and products from other regions within and outside the countrycould be the way forward and again, underscores the need for networking.

From these conclusions, it is recommended that, given the large community sorghum and millets are serving as food, feed and beer; researchers, policy makers and other stakeholders need to be aggressive in ensuring increased production for food security. In this context, minimizing bird and storage pests damage need immediate attention. In addition, assistance in improving dehulling, decreasing sand contamination and ensuring organized markets is needed. Good quality and appealing foods need to be in place as a result of product development work. In achieving all these goals networking is central and has to facilitate exchange of information from production, processing, marketing and utilization of the sorghum and the millets. Sorghum foods need to target biggest forms of consumption which are mostly porridges and dehulled sorghum and millet products.

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