RAPID
CHEMONICS INTERNATIONAL, INC.
REGIONAL ACTIVITY TO PROMOTE INTEGRATION THROUGH DIALOGUE AND POLICY IMPLEMENTATION

Task Order 4.1

DEVELOPMENT OF SIMPLE, COMMON GRAIN QUALITY STANDARDS FOR SORGHUM, TO FACILITATE TRADE IN SOUTHERN AFRICA

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LIST OF ACRONYMS AND ABBREVIATIONS

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BAMB	Botswana Agricultural Marketing Board
BOS	Bureau of Standards
Codex	Joint Codex Alimentarius Commission of the FAO and WHO
COMESA	Common Market for Eastern & Southern Africa
CSIR	Council for Scientific and Industrial Research
DP	Diastatic Power
FAO	Food and Agriculture Organisation of the United Nations
G&S	Grading and Standards
GMB	Grain Marketing Board
GM	Genetically modified organisms
ICC	International Association for Cereal Science and Technology
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ISO	International Standards Organisation
MGM	Manyaka Greyling Meiring
MSU	Michigan State University
NGO	Non Governmental Organisation
RAPID	Regional Activity to Promote Integration Through Dialogue and Policy Implementation
RH	Relative humidity
SACCAR	Southern African Centre for Cooperation in Agricultural and Natural Resources
SADC	Southern African Development Community
SAFEX	South African Futures Exchange
SD	Standard Deviation
SMIP	Sorghum and Millet Improvement Programme
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VAT	Value added tax
WFP	World Food Programme
WHO	World Health Organisation of the United Nations
WTO	World Trade Organisation
ZIMACE	Zimbabwe Agricultural Commodities Exchange

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SUMMARY

Work was carried out under Task Order 4.1 of IQC No 690-1-00-00-00149-01 by Chemonics International, Inc. as an activity for USAID. The task was to develop simple common grain quality standards for sorghum to facilitate grain trade in southern Africa.

This final report on the sorghum grades and standards activity covers the process used, the market analysis, the sorghum grades and standards endorsed by the working group, and the workplan for implementing those grades and standards. The report recommends additional steps to be taken by government, industry and donors to promote the commercialization of the sorghum and expansion of sorghum trade. The report is submitted to fulfill requirement 4.108 of the Task Order.

Section 1 is an introduction of the process used. It specifies the activities completed: Technical Report #1 "Market analysis and feasibility of sorghum grain standards for southern Africa's industrial processors", Technical Report #2 "Methods to be used to identify and specify characteristics desired by industrial processors that use sorghum as an input", Ring trial procedure to validate methods, Workshop to review the reports and ring trial results, and solicitation of a Working Group to carry out further activities. Consideration is given to the use of the system analysis method for analyzing the sorghum commercial marketing system, the function of grades and standards in that type of system and the concept of using simple qualitative methods for sorghum differentiation in a developing marketing system.

Section 2 provides an assessment of current sorghum grain standards in Botswana, South Africa, Tanzania and Zimbabwe. Results of a survey conducted by the authors in the four countries of sorghum grain quality criteria considered important by the sorghum community was evaluated. It was concluded that the interviewees considered five selected criteria: high-tannin/non-tannin, grain colour, hardness, germinability and grain purity all to be important with respect to sorghum end-use quality. Certain other criteria, in particular grain cultivar, are also considered to be important. Survey results from the same participants regarding role of quality in sorghum marketing and facilitating marketing services to increase sorghum trading were evaluated. The major concerns and suggestions were summarized by country. Analysis of current production and potential use provided an estimate of 101,000 MT or 35% potential increase over current use for the commercial marketing system of the four countries following the implementation of the proposed quality methods and gradual resolution of other marketing impediments. The estimated economic gain for traditional farmers in the four countries was over US$330,000.

The material in Sections 3 through 5, focuses on activities that took place after Technical Reports #1 and #2 were prepared. Section 3 initially covers the development of the simple methods. Then a collaborative evaluation trial, also known as a Ring Trial was carried out with the objective to establish whether the methods can be followed and carried out by persons other than the laboratory that developed the method, and to determine the between persons variability of results obtained by the method. It was concluded that all the five methods would work reasonably well in their intended application, that is in the sorghum trading situation in southern Africa.

After validation of the five methods through the Ring Trial, a workshop was held in Johannesburg, South Africa. Objectives were: to report on the surveys and studies to date, report on the development and evaluation by Ring Trial of the five simple methods of sorghum quality, familiarisation of the methods by hands-on testing of sorghum grain samples, review workshop results and propose suggestions for revisions or additional considerations, and finally to propose a strategy and workplan for implementing the proposed methods and grades including the nomination of an *ad hoc* Working Group to carry out the proposed strategy.

Section 4 covers the reports back from the workshop participants on the test methods and recommended sorghum grain quality grades and standards. Recommendations and suggestions on a strategy to implement proposed grades and standards are summarized. A process to take the initiative forward to implementation is also covered through summaries of report backs by breakout groups.

In Section 5, the workshop participants' workplan for implementing sorghum grain quality methods and standards in southern Africa is outlined with emphasis on stakeholder identification, publicity, institutional relationships and structure, and training. Members of the *ad hoc* Working Group were selected and an action plan proposed and accepted.

The report continues in Section 6 with recommendations for additional work to facilitate sorghum grain marketing in the region. These include: suggestions to facilitate activities of the *ad hoc* Working Group; additional quality methods to be developed and tested; investigation of the types of sorghum quality needed for sorghum grain uses of wet milling for starch and technological investigations of milling and new products; expanding the simple quality methods concept to nearby countries of Malawi, Mozambique, Zambia, Lesotho and Swaziland; and, an economic analysis of the VAT effects on producing and marketing sorghum grain in South Africa.

References and author contact details are provided in Section 7.

Appended to the report is a listing of workshop participants, the workshop press release, the brief for government officials, a sorghum instant food product description, and the sorghum grain quality methods written in the format of the ICC.

1 INTRODUCTION

The overall objective of this USAID/RAPID sponsored project, "Development of simple, common grain quality standards for sorghum, to facilitate grain trade in southern Africa" is as follows:

> "The purpose of the activity described in this task order is to facilitate grain trade, particularly sorghum, in Southern Africa. This will be accomplished by developing simple, grain quality grades and standards for sorghum. Common grain quality grades and standards are a prerequisite to increase the trade and marketing of this crop, particularly trade between countries within the Southern Africa Development Community (SADC). Under this task order, a simple set of standards for sorghum grain quality will be validated by the region's grain traders and the region's food and feed sorghum grain processing industry. Regional grades and standards implemented by industry in SADC may also be endorsed by the International Association for Cereal Science and Technology (ICC), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and SADC".

Technical Report #1, "Market analysis and feasibility of sorghum grain standards for southern Africa's industrial processors" covered that portion of the activity related to the economic aspects of the project. It was completed in June, 2001 by Dr. Floyd F Niernberger, Market Economist (Niernberger, 2001). Technical Report #2, "Methods to be used to identify and specify characteristics desired by industrial processors that use sorghum as an input" described the aspects of the investigative activity related to development of methods to determine sorghum grain quality. It was completed in May, 2001 by Professor J R N Taylor, Food Scientist (Taylor, 2001). There were five methods developed as a result of the research. These were: Detection of high-tannin sorghum grain, grain color, grain hardness, germinability and grain purity. The methods were evaluated by the Ring trial procedure and a validation conducted. A workshop to review the Technical Reports was held after validation was completed. An outcome was a grades and standards working group of interested parties in the southern Africa region to propose activities to carry out means of introducing use of the methods by sorghum traders and processors. This is the final report on the sorghum grades and standards activity.

The project team consisted of an agricultural economist and food scientist. The interaction of the two disciplines proved invaluable in conducting the interviews and discussions about the information provided by interviewees. The effectiveness of the partnership resulted in consideration of Grades and Standards issues that might have been overlooked without the thoughtful analysis of the other concerning the consequences on either food science or economic prospects.

Governments is southern Africa now recognize the importance of liberalizing grain markets. From state marketing board control, countries starting in the 1990's turned to free-markets and began promotion of market-orientated economic activities carried out by the resurging private grain sector. Unfortunately, money for this purpose is often unavailable and any undertaking limited.

There are two major southern Africa trade blocs that are implementing free-trade agreements among members: The Southern Africa Development Community (SADC) free-trade area and the Common Market for Eastern and Southern Africa (COMESA). Both trade areas foresee the removal of tariff and non-tariff barriers to trade among members. Passage of the US Africa Trade Act last fall allows products from sub-Saharan Africa, preferential access to the US market. Because the US itself is a major producer and world exporter of sorghum, this Act will have little impact on the likelihood of sorghum products from southern Africa, even duty free, finding a

market in the US. In the case of sorghum grain, SADC at present offers the most opportunity for increasing trade in southern Africa.

1.1 Sorghum Commercial Marketing System Analysis

A way to evaluate the impact of the proposed quality methods on the sorghum food and feed grain complex is to consider that the marketing process as an interrelated system and that quality effects in one sector pass forward and backward throughout it. One marketing classification could be to consider all decisions and transactions from farm until final sale to consumers. For purposes of this analysis, the sorghum commercial marketing system was interpreted as beginning at the farm gate as sorghum moved into commercial channels and ends after sorghum is made into products at the processor (wholesalers and retailers of product are not considered). The focus is on commercial activities because a large percentage of sorghum grown in southern Africa is for subsistence use where grown or used in the local area. There are several main ways this takes place. One is, local consumption by the farmer either by direct home use (hand preparation into meal) or by taking sorghum grain into a village mill operation (hammermill) and bringing the ground meal back home for consumption. Another local use is the farmer selling sorghum grain to villagers where it is ground into meal and returned to the purchaser or the farmer selling directly to the miller. A third use is that sorghum is sold to a village traditional brewer where the product is made and sold for drinking at or around the facility where it is made. Sorghum for all of these purposes was considered local use and not commercial marketing. The reasoning is that this sector of sorghum consumption is not thought to have potential for significant increase and movement into marketing until the commercial marketing system first expands and then demands additional production. Population growth is low; migration to urban areas from farms is significant, and the subsistence growers will by necessity consume what they can produce.

Elements of the commercial sorghum marketing system can be identified by physical functions of assembly, storage, transportation and processing. Also to consider are facilitating functions of market information and commodity exchanges, grades and standards, financing activities, and Government policy/research/extension. There can be other processes included, but these categories are most familiar to grain marketing participants. The development and expansion of commercial marketing can contribute greatly to the commercialization of subsistence farmers because it will provide outlets and incentives for increased production.

1.2 Grades and Standards

Grades and Standards (G & S) are considered a facilitating service function in the above marketing system. G & S define in a uniform manner what quality factors are considered important by the country approving them, with limits/defined values for these factors and identification of the methods used for determining the factor values. The value of G & S is in providing information to enable participants who wish to trade sorghum a recognized base so that they can communicate effectively and contracts or price can be negotiated. Using a standard allows trade to progress beyond the necessity of visually and physically handling the sorghum to viewing the G & S results. Uniformity in the application of G & S is essential if buyers and sellers are to have confidence in the measurement and interpretation of results. A central organization is thought to be often necessary to achieve uniformity of testing application and reporting. Also, many feel adherence to proper procedures requires regulation and enforcement by a central body. Standards are generally developed by industry participants through Government support and usually regulated by the Government. Usually the Government attempts to recover partial or entire costs by some type of user fee or assessment for services. In the case of a grain standard this often consists of inspection and license fees, laboratory charges, certificate fee, appeal fee,

and so forth. The imposition of additional costs of G & S on a developing free-market system where costs at most stages are already high because of small volume and inadequate infrastructure could result in little participation or use by private industry.

Botswana, South Africa, Tanzania and Zimbabwe are subscriber members of the International Organization for Standardization (ISO), one of the associated groups of the United Nations International Development Organization, dedicated to a worldwide awareness of necessary activities for development. Each country has a Bureau of Standards (BOS) organization within the Government that follows the requirements and guidelines for ISO membership. Requirements include procedures for use of approved quality methods and accredited testing laboratories. The review of sorghum grain standards reported in Technical Report #2, reported that South Africa and Zimbabwe have sorghum grain quality standards (grades), with Botswana currently reviewing proposed standards. It is expected that any sorghum grain quality methods developed as a result of this USAID/RAPID study would follow the ISO procedures for standards development. This would involve sorghum industry members requesting the Agricultural and Food Standards Committee in a country to consider the proposed methods and possible standards. There follows a defined series of reviews and meetings between industry committee members and BOS, with eventual public involvement in the process. Recommendations are submitted by the committee to BOS for approval/disapproval that can culminate in published standards for the country.

1.3 Quality Methods Concept

A few simple qualitative criteria of sorghum characteristics may be all that is needed to facilitate initial classification of southern Africa production into desired groupings for industrial processors. It was proposed that methods to identify the quality characteristics be inexpensive, simple, sustainable and not require laboratory conditions or trained personnel to conduct them.

Use of the methods is primarily for grain differentiation at the beginning stages of the marketing system, although they can be used throughout. This could allow users to identify sorghum offered for sale at the assembly stage, then to maintain separation in desired quality categories until processing. By doing this, the current difficulty in gathering small amounts of differing quality sorghum from farmers into economically sized transport loads which results in mixed quality of the cargo can be avoided. By the buyer selecting the quality desired and pricing the offering accordingly, the price signal is transparent to the grower as to the quality desired in the commercial market**.**

1.4 Constraints to Sorghum Grain Marketing in Southern Africa

There were a number of constraints to increased commercial sorghum marketing within and between the four Southern African countries surveyed in this study. These were discussed in Technical Report #1. A summary of these by country is contained in the physical and facilitating function tables (Tables 2.6 and 2.7) shown in the next Section 2.3. An overview is that there are constraints of high assembly costs in the traditional farming areas because of transportation, small lots of sorghum for sale, and undesirable milling and malting varieties being grown. The smaller mills lack capital or ability to borrow sufficient money to purchase necessary cleaning equipment and sufficient storage space to efficiency process the present quality of sorghum (high amounts of defects, dirt, stones, etc.) being offered for sale by smallholder farmers. There are infrastructure problems in some countries: having inferior farm to market roads and, during rainy season, impassable roads from main growing regions to markets; need for extension services to educate smallholder and even middle size growers in marketing techniques now that free markets have replaced grain boards; lack of consistent, accurate, and timely market information available to

growers; and gaps in extension services providing information on improved milling varieties, management training, and nutritive value of low tannin sorghum.

This study focuses on the potential benefits of rapid and inexpensive methods of determining quality for use in grades and standards, to facilitate sorghum commercial trading. The enhancement to commercial marketing functions from use of the proposed standards creates a stronger market potential and reduces the effect, in some cases, of the other aforementioned constraints. Inexpensive quality methods that can be used at the farm-gate by both farmers and traders to classify sorghum grain quality as it is being assembled are a stride forward to address marketing constraints of sorghum. It follows that to continue the potential marketing increase from adoption of proposed methods and standards that the other constraints should be subsequently addressed.

2 SURVEY OF SORGHUM GRAIN STANDARDS AND MARKETING IN SELECTED SOUTHERN AFRICAN COUNTRIES

An assessment of current sorghum grain standards and proposed sorghum quality methods and standards impact on the marketing system of four southern Africa countries was undertaken during the period February to April 2001. Interviews with persons working in the sorghum sector were conducted in Botswana, South Africa, Tanzania, and Zimbabwe.

2.1 Current Standards and Proposed Standards in Southern African Countries

In southern Africa, only South Africa and Zimbabwe currently have sorghum grades and standards. The South African standards (South African Department of Agriculture, 1999) classify sorghum varieties according to their potential to produce good quality malt, that is malt having high diastatic power (amylase activity) which is used for opaque beer brewing.

The South African classification system grades sorghum varieties into the three groups

- GM-malting class, no tannins, high diastatic power
- GL-feed class, no tannins, low diastatic power
- GH-malting class, tannins, high diastatic power

The three classes are then divided into various grades, according grade purity, with specifications for: foreign matter, unthreshed sorghum, defective sorghum, small kernel sorghum, sorghum of another group, white sorghum, weather-stained sorghum. The major omission in the South African grading system is that there are no specifications for sorghum for milling, which is other major use for sorghum in southern Africa. This omission is of importance since malting sorghum varieties are often soft, whereas for milling hard kernel sorghums are required. There is also a problem with respect to malting quality. Sorghum grain (ungerminated grain) has no diastatic power. To develop diastatic power the grain must be malted (germinated). Dead grain does not germinate. The standard does not specify germinability

The Zimbabwean Grain Marketing Board regulations divide sorghum into four grades: A, B, C, or D according to colour, endosperm type and whether grain is birdproof (high tannin) or not (Beta, 1998).

- Grade A-unmixed white and red varieties, excluding bird proof and horny (vitreous) endosperm types
- Grade B & C-unmixed white and red varieties possessing a horny endosperm, excluding birdproof varieties
- Grade D-any variety of sorghum, which is birdproof (high-tannin) or fails to comply with provisions applicable to A, B, or C.

Within the grades there are specifications for: maximum moisture content, test density (weight), defects, and germination. In summary, the regulations deal with the issues of malting quality (germination) and milling quality (horny endosperm grain). However, methodology for the regulations does not appear to have been standardised.

In Botswana, the Botswana Bureau of Standards is in the process of developing standards for sorghum for human consumption, based on end-use quality (Botswana Bureau of Standards, 2001). Four classes have been proposed: Food, Feed, Malting and Other. Within in each class it is proposed that there be sub-classes according to the colour of the grain and whether it is a tannin (high-tannin) type.

The lack of common standards and deficient within country standards for sorghum in southern Africa showed the need to identify which particular quality criteria are considered important by the sorghum community with respect to sorghum utilisation. This would facilitate the development of simple analytical methods to measure well-defined parameters based on these criteria and hence implementation of uniform quality standards for sorghum in southern Africa.

2.2 Survey of Sorghum Grain Quality Criteria Considered Important by the Sorghum Community in selected Southern African Countries

2.2.1 Procedure

During the period February to April 2001 a survey of persons in the sorghum community in southern Africa was undertaken to determine which sorghum grain quality criteria they considered to be of importance with regard to end-use. Five criteria were selected:

- High/Non-tannin grain. High-tannin (tannin) grain is not desirable for porridge or rice type applications. High-tannin grain also is not appropriate for use in home brewing of traditional beverages, but can be used for industrial malting.

- Grain colour. Brown and red grain is required for brewing. Some communities like porridges from red grains. Typically, white sorghum grain is preferred for stiff porridge; i.e. when maize meal is the alternative.

- Degree of grain hardness. For milling, the grain must be hard; otherwise the meal yield is poor and often uneconomical. For malting, hardness is not so important.

- Live versus dead grain (Germinability). Obviously if the grain is dead it does not germinate. If it does not germinate it will not produce the diastatic power (amylase activity) required from malt for brewing traditional beverages.

- Grain purity. Consumers have a strong preference for sorghum products that are not full of foreign matter (sand, dirt, small rocks, rodent remains and droppings, chaff, etc.). Foreign matter reduces the units of output per unit of input for industries and may significantly increase the rate at which industrial equipment wears out.

A questionnaire was prepared whereby respondents were asked to rate these criteria on a 1 to 5 scale, where 1 = most important and 5 = least important. The respondents were also asked to state which other quality criteria they considered as being important with the regard to end-use. The respondents were given the choice of either: not specifying the end-use for which the criteria were important, or specifying the criteria which were important for milling and/or malting.

The survey was performed in four selected countries in SADC (the Southern African Development Community): Botswana, South Africa, Tanzania and Zimbabwe. The countries were selected for the following reasons:

Botswana – has the highest per capita consumption of sorghum
South Africa – has the most developed sorghum processing industry
Tanzania – has the highest sorghum production
Zimbabwe – has considerable potential to increase commercial production and sorghum processing

In so far as practical as wide a range as possible of respondents involved in sorghum utilisation was surveyed. The respondents were categorised as follows: brewer, government/parastatal, maltster, miller, scientist, stockfeed manufacturer and trader. They were interviewed in person by Prof J R N Taylor and/or Dr F Niernberger. A total of 39 questionnaires were completed: 9 from Botswana, 16 from South Africa, 5 from Tanzania, 8 from Zimbabwe, plus 1 from a Mozambique sorghum scientist currently studying in South Africa.

2.2.2 Results

Survey responses are summarized in the following Tables 2.1 through 2.3.

Table 2.1: Sorghum grain quality criteria considered as important by industrial processors and other persons in sorghum community in selected countries in southern Africa (Scale: 1 = most important, 5 = unimportant)

		Quality Criteria					
Respondent description	**Country**	**High tannin/ Non-tannin**	**Grain colour**	**Hardness**	**Germin-ability**	**Grain purity**	**Other**
End-use Milling							
Miller	Botswana	1	2	1		2	Moisture
Miller	Botswana	1	1	1		1	Cultivar
Scientist	Botswana	1		3		2	
Brewer	Botswana		1				
Gov/Parastatal.	Botswana	1		3		2	
Scientist	Mozambique		2	1		1	
Miller	South Africa	1		2			
Trader	South Africa		2	1			
Trader	South Africa	1		1			
Gov/Parastatal	South Africa	2	3	1			
Gov/Parastatal	South Africa		1			1	
Miller	South Africa	2	3	1			
Scientist	South Africa	1	2	1		1	Cultivar
Trader	Tanzania					1	Grain size
Miller	Tanzania		1			2	
Trader	Zimbabwe		3	2		1	
Miller	Zimbabwe		2			1	
Miller	Zimbabwe		3	1		2	
End-use malting							
Maltster	Botswana		1		1	2	Moisture
Scientist	Botswana	1			2	3	
Brewer	Botswana	2	3		1		
Brewer	South Africa	3	2		1		Noxious seeds, Mould, Diastatic power
Brewer	South Africa	1			2		
Maltster	South Africa				1		Weather staining
Trader	South Africa	1			1		
Trader	South Africa				1	2	
Gov/Parastatal	South Africa	2			1	3	
Gov/Parastatal	South Africa	1			1		
Maltster	South Africa	2			1	3	
Scientist	South Africa	1	1			1	Cultivar
Trader	Tanzania		2		1		Grain size
Trader	Zimbabwe		1		2		
Brewer	Zimbabwe			3	1	2	Diastatic power Cultivar
Brewer	Zimbabwe		2		1	3	Cultivar
End-use not specified							
Trader	Botswana	1		3		2	
Brewer	Tanzania	3	2			1	
Stockfeed	Tanzania					1	Nutritional value
Stockfeed	Zimbabwe		2			1	
Stockfeed	Zimbabwe			2		1	

Table 2.2: Relative importance of the sorghum grain quality criteria with respect to end-use

	Quality criteria				
	High/non-tannin	**Grain colour**	**Hardness**	**Germinability**	**Grain purity**
All data					
% respondents rating criterion important	51	56	41	38	64
Importance of criterion (scale 0-100)	67	53	58	83	63
Milling					
% respondents rating criterion important	50	72	72	0	67
Importance of criterion (scale 0-100)	83	50	67	0	67
Malting					
% respondents rating criterion important	63	59	0	83	42
Importance of criterion (scale 0-100)	56	44	0	94	50
Not specified					
% respondents rating criterion important	50	50	40	0	83
Importance of criterion (scale 0-100)	40	40	40	0	100

Table 2.3: Relative importance of the sorghum grain quality criteria with respect to country

	Quality criteria				
	High/non-tannin	**Grain colour**	**Hardness**	**Germinability**	**Grain purity**
All countries (Botswana, South Africa, Tanzania, Zimbabwe) (38 Respondents)					
% respondents rating criterion important	53	58	42	39	66
Importance of criterion (scale 0-100)	67	53	59	83	59
Botswana (9 Respondents)					
% respondents rating criterion important	78	56	56	33	67
Importance of criterion (scale 0-100)	91	63	45	77	43
South Africa (16 Respondents)					
% respondents rating criterion important	75	33	38	50	38
Importance of criterion (scale 0-100)	67	50	83	91	56
Tanzania (5 Respondents)					
% respondents rating criterion important	20	40	0	20	80
Importance of criterion (scale 0-100)	33	67	0	100	77
Zimbabwe (8 Respondents)					
% respondents rating criterion important	0	75	50	38	88
Importance of criterion (scale 0-100)	0	45	50	77	63

2.2.3 Discussion

All five of the selected end-use quality criteria (High-tannin/non-tannin, Grain colour, Hardness, Germinability and Grain purity) were considered as being very important by the sorghum community (Table 2.1). Also, end-use had a great influence on which particular criteria were considered as being important. There were also some differences between countries.

Some other quality criteria were also considered to be important: Cultivar (variety), Diastatic power (amylase activity of malt made from grain), Grain size, Moisture content of grain, Nutritional value of the grain, Presence of noxious seeds, Weather-staining of grains. Of these other criteria, cultivar was the one most frequently cited.

With respect to end-use (Table 2.2), considering all data, grain purity was rated as important by most respondents (64% of respondents) and germinability the by the least (38% of respondents). Interestingly, however, of the criteria, germinability had the highest importance rating (83). Considering milling as the end-use, most respondents rated grain colour and hardness as being important (72% of respondents), whereas no respondents rated germinability as being important

for milling. However, of the criteria, high-tannin/non tannin received the high importance rating for milling (83). For malting, germinability was considered as being important by most respondents (83%) and it had the highest rating (94). In contrast, grain hardness was not considered important for malting. Where end-use was not specified, grain purity was considered as being important by the most respondents (83%) and of the criteria it had by far the highest rating (100). In contrast, germinability was not considered important.

Considering the data with respect to country (Table 2.3), all quality criteria were rated as important by Botswanan and South Africa respondents, whereas Tanzanian respondents apparently did not consider grain hardness as important and Zimbabwean respondents apparently did not consider high/non-tannin as important. In contrast, most Botswanan and South African respondents rated high/non-tannin as an important criterion (78% and 75% of respondents, respectively). Most Tanzanian and Zimbabwean respondents rated grain purity as important (80% and 88% of respondents, respectively).

2.2.4 Conclusions

From the survey it was concluded that the sorghum community in southern Africa considers the five selected criteria: high-tannin/non-tannin, grain colour, hardness, germinability and grain purity all to be important with respect to sorghum end-use quality. Certain other criteria, in particular grain cultivar, are also considered to be important. Of the five criteria, grain colour, hardness and high/non-tannin are considered most important for milling. Germinability is considered to be of critical importance for malting. Grain purity is generally considered to be of importance.

2.3 Survey of Sorghum Grain Marketing in Selected Southern African Countries

Interviewees in Botswana were primarily concerned with increasing domestic production for trading, improving the transportation infrastructure to efficiently move sorghum from rural areas into the commercial marketing system, and improvement of sorghum quality. Persons interviewed in South Africa favoured better methods of determining sorghum quality, improvement in sorghum grain quality (particularly white sorghum), and community development programs to assist small-scale farmers to increase production and enter into the commercial market. Tanzania interviewees felt reliable suppliers were lacking, cleanliness and quality of sorghum required improvement, and action was needed to improve deteriorating transportation infrastructure. Persons surveyed in Zimbabwe felt that a reliable supply and improved sorghum cleanliness and purity were necessary to increase trading. Most interviewees of the four countries were satisfied with progress in moving to a free market system and the phase out of government grain boards. Few thought that government assistance was needed to facilitate increased sorghum trading.

A way to evaluate the impact of the proposed quality methods on the sorghum food and feed grain complex is to consider that the marketing process is an interrelated system and that quality effects in one sector pass forward and backward throughout it. One marketing classification could be to consider all decisions and transactions from farm until final sale to consumers. For purposes of this analysis, the sorghum commercial marketing system was interpreted as beginning at the farm gate when sorghum moved into commercial channels and ending after sorghum is made into products at the processor (wholesalers and retailers of product are not considered). The focus is on commercial activities because a large percentage of sorghum grown in southern Africa is for subsistence use where grown or used in the local area. Population growth is low, migration to urban areas from farms is significant, and the subsistence growers will by necessity consume what they can produce.

Traditional, transitional, and market orientated are names of stages often used to classify the development of a marketing system. After completing the interviews and reviewing data it was felt that Botswana and Zimbabwe were at the traditional stage in the smallholder farm sector but both were in the transitional stage in the commercial farming sector. Tanzania was traditional in most of the production areas but a small transitional sector provided all the sorghum moving into commercial marketing. Although South Africa is mostly market-orientated there is the sector of smallholder farmers where land redistribution took place. A summary of the four countries by recent average production, marketing system stage, the percentage estimate of production marketed, and the production conditions are shown in the following Table 2.4.

Table 2.4: Sorghum average production, marketing system stage, production marketed and condition, by country

Country	Production (000 MT)	Marketing System Stage	Production Marketed	Production Conditions
Botswana	13.2 (1997/00) Ave.	Traditional-smallholder Transitional-commercial	Less 5% Greater 50%	Low yields; return labour low; production decline; migration out of agriculture
South Africa	314.5 (1996/01) Ave.	Market-Oriented	Greater 50%	High yields; returns less than maize; lack of quality white milling varieties grown
Tanzania	564.0 (1995/00) Ave.	Traditional	Less 2%	Medium yields; poor threshing practices/dirt & stones; mixing of varieties being grown not suitable for processors
Zimbabwe	99.7 (1995/00) Ave.	Traditional-smallholder Transitional-commercial	Less 5% Greater 50%	Low yields; poor threshing practices/dirt & stones; mixing of varieties being grown not suitable for processors

The implications of the greatly differing marketing systems are that market understanding is lacking at the traditional stage and extension type education is needed not only for production practice improvement but marketing skill as well. In Botswana and Zimbabwe, smallholder farmers grow a large quantity of sorghum that is consumed locally and does not enter commercial marketing. In Tanzania, the largest sorghum producer of the four, almost all production is consumed locally. Although potential for increased sorghum production may be significant in a traditional stage country the smallholder farmer participation in marketing can remain static. That is why private sector commercial marketing interests are necessary to participate in education and adoption of facilitating marketing functions.

Estimated current and potential sorghum grain use and exports by country are listed in Table 2.5. The information for current data comes from published reports and interviews. The potential use is based on the projection that farmers and traders will gradually use the proposed methods over the next 5 years and concurrently there will be sustained improvement in addressing constraints limiting overall market efficiency.

Table 2.5: Summary of sorghum grain yearly use and exports, by country

Country	Current Use (MT)	Potential Use (MT)	Potential Increase (MT) (%)	Current Exports (MT)	Potential Exports (MT)
Botswana	64,000	80,000	16,000 (16)	0	0
South Africa	205,000	275,000	70,000 (34)	60,000	80,000- 90,000
Tanzania	1,000	10,000	9,000 (900)	300	2,000- 4,000

Zimbabwe	19,000	25,000	6,000 (32)	0	2,000- 4,000
Total	289,000	390,000	101,000 (35)	60,300	84,000-98,000

A description of the marketing conditions in each country, prepared from interviews and data, was detailed in Technical Report #1. A summary of country findings in the physical and facilitating marketing function areas are shown in Tables 2.6 and Table 2.7.

Table 2.6: Assessment of commercial marketings, by physical function, by country

Country	Assembly	Transportation	Storage	Processing
Botswana	Domestic costs high & quantities limited; bag & bulk handling	Costs med to high due to wide dispersion; bag & bulk hdlg; importing transport costs reasonable	Excess capacity at BAMB sites; bag & bulk hdlg; insufficient capacity at small mills	Mills underutilized seasonally; local supply uncertain and poor quality late in marketing year
South Africa	Reasonable costs; bulk handling	Reasonable costs; bulk handling; access to most production areas	Adequate for needs & condition good;	Dominated by a few processing firms; contracts with farms and traders for sufficient supply
Tanzania	Costs very high; bag handling; roads very poor in growing areas; trader/processor directly buys and picks-up	Costs high because few feeder roads & often impassable in growing areas; bag handling	Adequate for stocks for food security department needs; bag handling except for brewery	Mill and animal feed capacity underutilized; uncertain supply; poor quality with dirt, stones, & other material
Zimbabwe	Costs high; bag handling	Costs high because of distant growing areas; low density; bag handling	Excess capacity at GMB sites; bag & bulk handling at processor facilities	Few large mills; direct contracts with farms and traders due to uncertain supply & poor quality with dirt, stones, & other material

Table 2.7: Assessment of commercial marketings, by facilitating function, by country

Country	Grades and Standard (sorghum grain)	Financing	Grain Exchange Market Information	Research and Extension
Botswana	ISO member; B of S organization; presently developing G & S for milling use	Financial Assistance policy for new mills; loans are needed for small operators for storage & inventory	No commodity/ grain exchange; need price transparency as most trades are direct contracts	White varieties for millers needed; management & market training for smallholders needed
South Africa	ISO member; B of S organization; currently have standards and grades for sorghum	Land redistribution & land bank program; no small mill loan program	No sorghum traded on SAFEX; need price transparency as most trades are direct contracts	Ag Research Council; white varieties for mill products needed; need to eliminate VAT on sorghum
Tanzania	ISO member; B of S organization; do not have G & S; poor farm quality with excess foreign and other material	Low loan ceiling on capital to buy cleaning equipment to remove foreign material and build storage	No grain exchange; thin market/little trade; wide price difference of time and location; need information on price margins/spreads	Educate animal feed processors on correct nutritive value of sorghum as ingredient: processors need info on sorghum cleaning equip. and operation.
Zimbabwe	ISO member; B of S org; grade regulations by GMB; poor farm quality with excess foreign, other material	No small-scale mill financial incentive gov program; need loans for cleaning equipment	Few contracts are traded on ZIMACE most trades are direct contracts; price transparency needed	Yield and quality improvement being done at ICRISAT; feed processors need nutritive value information

Sorghum commercial marketing is projected to undergo significant trading change from the current marketing conditions when proposed quality changes are implemented as shown in Table 2.8 below.

Table 2.8: Projected country trading changes by market type, after proposed quality changes are implemented

Market Type	Time	Botswana	South Africa	Tanzania	Zimbabwe

		%	%	%	%
Trader	Current	52	30	65	7
	Estimate	89	35	74	18
Brewer/Malster	Current	6	40	30	80
	Estimate	5	35	20	64
Mill/Animal Feed	Current	3	28	5	6
	Estimate	4	27	4	15
Government	Current	38	0	0	6
	Estimate	0	0	0	0
Other 1/	Current	1	2	0	1
	Estimate	2	3	2	3

1/ Marketings from traditional farmers belonging to development projects and direct deliveries by farmers without contracts to local processors.

After proposed quality methods and standards are implemented, along with gradual improvement in major infrastructure constraints, the approximate economic gain to traditional farmers in the four countries is over US$330,000 as shown in Table 2.9. It was assumed that the economic gain to traditional farmers would be the difference from a selling price near that presently offered commercial farmers for sorghum meeting quality requirements and the discount value they presently receive for inferior quality sorghum. But the price actually received will likely be less than that offered commercial farmers because traders will need to cover the higher costs of purchasing and assembling sorghum from traditional farmers. Using a lower US$45/MT price instead of an average price of US$55/MT reflects the greater margin spread by traders.

Table 2.9: Estimated economic gain for traditional farmers in the four countries

Country	Production (000 MT)	Potential Sales (MT)	Farm Price Current (US$/MT)	Farm Price Estimate (US$/MT)	Economic Gain (US$)
Botswana	13.2	132	25	45	2,640
South Africa	314.5	3,145	25	45	62,900
Tanzania	564	11,280	25	45	225,600
Zimbabwe	99.7	1,994	25	45	39,880
Total		16,551			331,020

The proposed sorghum quality methods should sufficiently classify sorghum grain quality for many traders and processors in the Southern African Development Community. This proposal is for quality methods and standards to be done by private industry. Government involvement in G & S would be through existing services, but there will be need for Government services and expenditures to address existing constraints of road deterioration; inability to obtain sufficient capitol improvement loans for small-scale millers and processors; and extension education efforts for traditional farmers in marketing and farm management. There also remains the issue of the inequitable VAT on sorghum grain compared to the close substitute of maize for food and animal feed use in South Africa which places all sorghum commercial trading at a price disadvantage both within the country and SADC.

3 SIMPLE METHODS TO DETERMINE SORGHUM GRAIN QUALITY, INCLUDING RESULTS OF RING TRIAL

3.1 Development of Simple Methods to Determine Sorghum Grain Quality

To facilitate sorghum grain trade in southern Africa, it was considered essential that the methods developed to measure quality parameters fulfilled certain requirements; some of which are particular to the Region, such as entrepreneur small milling and malting enterprises and a lack of scientific infrastructure:

- The methods must be simple to perform; i.e. they should not require a skilled laboratory technician to perform them
- The methods must not require the use of specialised equipment or instruments
- Any chemicals required to perform the analyses must be readily available
- The methods should ideally be rapid

The methods should be such that they can be performed by those in the sorghum trade, i.e. there must be no necessity to send samples to a specialist organisation to perform the analyses.

A review of the literature revealed that none of the methods that were currently available for determining s the five desired sorghum quality parameters were directly suitable for the desired application. Even the most suitable methods required some simplification. Modifications to the following methods were undertaken:

- High (tannin)/Non-tannin grain determination - by the Bleach test of the South African Council for Scientific and Industrial Research (CSIR) (Dewar et al., 1995) so that it could be carried out at room temperature with chemicals that are readily available
- Grain colour determination - by a visual assessment procedure with simple criteria
- Grain hardness estimation - by a visual grain endosperm assessment procedure (Rooney and Miller, 1982) with more simple criteria
- Germinability determination - by the Germinative Energy test of the CSIR (Dewar et al., 1995) so that it could be carried out without the use of a temperature and humidity controlled incubator and filter papers
- Grain purity determination - based on the Codex Alimentarius (1995) and South African Department of Agriculture (1999) sorghum purity methods so that it could be determined without the requirement for a balance and sieves

Simple methods for determination of the five quality criteria were developed to fulfil the above requirements and are given in Appendix 5. During development, the methods were compared with the standard methods described and other standard methods. In all cases the results obtained were highly significantly correlated with the standard methods. The methods were written up in the format of International Association for Cereal Science and Technology (ICC) standard methods.

3.2 Ring Trial of Sorghum Grain Quality Methods

On this basis of the fact that the methods developed were highly significantly correlated with the existing standard methods, it was decided to subject them to a collaborative evaluation trial, also known as a Ring Trial or Ring Test. The objectives of carrying out a Ring Trial are to establish whether the method can be followed and carried out by laboratories (persons) other than the

laboratory that developed the method, and to determine the between laboratory variability (Reproducibility) of results obtained by the method.

3.2.1 Ring trial procedure

During June to August 2001, the five methods were evaluated by a ring trial, organised by Prof Taylor, according to the procedures of the ICC (International Association for Cereal Science and Technology, 1992). Between 22 and 26 persons in the sorghum grain community in Africa, Europe and the USA took part in the Ring Trial of each of the methods. The participants in the ring trial comprised millers, maltsters, brewers, grain traders and scientists. The ring trial procedure involved sending the methods together with at least two common test samples per method, plus standard samples where appropriate, to the participants in the ring trial. The participants completed and returned a form containing the results of their analyses and any comments on the methods that they wished to make. This procedure was followed to determine the Reproducibility (between laboratory variation) of the methods. The methods were also performed several times on the same samples by the analyst in the Prof Taylor's laboratory (Mrs J Taylor) to determine the Repeatability (within laboratory variation) of the methods. The results of the ring trial were statistically evaluated according to the procedures of the ISO (International Organization for Standardization, 1994).

3.3.2 Results

Table 3.1: Summary of comments by participants in the ring trial on the various simple methods to determine sorghum to determine sorghum grain quality

Detection of Tannin Sorghum Grain
Simple technique, method easy
Difficult in some cases to purchase drain cleaner/caustic soda and commercial bleach of correct concentration
Some indication of volume needed, easy to use too much reagent and get peeling of seed coat
Grain Colour
Problem defining white, especially with respect to yellow endosperm sorghums
Weathering and mould caused problems determining colour
Removal of glumes before analysis suggested
Grain Hardness
Subjective, drawings not sufficiently clear, difficult to differentiate between hard and medium grain
Easier to do assessment on coloured paper if available
Magnifying glass helps if available
Forceps suggested for holding grain
Emphasis needed on 'sharp' blade
Germinative Energy
Room temperature below 20°C in parts of Africa during the winter, effects rate of germination
Method for calculating cumulative germination needs clarifying
Use of any polystyrene box with lid
Serious mould infestation at 72h, suggest disinfecting seeds prior to test
Some problems with maintenance of high RH over 72h
Total defects
Time consuming and labour intensive
Method not accurate with highly defective samples

When film pot is used different grain sizes cover different total number of squares
Suggestion of use of balance if available

Table 3.2: Detection of tannin sorghum grain by the bleach test: Ring trial - mean and precision parameters for all valid results

	Sample A	Sample B
Mean (Repeatability)	96.0	99.3
Repeatability standard deviation (s_r)	1.2	0.7
Repeatability relative standard deviation (RSDr, %)[a]	1.2	0.7
Mean (Reproducibility)	92.7	97.0
Reproducibility standard deviation (S_R)	15.2	2.8
Reproducibility relative standard deviation (RSDR, %)[a]	16.4	2.9

[a]Standard deviation expressed as a percentage of the mean

Table 3.3: Classification of sorghum grain according to colour: Ring trial - mean and precision parameters for all valid results

	Sample C	Sample D
Mean (Repeatability)	99.9	99.6
Repeatability standard deviation (s_r)	0.4	0.5
Repeatability relative standard deviation (RSDr, %)[a]	0.4	0.5
Mean (Reproducibility)	99.3	90.7
Reproducibility standard deviation (S_R)	1.9	23.5
Reproducibility relative standard deviation (RSDR, %)[a]	1.9	26.0

[a]Standard deviation expressed as a percentage of the mean

Table 3.4: Estimation of sorghum grain hardness: Ring trial - mean and precision parameters for all valid results

	Sample E			Sample F		
	Hard	Medium	Soft	Hard	Medium	Soft
Mean (Repeatability)	41.1	56.1	2.8	1.7	88.3	10.0
Repeatability standard deviation (s_r)	17.1	16.5	3.6	5.0	8.7	7.1
Repeatability relative standard deviation (RSDr, %)[a]	41.6	29.5	130.8	299.9	9.8	70.7
Mean (Reproducibility)	71.8	23.2	5.1	34.2	47.3	17.8
Reproducibility standard deviation (S_R)	25.6	20.6	11.2	24.3	21.0	18.6
Reproducibility relative standard deviation (RSDR, %)[a]	35.7	88.9	219.5	71.2	44.4	104.7

[a]Standard deviation expressed as a percentage of the mean

Table 3.5: Estimation of sorghum grain hardness: Ring trial - mean and precision

parameters for all valid results – hard and medium grain data combined

	Sample E		Sample F	
	Hard and Medium	Soft	Hard and Medium	Soft
Mean (Repeatability)	97.2	2.8	90.0	10.0
Repeatability standard deviation (s_r)	3.6	3.6	7.1	7.1
Repeatability relative standard deviation (RSDr, %)[a]	3.7	130.8	7.9	70.7
Mean (Reproducibility)	94.9	5.1	81.7	17.8
Reproducibility standard deviation (S_R)	11.2	11.2	18.7	18.6
Reproducibility relative standard deviation (RSDR, %)[a]	11.7	219.5	22.9	104.7

[a]Standard deviation expressed as a percentage of the mean

Table 3.6: Determination of Germinative Energy of sorghum grain: Ring trial - mean and precision parameters for all valid results

	Sample G	Sample H
Mean (Repeatability)	82.4	53.4
Repeatability standard deviation (s_r)	5.4	3.9
Repeatability relative standard deviation (RSDr, %)[a]	6.6	7.2
Mean (Reproducibility)	86.2	55.7
Reproducibility standard deviation (S_R)	6.6	15.7
Reproducibility relative standard deviation (RSDR, %)[a]	7.6	24.2

[a]Standard deviation expressed as a percentage of the mean

Table 3.7: Determination of total defects in sorghum grain: Ring trial - mean and precision parameters for all valid results

	Sample X	Sample Y
Mean (Repeatability)	18.2	2.6
Repeatability standard deviation (s_r)	2.0	0.8
Repeatability relative standard deviation (RSDr, %)[a]	11.1	30.3
Mean (Reproducibility)	27.2	5.5
Reproducibility standard deviation (S_R)	10.9	4.0
Reproducibility relative standard deviation (RSDR, %)[a]	40.2	73.1

[a]Standard deviation expressed as a percentage of the mean

3.3.3 Discussion

The comments on the methods were mostly minor in nature, comprising suggestions on slight modifications to the text or the methodology itself to make the methods easier to carry out. Perhaps the two most substantive comments concerning the issue of yellow sorghums (sorghums which appear yellow in colour due to xanthophyll pigments in the endosperm), which was not

addressed in the method developed and the problem with distinguishing between hard and medium sorghum grains. In the latter case, the results were statistically evaluated with the hard and medium grains considered separately (Table 3.4) and combined together (Table 3.5).

A good method should show a low repeatability relative standard deviation, approximately ± 3-5%, depending on the complexity of the method and the uniformity of the material being analysed. The reproducibility relative standard deviation is invariably greater, in the order 2 to 3 times higher, on account of the fact that different analysts are carrying out the assay, and different reagents and different apparatus are used. When the considering the results, it can be seen that the repeatability standard deviations of the tannin sorghum (Table 3.2), colour classification (Table 3.3) and Germinative Energy (Table 3.6) methods are clearly acceptable. Concerning the estimation of hardness (Table 3.4) it is clear that the analyst found it difficult to distinguish between hard and medium grains, as mentioned in the comments by the participants in the ring trial. However, when the results for the hard and medium sorghum grains were combined together (Table 3.5), the repeatability relative standard deviation was acceptable. In the case of determination of total defects (Table 3.7), the repeatability relative standard deviation appears to be rather high. However, the apparent high deviation is misleading due to the fact that defects only comprise a relatively small proportion of the batch of grain. If, instead, the relative standard deviation of the sound grains is considered, then in the case of sample X it would only be 2.4% instead of 11.1%.

Considering the reproducibility relative standard deviation, in the case of the hardness estimation when the results for the hard and medium sorghum grains were combined together (Table 3.5), the variability was acceptable. However, in the case of the tannin sorghum (Table 3.2), colour classification (Table 3.3), Germinative Energy (Table 3.6) and total defects (when considering variability of sound grain determination) (Table 3.7) methods, it appears that for one of the samples assayed, the reproducibility variability was rather high. However, it has to be taken into account that in the statistical analysis of the data all valid results were analysed. This means that all results that were not impossible (impossible results are those where, for example, a calculating error would give a figure of >100%) were used in the determination of the reproducibility. In other words, so-called outliers were not removed prior to calculation of the reproducibility. In practice, when the acceptability of a method is considered , it is permitted that clear outliers, amounting to up to 20% of the total results may be eliminated. Hence, the true reproducibility standard deviation is generally much better than appears from analysis of the all the valid results. The determination of what is an outlier is, however, left to the responsible body, in this case the ICC. Thus for the purpose of this report, all valid results were considered.

3.4 Conclusions from ring trial

The statistical analyses of the results of the Ring Trials of the five methods indicated that all the five methods would work reasonably well in their intended application, that is in the sorghum grain trading situation in southern Africa. Thus the methods would be suitable for determination as to whether sorghum being traded conformed to grades and standards to be agreed upon by the sorghum community in southern Africa.

4 RESULTS OF THE WORKSHOP HELD TO REVIEW METHODS AND MARKET ANALYSIS

A workshop for the development of simple, common grain quality standards for sorghum to facilitate grain trade in southern Africa was held on 12 to 14 September 2001 at the Holiday Inn Garden Court, Johannesburg International Airport, South Africa. Delegates represented the four SADC countries Botswana, South Africa, Tanzania and Zimbabwe. The workshop was sponsored by USAID.

The facilitator outlined the workshop objectives to give delegates the opportunity of clarification or addition at the outset of the workshop.

1) To report on a study of the cost-benefit and feasibility of sorghum grain standards in southern Africa's food industry.
2) To report on a survey of the requirements for specific sorghum grain quality standards in southern Africa.
3) To report on the development and evaluation by ring trial of simple methods for the determination of sorghum grain quality:
   - Determination of defects in sorghum grain
   - Detection of tannin sorghum
   - Classification of sorghum according to grain colour
   - Estimation of sorghum grain hardness
   - Determination of sorghum grain germinability
4) Familiarisation of the methods developed by participating in hands-on testing of sorghum grain samples.
5) To discuss the results of the ring-trial and hands-on testing for the purpose of proposing recommendations on the methods.
6) To appoint an *ad hoc* Working Group on implementing sorghum grades and standards in southern Africa.

The scene for the workshop was set with presentations and discussions on the results of surveys on the current sorghum grain trade and the status of sorghum grain standards in the four countries.

The marketing survey revealed a number of needs and constraints in the sorghum grain industry, manifesting themselves in different ways in the very different production, processing and trading circumstances of the four countries. With the introduction of sorghum grain grades and standards and the resolution of some of these problems, it was estimated that sorghum use and trading would increase, to a greater or lesser extent, in the four countries.
Uniform grain grades and standards were expected to become important as they would support an agricultural marketing system through improved efficiency of the pricing and trading processes. Grades and standards would allow producers to grow and processors and traders to select the correct type of grain for the processes and products. The implementation of grades and standards would not, however, eliminate poor quality grain which would only be achieved through effective breeding, cultural practices, harvesting, storage and handling.

Projected marketing changes after the implementation of the proposed grades and standards include 1) Traders handling most of commercially-marketed sorghum grain, 2) Market liberalisation with little-to-no government trading involvement, 3) Increased export movement between SADC countries and present buyers and 4) Decline in direct processor contracts with growers as sorghum grain quality improves and trader reliability increases. Increased emphasis needed to be given to the smaller producers and their entry into commercial trading channels.

The grain standards survey showed that the five most important sorghum grain quality criteria in southern Africa were tannin/non-tannin content, grain colour, grain hardness, germinability and grain purity. Grain colour, hardness and tannin/non-tannin were the most important for milling while germinability was critically important for malting. Cultivar was also considered to be important. Grain purity was considered generally important.

Simple test methods to determine the five sorghum grain quality criteria were presented to workshop delegates. The methods had been developed or adapted to meet the basic criteria of simplicity, no requirement for specialised equipment, chemicals readily available, quick, performed easily and inexpensive. All five methods had been tested against and compared well with standard grain quality tests. Evaluated in ring trials undertaken by 26 participants from the sorghum industry in 11 countries in southern Africa, USA and Europe, the results obtained provided statistical validation and acceptance for all five test methods.
The modified test methods are described in Table 4.1.

Table 4.1: Modified simple test methods for sorghum grain quality

Test	Method
Detection of high-tannin sorghum grain	High-tannin grains turn black when soaked in sodium hydroxide solution. USA Chlorox Bleach Test modified by using commercially-available caustic soda and carried out at room temperature.
Grain colour	Visual classification into white or coloured grain.
Grain hardness	Modification of Rooney and Miller's visual test in which the texture of the grain endosperm indicates its hardness (the more vitreous endosperm, the harder). The modified test distinguishes between hard, medium and soft endosperm.
Grain germinability	The modified CSIR standard germination test includes testing at room temperature, using a polystyrene cooler box instead of an incubator and using newspaper instead of specified filter paper.
Grain purity	The defects test methods of the South Africa grain standards and Codex Alimentarius are modified by replacing sieving, sorting and weighing to entirely manual processes.

4.1 Working Groups Familiarisation of the Five Test Methods

Workshop delegates were split into three working groups for a hands-on familiarisation of the five test methods. Each group appointed a recorder and spokesperson so that all observations and comments could be reported back to the workshop. Delegates obtained hands-on familiarisation of the five test methods after which they provided valuable feed-back, suggestions and discussion. The working group's reports are summarised in Table 4.2.

Table 4.2: Test methods: A Summary of the Working Groups report-back

Test	Observation/Comment		
	Group Orange	Group Blue	Group Red

Test	Observation/Comment		
	Group Orange	**Group Blue**	**Group Red**
Colour	Endosperm colour not specified in method, important for milling	Test easy and simple	Subjective test, colour seen differently by different people
	Pato, Piriraz and Mozambique are 100% white	SNK3640 – red – 99% Pato – white – 100% PAN8564 – coloured – 100% Piri 2 – white – 100% SNK33 – coloured – 100%	Need better definition of white grain, confusion with weathered and mouldy grain
	Glume colour leached to the seed coat in Piriraz, affecting colour and possibly milling quality		
Tannin	*Just* cover the seed with reagent	Test easy and simple	Useful to state quantity of reagent to use rather than just covering grain (split view)
		Sometimes difficult to decide how black the grain has turned	Issue marketing kit explaining tests
			Use Jik only, economical
Hardness	Hard to distinguish between medium and hard	Test easy and simple	
	Mozambique, hard; NK283, medium hard; DC99, soft	Agreed combine hard and medium	Difficult to distinguish between medium and hard
		Magnifying glass required	Test too technical for the farmer, may get used to it
		Variability within a variety	Variations within a variety and problem of grain mixtures
Germinability	Use plastic wrap instead of foil for sealing container	Test easy and simple	Test easy to undertake
		Two samples, one without and one with bleach, to control contamination	Facilities to undertake the test both at the farm and the mill
Defects	Need to separate small grains out, define how to separate from rest of sample	Do defects testing before germination (done on sound grain)	Suggest numbering the squares on the grid to avoid counting.
	Some batches may be discarded on visual inspection without the need for testing as the defects are too high	Sampling technique should ensure sample is truly representative	Provide hand-out of grid as part of marketing
		Do defects and purity measurements together	Farmers require training on what defects are
		Difficult if there is mixed white and coloured grain	
General		Methods are good for the producer, user and farmer	Drawing of samples should be in presence of farmer to avoid dispute
		Tests should be done together with the farmer, will avoid misunderstandings	All levels of user require training prior to introduction of tests; may look simple but need understanding
		Methods could be used by breeders to characterise varieties	Advantage of the tests is farmer education
		Importance and relevance of each standard in each country	

4.2 Working Groups Review of the Proposed Sorghum Grain Quality Standards

Similar to the first working group session, workshop delegates were split into three groups. Assistants were available for guidance within each group. Each group appointed a recorder and spokesperson so that all observations and comments could be reported back to the workshop at the following plenary session.

Delegates were provided with a summary of the five proposed sorghum grain quality standards that had evolved from the workshop to date. After review and discussion by each group a general discussion lead to the recommended sorghum grain quality standards are shown in Table 4.3.

Table 4.3: Recommended sorghum grain quality grades and standards

Grain characteristic	Standard/Grade
Tannin (high-tannin) sorghum grain	Batches containing ≥ 95% tannin or non-tannin sorghum be classified as **Tannin** or **Non-tannin Sorghum** respectively.
	Where batches contain < 95% tannin (or non-tannin) sorghum and > 5% non-tannin (or tannin) sorghum, the batch be classified as **Mixed Tannin and Non-tannin Sorghum** and that the percentage tannin sorghum be given.
Sorghum grain colour	Batches containing ≥ 95% white (or coloured) sorghum be classified as **White (or Coloured) Sorghum** respectively.
	Where batches contain < 95% white (or coloured) sorghum and > 5% coloured (or white) sorghum, the batch be classified as **Mixed White and Coloured Sorghum** and that the percentage coloured sorghum be given.
Sorghum grain hardness	Batches containing 100% hard plus medium sorghum be classified as **Medium Hardness Sorghum.**
	Batches containing ≥ 90% soft sorghum be classified as **Soft Sorghum.**
	Where batches contain < 100% hard plus medium sorghum or < 90% soft sorghum, the batch be classified **as Mixed Medium Hardness and Soft Sorghum** and the percentage soft sorghum be given.
Germinative Energy of sorghum grain (germinability)	Sorghum grain for malting should have a Germinative Energy at 72 hours of ≥ 90%.
Total defects in sorghum grain (grain purity)	The maximum permissible total defects in sorghum grain for human consumption should not exceed 8%, as specified by Codex Alimentarius.

In the general session it was recommended that, in addition to acceptance of the five test methods with associated grades and standards, feedback from industry should be obtained prior to implementation. It was recommended that standards/specifications/methodology for weathering, mould, moisture content and endosperm colour be considered in future work.

4.3 Working Groups Reports on Strategy of Implementing Proposed Grades and Standards.

The last session of the work groups concentrated on the strategy for implementing proposed grades and standards and a process to take the initiative forward to implementation. Their recommendations and suggestions are summarized in the following tables.

Table 4.4: Summary of Group Blue report back

Issue	Report
Organisational/	At the national level:

institutional	Bureau of Standards recognise the methods and standards; guidance Establish national committee comprising producers, millers, brewers, seed companies, farmers, university, research, breeders At the regional level: Establish regional committee comprising SADC, RAPID, SACCAR, ICRISAT and relevant NGOs (eg: World Vision)
Terms of reference	Establish training workshop Educate extension workers (for farmers) and all stakeholders Establish regional database of producers and traders Establish national coordinator in each country to help stakeholders maintain progress, address problems and attend to trade matters
Funding	Regional – RAPID (stakeholders) National – Bureau of Standards (time, education, method adoption) Private companies and associations (participation)
Timetable	Educate and get interested people on board (3 months) Training workshop at national and regional level to educate all stakeholders May 2002 – implementation and grade new crop using the new standards

Table 4.5: Summary of Group Orange report back

Issue	Report
Standards	Proposed standards should be referred back to industry for comment, especially tannin (maltsters/millers), hardness (millers) Additional grades and standards should be listed – weathering, endosperm colour – and millers to define and decide
Forward process	Press release (soonest) Determine stakeholders. Countries may differ Appoint national delegates. Only where there is a sorghum industry; probably not government official Delegates should have authority. Mandate to involve other stakeholders in the implementation phase Integration and implementation: - Formalisation and registration of grades and standards, implemented as broad industry standards for the region - Training of all participants in the chain
Structure	Should be finite (ie: has an end) Secretariat (eg: based at SMIP, ICRISAT) with database etc Executive, tasked to complete the implementation process Delegates, part-time, reporting to executive
Stakeholders	Producers, industry/manufacturers Government (research, national departments, statutory bodies (eg; Bureau of Standards) SADC, WFP, FAO, ICRISAT, SMIP Industry forums (in South Africa, this already exists, may be problem elsewhere) Donors, potential donors
Timetable	November, 2001. Secretariat (SMIP) to write proposal, for presentation to RAPID, on promotion of intra-regional sorghum trade by setting of grades and standards 1st quarter 2002. First Working Group meeting End 2003. Integrated set of tasks to be completed; end of tenure of working group

Table 4.6: Summary of Group Red report back

Issue	Report
Standards	Tannin/colour. Clarify classes of grading (editorial) (eg: Tannin ≥95%, Non-tannin ≤5%, Mixed

	5-95%) Hardness/germination. Accepted. Defects. Create separate standard for weather-stained grain Moisture standard. Should be introduced. Review by the Working Group. Also, industry.
Issues for Regional Working Group	Stakeholders targeted for implementation. Breeders, government, industries, traders, farmers, SADC; involve in process but not necessarily part of Working Group Potential users should be informed and trained in the application of grades and standards Role of government. Inform relevant regulatory bodies of the proposal to introduce the grades and standards, particularly as voluntary standards Funding. External funding required to support Working Group activities and implementation Trading. Promote sorghum trading in SADC region (broader mandate)
Institutional	Inform SADC agricultural sector of the proposal to establish sorghum trade standards. Encourage them to attend Working Group meetings; SADC support important for USAID funding This initiative can be viewed as an example for harmonised regional trade standards Encourage use of the standards in resolving trade grading disputes Working Group should monitor implementation of the standards and review them for possible revision from time to time. Possible longer-term mandate than 1-2 years
Membership	Preliminary Working Group (year 1) with membership drawn from Workshop delegates, two from each country, plus one representative each from industry and another sector Expand over time to include representatives from other SADC countries Invite technical experts (eg: SADC, ICRISAT, Universities) to attend meetings
Administrative	Working Group should report to stakeholders, including industry, donors, traders and farmers. Mechanism required. Facilitator required to coordinate activities during and between meetings.
Terms of reference	Implement the agreed way forward
Funding timetable	31 December 2001. Develop proposal for RAPID. March 2002. First formal Working Group meeting.

5 WORKSHOP PARTICIPANTS' WORKPLAN FOR IMPLEMENTING SORGHUM GRAIN METHODS AND STANDARDS IN SOUTHERN AFRICA

5.1 Proposed Grades and Standards

It was AGREED that the workshop should recommend the acceptance of the five sorghum grain quality test methods and the associated grades and standards. The methods have subsequently (November 2001) been submitted to the ICC for provisional approval methods as standard test methods, Technical report #5 (Taylor, 2001b).

It was AGREED that feedback from industry on the proposed grades and standards should be obtained prior to implementation.

It was AGREED that consideration should be given to standards/specifications/ methodology for weathering, mould, moisture content and endosperm colour. Weathering should be a stand-alone assessment and not part of 'defects'. The research and development work required would form part of, and be motivated and costed in, the proposal to RAPID.

5.2 Stakeholders in Implementing Process

Broad AGREEMENT was reached on stakeholder identity. Stakeholder groups should include breeders, government (research, national departments, statutory organisations), industries (milling, brewing, stockfeed, seed), traders and farmers.

Regional organisations such as SADC and ICRISAT should be included to ensure broad involvement of the full SADC country membership.

Governments' role is acknowledged even though the process is to be industry-led.

5.3 Publicity of the Process

A national information and dissemination process is required in each country. For example, a sorghum forum already exists in South Africa.

A clear communication strategy, efficient and cost-effective, is required to inform stakeholders of the workshop, its outcome and the ongoing process of implementation.

5.4 Institutional Relationships

SADC is aware of this project and the workshop and is supportive of it. It should be informed of progress made at the workshop, the outcomes and the intended proposal.

RAPID's objective is to promote trade in the region and, as RAPID works closely with SADC, it is appropriate to involve SADC. SADC, in liaison with organisations such as the World Bank and the FAO and various donors, can assist in focussing attention and donors on projects.

SADC is thus recognised as an important role player in the project and ways should be determined to increase SADC's potential role in its implementation.

5.5 Implementing Structure

It was AGREED that the Sorghum and Millet Improvement Programme (SMIP), which is implemented by ICRISAT, should be asked to take on the role of coordinator/ secretariat for the ongoing process. While SMIP would be able to prepare a proposal in the short-term, internal discussions would be required by ICRISAT to assess its capability to perform an ongoing facilitation role. Funding would be required for the coordination role.

It was AGREED that membership of the *ad hoc* Working Group would be one or two representatives from each of the four countries drawn from the workshop delegates.

Unlike Botswana, South Africa and Zimbabwe, Tanzania does not have appropriate institutional structures, such as a sorghum forum/association, to accommodate reporting procedures. Its delegates' role would initially be to set up such structures.

5.6 Moving the Process Forward

It was AGREED that the sorghum grain grades and standards would be adopted and that, initially, they would be utilised on a voluntary basis, usually by trade contract between buyer and seller.

It was also AGREED that national Bureaux of Standards (or equivalent national regulatory body, eg: South African Department of Agriculture) should be encouraged to recognise these standards but initially without the formality of regulation.

It was AGREED that the *ad hoc* Working Group should monitor the implementation of the grades and standards. Tasks of the *ad hoc* Working Group would include:

- Technical advisory to ensure implementation of grades and standards
- Linkage to the national structures
- Promotion of regional sorghum trade

The secretariat to the *ad hoc* Working Group (SMIP) would provide administrative support, including coordination of activities, databases (traders, producers etc), information sharing, monitoring, implementation

5.7 Training of Industry, Farmers and Others in Methods Usage

It was AGREED that training initiatives should focus on grades and standards and not be involved with other sorghum issues (eg: production).

General discussion indicated that the circumstances for introducing training differed in each country and that any plan or proposal would need to reflect these differences. It was therefore suggested that a decentralised (country-by-country) approach be considered to meet the individual situations.

- South Africa. Private training centre (ex Sorghum Board) undertakes practical training, including cross-border. Training programmes could also be organised through the Extension Officer network.
- Tanzania. Training would be difficult to implement, although training of extension workers and forming interest groups around the traders are possibilities. Successes

with the cocoa bean and cashew industries were cited and the sorghum industry would play its part.

- Zimbabwe. Suggested first referring the proposal back to the industry stakeholders, then setting up a trade forum through which multi-stakeholder training could be undertaken (where trading actually occurs).

Series of separate modules and training materials would be required for each component of grades and standards. This should incorporate both specific training programmes and *ad hoc* training options. Funding would be required for both.

Training modules could be developed as "add-ons" to existing training programmes.

If there were to be a pledge of much-needed training materials, the South African sorghum industry would play its part in the funding/provision of training, possibly on a shared basis.

In view of the need for training on the ground, it was AGREED that the development of training modules, training implementation and funding thereof be included in the proposal. It was accepted that, in principle, funding should be a joint responsibility with cost-sharing between local resources and possible sponsors. It was AGREED that the *ad hoc* Working Group investigate the funding process and take it forward with the proposal.

5.8 Solicitation of Members of *ad hoc* Working Group

In order to ensure project continuity and progress and report-back to the four countries, it was AGREED that membership of the *ad hoc* Working Group should be nominated from the delegates of the Workshop. This would be for the initial term of the Working Group. Two members per country were AGREED.

Membership of the Working Group would be for an initial term during which period members, together with the secretariat, would:

- Prepare the proposal(s)and present to RAPID
- Assist with the dissemination of the Workshop information in the four countries
- Participate in the initial actions of implementation

Following a short caucus in country groups, the following nominations for membership of the *ad hoc* Working Group were made and APPROVED:

- Botswana
  - Mr Joseph Jagwer (Industry, Foods Botswana)
  - Mr Molefe Bannyaditse (Government, Botswana Bureau of Standards)
- South Africa
  - Mr Piet Skinner (Industry, Sorghum SA)
  - Mr Samuel Kgafane (Producer, Sorghum Trust)
- Tanzania
  - Mrs Anna Temu (Industry, Power Foods)
  - Mr Syed Risvi (Industry, Fidahussein & Company)
- Zimbabwe

- Mr Leo Mpofu (Government, Department of Research and Specialist Services)
- Mr Roland Murengwa (Industry, Chibuku Breweries)

The first members of the *ad hoc* Working Group were congratulated.

It was CONFIRMED that SMIP (ICRISAT), through Dr David Rohrbach, would provide the secretariat support services for the *ad hoc* Working Group.

5.9 Action Plan

The way forward was summarised by the following actions, in sequence:

1. Press release, widely based, MGM media database
2. Workshop proceedings, vetted by core team and then to delegates (4 weeks)
3. Dissemination of report to stakeholders in participating countries
4. Preparation of proposal, including additional research requirements
5. Finalisation of grades and standards specifications outstanding issues
6. *Ad hoc* Working Group formative meeting (by end-March 2002)

SMIP (ICRISAT) AGREED to coordinate proposal preparation, deadline end-November 2001, based on the Workshop proceedings and with input from Working Group members who would ensure involvement of their respective countries.

With regard to SADC involvement, it would be productive to meet directly with SADC and hold discussions rather than merely provide Workshop proceedings. This would have to be undertaken without funding.

6 RECOMMENDATIONS FOR ADDITIONAL STEPS TO BE TAKEN BY GOVERNMENT, INDUSTRY AND DONORS TO PROMOTE COMMERCIALISATION OF SORGHUM

It is evident from the outcomes of the Workshop that persons in the sorghum community in southern Africa believe that the development and implementation of simple, common grain quality standards for sorghum will grow the sorghum industry in the Region. There was a high level of enthusiasm at the Workshop and it is essential that the implementation stage be carried out optimally to achieve maximum effect in terms of increasing sorghum trade.

The further work required could be divided into a number of outputs.

6.1 Facilitation of the Activities of the Ad Hoc Working Group

Administrative support for Working Group - For the Working Group to function, it will require administrative support. As stated, ICRISAT, through the Sorghum and Millet Improvement Programme (SMIP) has kindly agreed to provide that administrative support. However, ICRISAT will require funding to employ secretarial assistance and for communication costs for this function.

Grades and standards finalisation meeting - Following consultation with the sorghum communities in their own countries, the members of the Working Group will have to meet to finalise the common sorghum grades and standards. Funding for this finalisation of grades and standards meeting will be required.

Development of training materials and holding of training sessions- At the Workshop it was proposed that in order to implement the methods, grades and standards, training sessions should be held in each of the four countries. At the training sessions, persons in the sorghum community in that country would be trained in how to carry out the methods and hence how to determine whether sorghum in trade met the agreed grades and standards. To facilitate the training, it is proposed that training materials (a booklet and presenter's visual aids) on the methods and standards be developed so that the trainers, the persons from each country on the working group, would be able to run a training session in their respective country. Partial funding for four two-day training sessions, one in each country will also be required.

6.2 Additional Methods, Grades and Standards

The Workshop agreed that some additional sorghum grain quality criteria were important with regard to trading grades and standards. Simple methods will have to be developed and tested, or existing methods tested, so that that these criteria can be incorporated into the grades and standards.

The additional quality criteria are as follows:
Yellow sorghum grain,
Weather-stained sorghum grain
Moulded sorghum grain
Moisture content of sorghum grain

Funding will be required for this activity to be carried out.

6.3 Sorghum Grain Quality Requirements for Particular End-uses

Two existing important end-uses for sorghum are as animal feed and for milling to produce meal for human consumption. Sorghum may also potentially be used as an alternative source of starch for the wet milling industry. According to Rohrbach (Dr D D Rohrbach, Economist, ICRISAT, Bulawayo, Zimbabwe, personal communication) specific questions have been raised by persons in the animal feed and dry and wet milling industries in southern Africa as to the quality requirements for sorghum grain for particular applications in these industries.

Concerning animal feed, since tannin (high-tannin) sorghum is invariably less costly than other types of sorghum, questions have been raised by the poultry industry as to what percentage tannin sorghum can be used in poultry feed without significant adverse effect on feed value.

Concerning wet milling for starch production, in southern Africa some 300,000 tons of maize is wet milled to produce starch. Sorghum grain has the potential to replace some of maize used, on account of the fact that it has a lower fat content and hence could give a higher yield of starch. However, the best type of sorghum for wet milling needs to be established.

Concerning sorghum for human food, over the past decade simple (2 roll) roller mills have been used increasingly in southern Africa for the milling of maize to produce meal. These simple roller mills, which produce meal in a single step, also have the potential to be a much more economic technology for milling sorghum than the two-step (dehulling then milling) process traditionally used in sorghum milling. Another food process development that is rapidly becoming important in consuming sorghum as human food is that of precooking meal and adding vitamin fortification to produce a powder for an instant breakfast porridge or beverage product (see Appendix 4 for details). However, it needs to be established which is the most suitable type of sorghum for roller milling and use in instant products.

Funding is required for small literature and pilot studies to determine the most suitable sorghum grain qualities for the above applications.

6.4 Expand Sorghum Quality and Economic Evaluation Work to Malawi, Mozambique, Zambia, Lesotho and Swaziland

Expansion of the research done in this study to other nearby countries seems practical because:

- The sorghum quality methods development research logically began in the countries of Botswana, South Africa, Tanzania, and Zimbabwe considering the sorghum production and trade data of southern Africa. The potential of the developed methods for use and trade with other southern African would complete this SADC concept.
- The impact of improved grades and standards on the export potential of targeted commodities research done by MSU for USAID, in Malawi, Mozambique, and Zambia, could readily be followed up by work on a commodity specific crop such as sorghum to continue focus on G&S in southern Africa.
- The apparent success to date of the rapid sorghum methods and standards work can be inexpensively expanded to other SADC countries by using the same: interview questionnaire; survey procedure for expansion; and, the quality methods proposed introduction into the commercial marketing channels of each country.
- There would be incentive and momentum for other countries with smaller production, use, and trade to adopt the quality methods already evaluated and approved for implementation by the original participants of the four countries in this study.

- Governments in the SADC region would require little expense or effort once standards are adopted because traders and industry bear most of the expense of carrying out this standards program.

6.4.1. Conduct sorghum quality and economic evaluation studies in Malawi, Mozambique and Zambia

Assume the rapid quality methods and standards process research on sorghum done to date is satisfactory. Using a second stage concept, conduct an evaluation the of the feasibility of use of the rapid quality methods in the 3 countries (Malawi, Mozambique and Zambia) that MSU submitted reports on G&S earlier in 2001 to USAID This could be a reasonable cost project. It would require an economist to conduct the quality survey (same survey done for this study), an economic evaluation (which could follow the same tasks as in Task Order 4.1), and use contacts and information already identified in the MSU reports. The interviews could be used to select potential ring trial participants and interested parties in further work and to brief Bureau of Standards personnel. Dr. David Rohrbach has performed studies already on sorghum production, use, and processing in Zambia and Malawi. Including Mozambique would add coverage of a major port for potential sorghum export from the SADC region.

6.4.2. Conduct sorghum quality and economic evaluation studies in Lesotho and Swaziland

Using the survey questionnaire and following the tasks of the economic evaluation perform an analysis for feasibility of use of the rapid quality methods in Lesotho and Swaziland. These countries have focused on maize as the major grain source for food because of their relation and availability of maize supply from South Africa. If traders begin to move sorghum using the rapid quality methods within and from South Africa, then domestic sorghum may be considered as a food security crop within the two countries. This work could be performed at reasonable cost, through use of the nearby Department of Food Science at the University of Pretoria. Professor Taylor or one of his post-graduate students may be available to carry out the travel and interviews. If the same questionnaire and evaluation tasks were followed, the quality survey and economic evaluation could be done in a short period because of the small area and few number of potential interviewees currently engaged in sorghum use.

Funding is required for travel and salary of the person conducting the interviews in the five countries and time preparing the reports.

6.5 Conduct an Economic Analysis on the Impact of South African Sorghum VAT on Sorghum Trading with SADC Countries.

In the course of the country studies the question was asked about what needed to be done to increase production and marketing of sorghum. The interviewees in South Africa most often suggested better measures of sorghum quality were necessary. The second most frequent response was that removal of the VAT on sorghum grain would greatly increase production and marketing. Respondents implied that “a level playing field should be considered for the grains competing for food usage”. A VAT is imposed on domestic sorghum grain but is not placed on domestic maize or imported rice. This places sorghum at the price disadvantage of the amount of the VAT with the other two major substitutable grains for food use. The inequity appears to be an issue of past practice to discourage sorghum moving into marketing channels for food use other than brewing. Numerous attempts have been made to remove or reduce the VAT by sorghum producers and marketing groups to no avail. A suspected side effect is the probable underreporting of sorghum exports and domestic feedlot use to avoid VAT. When a large processing firm reports direct

purchases from farmers and the same firm reports products, there is the possibility also of underreporting. A comparison of South African export quantities to Botswana import quantities for the same period revealed discrepancies. South African sorghum export traders said in the interviews, that their firms shipped more grain than government export data showed.

An economic evaluation of the South Africa sorghum grain VAT effects on discouraging use and trading between SADC countries is needed. An impartial international organization like INCRISAT at Bulawayo, Zimbabwe has the sorghum expertise and experience in the SADC countries to perform this evaluation. It is recommended that consideration be given to funding for this activity.

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APPENDICES

APPENDIX 1
PARTICIPANTS THAT ATTENDED THE SORGHUM WORKSHOP,
WEDNESDAY 12 SEPTEMBER TO FRIDAY 14 SEPTEMBER 2001
HOLIDAY INN GARDEN COURT, JOHANNESBURG INTERNATIONAL AIRPORT, SOUTH AFRICA

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APPENDIX 2

Draft Press Release

for

Workshop on development of simple, common grain quality standards for sorghum to facilitate grain trade in southern Africa

Title: SADC Regional Sorghum Trade

Text

A regional workshop was held in Johannesburg on 13 & 14 September 2001 as part of a process to help stimulate the sorghum grain trade within and between the trading countries of southern Africa, specifically the SADC countries.

This regional workshop was sponsored by USAID's Regional Centre for Southern Africa in Botswana, as part of its agricultural development and regional market integration program.

Participating in the workshop were some 25 invited delegates from four sorghum-producing SADC countries, Botswana, South Africa, Tanzania and Zimbabwe. Delegates represented important sectors of the sorghum industry, including millers, brewers/maltsters, producers and traders, together with standards institutions and government departments.

The specific objective of the workshop was to facilitate the process of developing simple and common sorghum grain quality standards for use in sorghum trading the SADC Region.

Following an analysis of the current sorghum grain trade and the results of a survey on current sorghum grain standards in the four countries, delegates were familiarised with details of simple test methods developed to determine sorghum grain quality. Delegates gave consideration not only to actual grades and standards but also to the strategies to be adopted to introduce and implement these in the Region.

There was:

- Broad agreement on a simple, common and voluntary approach to sorghum grain grading and standards.
- Broad agreement on the grades and standards to be adopted.
- Agreement on the process for the way forward, including an ad hoc working group of national representation.
- Awareness of the market potential for grain sorghum trading in southern Africa.

Delegates set targets and milestones into early 2002 to ensure that the momentum of this initiative is maintained and its purpose achieved.

APPENDIX 3

BRIEF FOR GOVERNMENT OFFICIALS
for

Development of simple, common grain quality standards for sorghum to facilitate grain trade in southern Africa

The purpose of this activity is to facilitate sorghum trade within and between the trading countries of southern Africa, specifically the SADC countries, through development and implementation of simple sorghum grain quality methods and grade standards. The project was sponsored by the USAID Regional Centre for Southern Africa in Botswana as part of its agricultural development and regional market integration program. The project team consisted of an agricultural marketing economist and a food scientist (specialists in grain quality methods and standards development).

The project started with an analysis of the current commercial sorghum grain trade and an assessment of quality criteria and standards through interviews and review of information in four SADC countries; Botswana, South Africa, Tanzania and Zimbabwe during February to April 2001. The SADC countries were selected for the following reasons:

- Botswana - has the highest per capita consumption of sorghum
- South Africa - has the most developed sorghum processing industry
- Tanzania - has the highest sorghum production
- Zimbabwe - has potential to increase sorghum commercial production and processing

The research resulted in selection of the following five criteria for quality methods development:

- High/Low tannin grain
- Grain colour
- Degree of grain hardness
- Live versus dead grain (germinability)
- Grain purity

Simple methods for determination of the five quality criteria were developed and compared with standard methods for the same criteria. On the basis of fact that the methods developed were highly significantly correlated with existing standard methods, a collaborative evaluation trial, also known as a Ring Trial was conducted during June to August 2001. The statistical analyses of the result of the Ring Trials of the five methods indicated all would be suitable for determination as to whether sorghum grain being traded conformed to grades and standards to be agreed on by the sorghum community in southern Africa.

A Workshop was held in September 2001 in South Africa as part of the process to consider the methods that were developed as a result of research and Ring Trials and also to propose strategies to be adopted to introduce and implement these sorghum quality methods in the Region.

Participating in the Workshop were 25 invited delegates from the four countries representing important sectors of the sorghum industry, including millers, brewer/maltsters, producers and traders together with standards institutions and government departments.

At the conclusion of the workshop there was agreement by the participants:

- On the market potential for commercial sorghum grain trading in southern Africa
- On a simple, common and voluntary approach to sorghum grain grading and standards
- On the suitability of the five methods developed for use in standards for sorghum trading
- On the process for the way forward to use the test methods

Delegates set targets and milestones into early 2002 to ensure the momentum of this initiative is maintained and its purpose achieved. Workshop delegates elected 2 members from each country to an *ad hoc* Working Group to monitor the implementation of the methods and standards. It was agreed that the Sorghum and Millet Improvement Programme (SMIP) which is under ICRISAT at Bulawayo, Zimbabwe would act as coordinator/secretariat for the ongoing process.

The five methods for determining the various sorghum grain quality parameters were prepared in the format of the International Association for Cereal Science and Technology (ICC) and submitted to the ICC for consideration and approval in September 2001 to complete the tasks for this project.

APPENDIX 4

MORVITE: FROM TRADITION TO CHOICE

It has often been stated that people in southern Africa will continue to eat sorghum "because it is part of their tradition". Morvite, from King Food in South Africa (part of the Tiger Foods group) is a sorghum product people are eating on the basis of choice.

Morvite is pre-cooked sorghum with added vitamins (hence the name), plus citric acid, sugar and other sweeteners. It is a dry powder to which one simply adds either hot or cold water or milk to make to make an instant breakfast porridge or beverage. One hundred grams of Morvite makes a substantial contribution to the recommended dietary allowance (RDA) for protein, vitamins A, B, C, D and E, and minerals such as calcium, phosphorus, iron and iodine.

King Food's sales and R&D manager Paul van Rooyen explained that Morvite was originally developed as an easy to prepare and consume mid-shift nutrient supplement for miners. Latterly it has been adopted by provincial governments in South Africa for school meals. But perhaps most interestingly, Morvite has found a place on the supermarket shelves. Production increased by 20% last year and is now running at about 12 000 tonnes a year, between 15 and 20% of South Africa's entire commercial sorghum milling market. Morvite is such a success that King Food is investing in additional manufacturing capacity and is bringing out flavoured varieties such as chocolate, malt and strawberry.

An instant sorghum porridge like Morvite is relatively simple to manufacture. In addition to the normal dehulling and milling machines, it requires equipment for dry cooking, such as an extrusion cooker or gun puffer and a ribbon blender to mix the dry ingredients. On account of its ease of manufacture, Morvite sells in the supermarket at about half the price of oat porridge and a third that of cornflakes. Hence, this type of added value sorghum product is an attractive choice for manufacturer and consumer alike, being convenient, tasty, highly nutritious and also affordable.

APPENDIX 5
METHODS FOR DETERMINING THE VARIOUS SORGHUM GRAIN QUALITY PARAMETERS, WRITTEN IN THE FORMAT OF THE INTERNATIONAL ASSOCIATION FOR CEREAL SCIENCE AND TECHNOLOGY (ICC)

Title
1. Detection of Tannin Sorghum Grain by the Bleach Test

2. Scope
Applicable to whole grain sorghum.

3. Definitions
Certain varieties of sorghum contain proanthocyanidins (commonly referred to as tannins or more strictly-speaking condensed tannins) in the seed coat layer beneath the pericarp (commonly referred to as the testa layer) of the grain. These varieties are variously referred to as: tannin, high-tannin, brown, bird-proof, bird-resistant, or bitter sorghums.

Varieties of sorghum not containing tannins are various referred to as: non-tannin, low-tannin, condensed tannin-free, or sweet sorghums.

In this Standard the term "tannin sorghum" shall be used for those sorghums containing tannins and the term "non-tannin sorghum" used for those sorghums not containing tannins.

4. Principle
Sorghum grain is immersed in a sodium hypochlorite solution (bleach) containing alkali. The solution dissolves away the outer pericarp layer of sorghum grain, revealing the presence of a black pigmented testa layer in the case of tannin sorghums, or its absence in the case of non-tannin sorghums.

5. Reagent

5.1 Bleaching reagent
Five g[1] sodium hydroxide[2] is dissolved in 100 ml[3] of 3.5% sodium hypochlorite solution (commercial bleach). Reagent can be stored at room temperature in light-proof bottle for up to one month.

5.2 Sorghum standards
An appropriate tannin and non-tannin standard.

6. Apparatus

Glass beakers (50 ml)[4].

Tea strainer

Aluminium foil

Paper towel

7. Reference

Waniska, R.D., Hugo, L.F. & Rooney, L.W. 1992. Practical methods to determine the presence of tannins in sorghum. Journal of Applied Poultry Research 1:122-128.

8. Procedure

8.1
Test must be performed in duplicate
8.2
Known tannin sorghum and non-tannin sorghum standards must be included each time the test is performed.
8.3
One hundred whole, sound sorghum grains are placed in a beaker.
8.4
Bleaching reagent is added to **just** cover the sorghum grains and close beaker with aluminium foil. Too much bleaching reagent will cause over bleaching and give false negative results. If in doubt repeat using less reagent.
8.5
Incubate beaker at room temperature (20-30°C) for 20 minutes, swirling contents of beaker every 5 minutes.
8.6
Empty contents of beaker into tea strainer, discarding bleaching reagent. Rinse sorghum grains in tea strainer with tap water.
8.7
Empty contents of tea strainer onto sheet of paper towel. Spread grains out into a single layer and gentle blot them dry with another piece of paper towel.
8.8
Count tannin sorghum grains.
Tannin sorghum grains are those grains that are **black over the entire surface of the grain**, with the exception of the where the germ is which is somewhat lighter in colour.
Non-tannin sorghum grains are those which are either completely white, **or** are brown over **part** of the surface of the grain.

9. Presentation of results

9.1
Calculate tannin sorghum grains as percentage of total sorghum grains. Duplicate determinations should not differ by more than +/- 5 grains, for example first determination 90%, second determination 85%, or 95%.

The mean of the duplicate determinations should be calculated.
9.2
Expression of results

Results should be expressed as:

Percentage tannin sorghum, e.g. 90% tannin sorghum

10. Recommended standards

It is recommended that:
Batches containing ≥ 95% tannin or non-tannin sorghum be classified as Tannin or Non-tannin Sorghum, respectively

Where batches contain < 95% tannin (or non-tannin) sorghum and > 5% non-tannin (or tannin) sorghum, the batch be classified as Mixed Tannin and Non-tannin Sorghum and that the percentage tannin sorghum be given.

NOTES
[1]A 5 ml medicine measuring spoonful may be used to measure out approx. 5 g of sodium hydroxide if a weighing balance is not available

[2]Commercial caustic soda, sometimes marketed as drain cleaner, may be used

[3]Measure using for example a 200 ml 'Buddy' soft drink bottle (after use wash out with water and then crush bottle before disposal) and use 2 x 5 ml medicine measuring spoonfuls of caustic soda**.**

[4]Any clear glass or plastic beaker or container with a diameter of around 3 cm.

Title
1. Classification of Sorghum Grain according to Colour

2. Scope
Applicable to whole grain sorghum.

3. Definitions
Sorghum grain colour is the overall visual perception of the colour of the grain as viewed with the naked eye, where the colour results from a combination of intrinsic factors, principally: pericarp colour, the presence or absence of a pigmented testa, endosperm colour.

Sorghum grain colour is important with regard to end-use, in particular for milling to produce meal for porridge making and for malting for use in opaque beer brewing.

4. Principle
Sorghum grains are viewed with the naked eye.

Sorghum grains are classified as being either "white" or "coloured".

5. Apparatus
Sheets of white (A4) paper

6. Reference

Rooney, L.W. & Miller, F.R. 1982. Variation in the structure and kernel characteristics of sorghum. in: Mertin, J.V. (ed.). Proceedings of the International Symposium on Sorghum Grain Quality. ICRISAT, Patancheru, India, pp. 143-162.

7. Procedure
7.1
Test must be performed in duplicate.
7.2
Known white and coloured sorghum standards must be included each time the test is performed.
7.3
Count out 100 intact sorghum grains without glumes and spread evenly over the surface of the sheet of white paper so that none of the grains are touching each other.
7.4
Examine the grains and count the number of "white" or "coloured" grains, which ever is the least.

A "white" grain is coloured white all over its surface, irrespective of whether the grain is: "weathered" i.e. shows signs of mould on its surface, and/or has purplish anthocyanic blotches on its surface.
A "coloured" grain is coloured yellow, pink, red, brown, or purple (or combinations of these colours) all over its surface.

8. Presentation of results

8.1
Calculation
Calculate white (or coloured) sorghum grains as percentage of total sorghum grains. Duplicate determinations should not differ by more than +/- 5 grains, for example first determination 90%, second determination 85%, or 95%.

The mean of the duplicate determinations should be calculated as a whole number.

8.2
Expression of results

Results should be expressed as:

Percentage white (or coloured) sorghum, e.g. 90% White Sorghum

9. Recommended standards

It is recommended that:
Batches containing ≥ 95% white (or coloured) sorghum be classified as White (or Coloured) Sorghum.

Where batches contain < 95% white (or coloured) sorghum and > 5% coloured (or white) sorghum, the batch be classified as Mixed White and Coloured Sorghum and that the percentage coloured sorghum be given.

Title
1. Estimation of Sorghum Grain Hardness

2. Scope
Applicable to whole grain sorghum.

3. Definitions
Sorghum grain hardness is the resistance of the grain to breakage during decortication (dehulling) and milling.

Sorghum grain hardness is of importance as hard grains yield proportionally more clean (uncontaminated with bran) endosperm of large particle size during milling operations than soft grains.

Sorghum grain hardness is related to the proportion of corneous (horny/glassy/vitreous) endosperm in the grain. Hard grains have a higher proportion of corneous endosperm than soft grains.

4. Principle
Sorghum grains are cut into halves longitudinally.

One half is viewed with the naked eye and the proportion of corneous endosperm is determined by reference to a standard.

On the basis of the proportion of corneous endosperm, grains are classified into: hard, intermediate and soft.

5. Apparatus
5.1
Sharp disposable scalpel or sharp single-edged razor blade[1]
5.2
Blunt ended forceps
5.3
Magnifying glass
5.4
Sheets of (A4) paper, preferably dark coloured
5.5
Rubbery gum used to attach posters to walls (for example Prestik)

6. Reference

Rooney, L.W. & Miller, F.R. 1982. Variation in the structure and kernel characteristics of sorghum. in: Mertin J.V. (ed.). Proceedings of the International Symposium on Sorghum Grain Quality. ICRISAT, Patancheru, India, pp. 143-162,

7. Procedure
7.1
Test must be performed in duplicate.

7.2
Press a small piece of "rubbery gum" (approximately the same size as a sorghum kernel onto the cutting surface (approximately 5 sheets of white paper). Push a sound sorghum grain germ side up into the side of the piece of "rubbery gum" to hold it in place. The germ side has a circular indentation at the end of grain.
7.3
Hold grain with forceps and cut the grain in two lengthwise, to produce two even size halves, so that each half contains an equal portion of the germ.
7.4
Repeat until 20 grains have been cut.
7.5
Compare one half of each grain against the illustration (Figure) and classify it as:

Hard – the endosperm is totally corneous (translucent) or most (>50%) of the endosperm is translucent
Medium – the outer, corneous endosperm is continuous, but comprises less than 50% of the total endosperm; the inner part of the endosperm being floury (having a chalky appearance)
Soft – the endosperm is totally floury or the outer, corneous endosperm is very narrow and incomplete.

8. Presentation of results

8.1 Calculation
Calculate the number of hard, medium and soft and grains as a percentage of total sorghum grains. Duplicate determinations should not differ by more than +/- 1 grain in each class.

The mean of the duplicate determinations should be calculated as a whole number.

8.2 Expression of results

Results should be expressed as:

Percentage of hard, medium and soft sorghum grains, e.g.

Grain hardness (%)	Hard	Medium	Soft
Sample X	85	10	5

10. Recommended standards

It is recommended that:

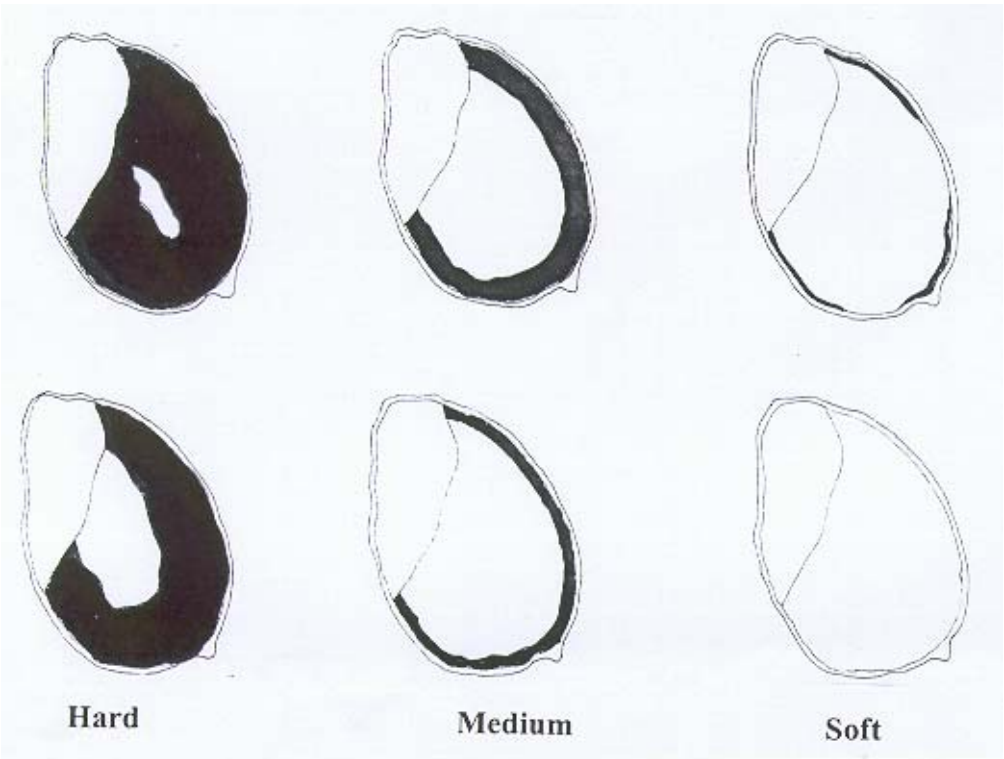
Batches containing 100% hard plus medium sorghum grains be classified as Medium Hardness Sorghum

Batches containing ≥ 90% soft sorghum be classified as Soft Sorghum

Where batches contain < 100% hard plus medium sorghum or <90% soft sorghum, the batch be classified as Mixed Medium Hardness and Soft Sorghum and the percentage soft sorghum be given

NOTES

[1]A very sharp, narrow bladed knife may be used



New illustrations for visual estimation of grain hardness

Title
1. Determination of Germinative Energy of Sorghum Grain

2. Scope
Applicable to whole grain sorghum.

3. Definitions
To produce sorghum malt, it is necessary that a high proportion of sorghum grains in a batch germinate.

Germinative Energy is the percentage of grains which can be expected to germinate if the batch is malted normally at the time of the test.

4. Principle
Sorghum grains are placed on damp filter paper in closed petri dishes and allowed to germinate at a set temperature for set periods of time.

The percentage of grains that have germinated at the end of each period is calculated.

5. Apparatus
5.1
Incubator set at 25°C and 100% relative humidity[1]
5.2
Petri dishes (glass or plastic) 10 cm diameter with lids[2]
5.3
Filter paper (Whatman No. 1) 9 cm diameter[3]
5.4
Graduated pipette with 4 ml measure[4]
5.5
Distilled water[5]

6. Reference

European Brewery Convention. 1987. Method 2.6. Germinative Energy. in: Analytica-EBC, 4th Ed. Brauerei- und Getranke-Rundschau, Zurich, E 19-20.

7. Procedure

6.1
Test must be performed in duplicate.
6.2
Moisten the filter paper with 4 ml[4] of distilled water[5]
6.3
Place two filter paper circles[6] into the bottom of the petri dish.
6.4
Count out 100 intact sorghum grains and spread evenly over the surface of the moistened filter paper so that none of the grains are touching each other. Close the petri dish.

6.5
Place the filled petri dishes in the incubator.

6.6
After 24, 48 and 72 hours, the grains are examined. At each time interval, the germinated grains are counted and removed from the petri dish. Germinated grains are grains where the root has penetrated the pericarp, i.e. the grain has chitted.

7. Presentation of results

7.1 Calculation
At each time interval calculate the percentage germinated grains. Duplicate determinations should not differ by more than +/- 5 grains, for example first determination 95%, second determination 90%, or 100%

Germinative Energy is the mean of the duplicate determinations, expressed as a whole number.

7.2 Expression of results

Results should be expressed as:

Germinative Energy (%) 24 hours, 48 hours, 72 hours, e.g.

Germinative Energy (%)	24 hours	48 hours	72 hours
Sample X	84	92	95

8. Recommended standard

It is recommended that sorghum grain for malting should have a Germinative Energy at 72 hours of ≥ 90%.

NOTES

[1]A polystyrene box with close-fitting lid may be used. Incubation may be carried out at ambient temperature in the range 20-30°C. High relative humidity is maintained in the box by placing two layers of thin cotton dishcloth saturated with water at the bottom of the box covering the entire surface area; and placing two layers of thin cotton dish cloth or newspaper saturated with water covering the petri dishes. The cloths must be re-saturated with water each day of the test.

[2]Any type of dish of similar diameter, such as a plastic lid, may be used. The dish may be covered with aluminium foil to close it.

[3]Circles of newspaper (black printing on only) of diameter the same size as the internal diameter of the smaller of the dishes may be used.

[4]When using newspaper circles, 5 ml of water should be used, which may be measured out using a 5 ml medicine measure, see also note 6.

[5]Tap water may be used, but there may be greater variability between results of different operators.

[6]Where newspaper and 5 ml of water are used, the number of circles of newspaper to be put in the dish has to be established prior to the test, since the thickness of newspaper is variable. The newspaper circles must be saturated with water, but there must be no free water on the surface, i.e. if for example it is found that after adding the two circles of newspaper to 5 ml of water there is still free water on the surface, additional circles must be added one at a time until such a number has been added that there is no free water.

Title
1. Determination of Total Defects in Sorghum Grain

2. Scope
This method is applicable to determination of total defects in consignments of whole grain sorghum intended for human consumption.

3. Definitions
The term total defects applies to all components of a sorghum sample which differ from the normal basic variety, including extraneous matter, filth, blemished grains, diseased grains, broken kernels and other grains.

3.1 Extraneous matter
All organic and inorganic material other than sorghum, broken kernels, other grains and filth. Extraneous matter includes loose sorghum seedcoats.

3.2 Filth
Impurities of animal origin including dead insects.

3.3 Blemished grains
3.3.1 Grains which are insect of vermin damaged, of abnormal colour, sprouted, diseased, or otherwise materially damaged.

3.3.2 Diseased grains – grains made unsafe for human consumption due to decay, moulding, or bacterial decomposition, or other causes that may be noticed without having to cut the grains open to examine them.

3.3.3 Insect or vermin damaged grains – Kernels with obvious weevil-bored holes or which have evidence of boring or tunnelling, indicating the presence of insects, insect webbing or insect refuse, or degermed grains, chewed in more than one part of the kernel which exhibit evident traces of an attack by vermin.

3.3.4 Grains having an abnormal colour – Grains whose natural colour has been modified by bad weather conditions, contact with the grain, heat, and excessive respiration. These grains may be dull, shrivelled, swollen, puffed, or bloated in appearance.

3.3.5 Sprouted grains – Grains exhibiting obvious signs of sprouting.

3.3.6 Frost damaged grains – Grains which are damaged by frost and may appear bleached or blistered and the seed coat may be peeling. Germs may appear dead or discoloured.

3.4 Broken kernels
Sorghum and pieces of sorghum which pass through a 1.8 mm round-hole sieve.

3.5 Other grains
Edible grains, whole or identifiable brokens, other than sorghum (i.e. legumes, pulses and other edible cereals).

4. Principle
The principle of the method is to separate all defects, defined under 3, from the normal basic grains by manual selection.

5. Reagents

No reagents are required for this determination.

6. Apparatus
6.1
Balance (precision 0.1 g)[1]
6.2
Sheet of cardboard approximately A4 size on which is drawn a 20 x 20 cm square divided into 400 x 1 cm square bocks with a 10 x10 cm square marked in the corner of the larger square (Figure). If determination is to be carried out routinely, it is recommended that the square should be drawn on A4 sized piece of wood, metal or plastic, or on paper and then laminated.
6.3
Thin object with straight flat edge (for example 15 cm ruler)

7. References

Codex Alimentarius. 1995. Codex standard for sorghum grain. Codex Stan 172-1989 (Rev. 1-1995). in: Codex Alimentarius, Volume 7, Cereals, Pulses, Legumes and Derived Products and Vegetable Proteins. FAO/WHO, Rome, pp 37-42.

International Association for Cereal Chemistry 1972. Determination of besatz of wheat. ICC Standard No. 102/1. In: ICC Standard Methods. International Association for Cereal Science and Technology, Schwachet, Austria.

8. Sampling
According to ICC Standard 101/1[2]

9. Procedure
9.1
Test must be performed in duplicate.
9.2
Weigh out an average (final) sample of 25.0 g[1] and empty sample onto A4 sheet.
9.3
Spread sample into a monolayer on the 10 x 10 cm square. The sample should approximately fill the square.
9.4
With the aid of the ruler move all defects described out of the 10 x 10 cm square.
9.5
When all the entire sample has been carefully and completely sorted through and all defects have been moved out of the 10 cm square block, with the aid of the ruler systematically fill the 1 cm square blocks with a monolayer of defects. There must be no space between the defects.
9.6

Count the number of 1cm squares of defects. If there is a square that contains less than 1 square cm of defects it should be counted as a full square.

10. Presentation of results

10.1 Calculation
Express total defects as percentage of the sample.

The following formula should be used to convert the number of squares of total defects into percentage total defects.

% Total defects = number squares of defects x 0.5

Duplicate determinations should not differ by more than +/- 2 squares, for example first determination 10 squares (5%), second determination 8 squares (4%), or 12 squares (6%).

The mean of the duplicate determinations should be calculated.

10.2 Expression of results

Results should be expressed as:

Percentage total defects of sorghum grain, e.g. 5%

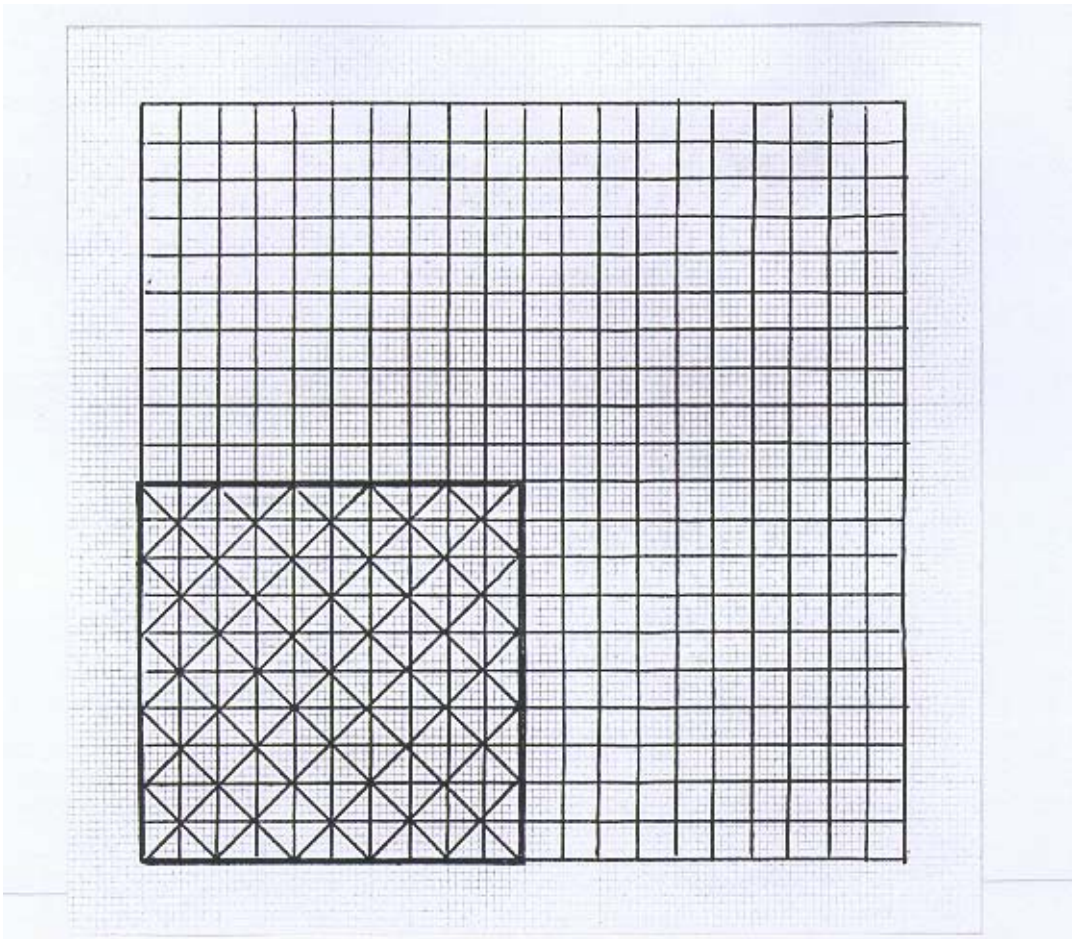
11. Recommended standard

It is recommended that the maximum permissible total defects in sorghum grain for human consumption should not exceed 8%, as specified by Codex Alimentarius.

NOTES

[1]A container holding between 30-35 ml (when filled to the brim), for example a 35 mm film container, may be used to measure the required quantity of grain (25.0 g)

[2]Representative laboratory samples may be obtained by emptying the bulk sample (normally 50-100 kg) onto a large plastic sheet (approx 3 x 3 m) and spreading it out and then heaping it. This procedure is repeated two further times before taking the laboratory sample.



20 x 20 cm square grid for sorting total defects from sound whole sorghum grains, with 10 x 10 cm insert for checking sample size