Strategy for the Global *Ex Situ* Conservation of Sorghum Genetic Diversity

September 2007

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DISCLAIMER

This document has been developed by the crop experts. The objective of this document is to provide a framework for the efficient and effective ex situ conservation of the globally important collections of sorghum.

The Global Crop Diversity Trust (the Trust) provided support towards this initiative and considers this document as a critical framework for guiding the allocation of its resources. However the Trust does not take responsibilities for the relevance, accuracy or completeness of the information in this document and does not commit to funding any of the priorities identified.

This strategy document is expected to continue evolving and being updated as and when information becomes available. The Trust therefore acknowledges this version dated 20 September 2007.

In case of specific questions and/or comments, please direct them to the strategy coordinator mentioned in the document.

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Cover photo: Sorghum at the research station of the Plant Genetic Resources Unit, Agricultural Research Corporation, Wad Medani, Sudan (courtesy, Brigitte Laliberté, Global Crop Diversity Trust)

1. Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is the fifth most important cereal crop in the world. It is traditionally grown in marginal agricultural lands, primarily because of its adaptation to drought. However, this does not mean that it cannot produce tremendous yields under optimal growing conditions. For example, the Bahia region of Mexico consistently reports sorghum yields of more than 13,000 kg ha^{-1} on an annual basis. As the population of the world continues to grow, the demand for greater and more reliable food and feed sources will expand agricultural lands into environments that will be challenged by limited water supplies and high temperatures. Because of sorghum's wide adaptation, its role in feeding the world will increase in importance. It is unique in that it can be used in human food production systems, as a reliable animal feed, as building material, converted in to both high and low value alcohols, and most recently as an important source of feedstock for biofuels production using starch, sugar, and biomass as feedstocks. Preserving this variability has been a primary goal of the sorghum research community. Sorghum's relative drought and heat resistance may also increase its importance world wide if the predicted effects of global warming come to pass.

The development of an effective strategy for the conservation and use of sorghum's immense genetic diversity is therefore essential for its long term maintenance and improvement of its utility.

1.1 Purpose of the global conservation strategy for sorghum

To contribute to an efficient and effective conservation system for sorghum genetic resources.

1.2 Objectives

Development of a comprehensive International Sorghum Germplasm Collection through:

- Identification and assessment of the global, regional and national collections of sorghum genetic resources meeting the international standards for conservation and playing a key role in a global conservation system
- Identification of critical gaps in existing world collections of sorghum genetic resources and development of strategies to fill these gaps.
- Development of a model for collaboration, cost sharing, and international responsibilities for the effective and efficient management of key sorghum genetic resource collections which will become the International Sorghum Germplasm Collection (ISGC).
- Identification of information needs for a comprehensive integrated global database network that enhances the maintenance, sharing, and utilization of the ISGC.
- Capacity building in order to upgrade and enhance various collection repositories to ensure the maintenance, regeneration, and sharing of the ISGC.

1.3 Focal person coordinating the strategy development process

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1.4 Contributors to the strategy development process

- Advisors: Dr CLL Gowda and Dr HD Upadhyaya (ICRISAT)
- Nineteen sorghum collection curators completed the survey
- Representatives of ten sorghum collections and other experts (Annex 2 - participants) participated in the Expert Consultation Meeting for Developing a Strategy for the Global Conservation of Sorghum Genetic Resources, 12 -14 March 2007, ICRISAT – Patancheru, Andhra Pradesh, India. The results of this meeting are incorporated into this sorghum strategy.

1.5 Process for Developing the Strategy

This strategy is based on an inventory of basic information and relevant data on the collections from the Germplasm Holdings Database maintained by Bioversity International (formerly know as IPGRI, International Plant Genetic Resources Institute) as at January 2006 with some additional information supplied by Ms Brigitte Laliberte. It listed (Annex 1) 122 different collections containing 194,250 "accessions". This huge number of accessions no doubt highlights the major issue of duplication of accessions across collections. The 122 collections were prioritised based on size and likely contribution to sampling the world population of land-race-type sorghum genetic diversity. A questionnaire (see format in Annex 3) was sent to the 57 institutes so chosen in September 2006 and 19 responses were received by February 2007. The strategy is based mainly on the information supplied by the 19 respondents and complemented by the outcomes of the Expert Consultation Meeting at ICRISAT in March 2007 (Annex 2) and additional key stakeholders consultations with respect to the key elements of an effective Global Strategy. This is a representative sample containing a total of 86% of the total listed on the Bioversity International data base on January 2006.

2. Origin and taxonomy of *Sorghum bicolor* (L.) Moench

2.1 Centres of diversity

De Wet and Harlan (1972) have an excellent discussion on the origin and domestication of *Sorghum bicolor* (L.) Moench. In short, it is generally agreed that *S. bicolor* (L.) Moench originated and was domesticated in the Sub-Saharan region of Africa and spread to India and China. It probably follows that the Sub-Saharan and north east regions of Africa are the primary centres of diversity and that India and China are secondary centres. A tertiary pool of diversity is considered to be the nineteen wild species indigenous primarily to Australia, but also to South East Asia and Africa (Lazarides et al 1992).

The literature cited in the Taxonomy section below, suggest that *S. bicolor* (L.) Moench (or *Sorghum bicolor* subs. *bicolor*) was derived from *Sorghum verticilliflorum* and *S. drummondii* (or *Sorghum bicolor* subs. *verticilliflorum* and *Sorghum bicolor* subs. *drummondii*) in Africa and from *S. halepense* and *S. propinquum* in Asia.

2.2 Taxonomy of *Sorghum bicolor* (L.) Moench

Doggett (1988) and Dahlberg (2000) have comprehensive discussions on the classification of sorghum. Their papers form the basis of the following discussion along with some key publications for further reading. It is common that there are variable interpretations of taxonomic literature and that for sorghum is no exception.

Sorghum (described by Linnaeus in 1773 and named by Moench in 1794) belongs to the Family Poaceae, Tribe Andropogonaea which consists of 16 sub-tribes, one of which is Sorghastrae (Stapf 1917 and Garber 1950). Garber (1950) considered this sub-tribe comprised two main genera, Cleistachne (Hackel 1889) and Sorghum, the latter having a basic chromosome number of n=5 (see also Celarier 1956a). Recent DNA evidence suggests that n=10 is a possibility (Sprangler et al 1999). Snowden (1935 and 1936) and Garber 1950) suggested that the genus Sorghum comprises six sub-genera (later named "sections"):

1. *Eu-Sorghum* – is considered to be the same as Snowden's (1935 and 1936) section *Eu-sorghum.* The term *Eu-sorghum* has been discarded (de Wet 1978) and is now known as *Sorghum*. It is the likely progenitor of *S. bicolor* (n=10) in Africa, of the n=20 chromosome *S. halepense* in India and of *S. propinquum* (n=10) in South East Asia. It has been suggested that crosses between *S. propinquum* and *S. bicolor*, when the latter reached China, gave rise to the distinct Chinese landraces. *S. propinquum* is rhizomatous so is considered to be a progenitor of the strongly rhizomatous and geographically neighbouring, *S. halepense*
2. *Sorghastrum* (Nash) – *Sorghum* and *Sorghastrum* probably had common ancestors *Sorghastrums* were found in Africa and the Americas
3. *Chaetosorghum* – (Snowden 1936) found only in Australia
4. *Stiposorghum*- (Snowden 1936) found only in Australia
5. *Heterosorghum* - (Snowden 1936) found in South East Asia, Phillipines and Australia
6. *Para-sorghum* (Snowden 1936) - widely spread in South and East Africa, India, South East Asia, Australia, and as *S. trichocladum* in western Mexico and Guatemala

Doggett (1988) presents a discussion on how the locality of these ancient types can be related to continental shifts during the breakup of Pangaea, the super continent.

For further reading see Celarier 1956 and 1959, Lazaredes et al 1991, and Dillon et al 2004. See Sun et al (1994), Spangler (2003) and Dillon et al (2004) for a discussion of the use and results of using molecular technology to elucidate the taxonomy of *Sorghum.* Sprangler's suggested changes are not included here.

The six sections (sub-genera) are distinct types and until very recently (Price et al 2006) no crosses between *Sorghum* and the five other sections were reported. While Prices's work needs to be developed it seems that the genetic diversity in this tertiary centre of diversity will be available for *S. bicolor* grain or forage sorghum breeding.

The basis for the unique genetic diversity within the *Sorghum* section is derived from thousands of years' of natural and farmer/user selection and the grain and forage sorghum breeding programs that have occurred internationally during the last century. To assist breeders, this large genetic diversity represented in the world collection of sorghums has been grouped on the basis of their similarities and this forms the basis of the following discussion, (Doggett 1988).

De Wet (1978) considered the *Sorghum* subgenus comprise three species, *Sorghum halepense* ((Linn.) Pers.)), *S. propinquum* ((Kunth) Hitchc.)), and *Sorghum bicolor* ((L.) Moench)). The cultivated taxa of the subgenus *Sorghum* were first grouped into 28 species by Snowden (1936). Classification schemes since then have all been based on his historic work. Later all named *S. bicolor* (L.) Moench were grouped into working groups (WG) by Murty and Govil (1967) and later into five races and ten

intermediate groups by Harlan and de Wet (1972). The five races are Bicolor, Kafir, Caudatum, Durra and Guinea. Dahlberg (2000) integrated the WG and race/intermediates grouping system for use by researchers who require a more detailed description of groups. Most sorghum workers recognize and use the race/intermediate method of grouping. Historically, the Kafir, Caudatum and Durra races have contributed most to grain breeding. For example, the cytoplasmic-genetic male-sterility system almost exclusively used to produce F1 hybrid cultivars is based on the Milo cytoplasm (A1) from the Durra race and to the non-restorer genes from Kafir. A1 cytoplasm male-fertility restoration genes are ubiquitous across the races.

It is evident from the surveys that the currently accepted taxonomy of sorghum has not been used. This is a point that was discussed at the Experts Meeting and it was agreed that getting the taxonomy section in this strategy correct and agreed upon is therefore very important.

3. Overview of Sorghum *Ex situ* Collections

The expert group during the March 2007 meeting reviewed the data compiled on existing collections through the survey and proposed some additional country collections for which the group would need more information. This decision was based on the perceived unique diversity of sorghum within these countries reflected upon by their importance within the country.

3.1 Major collections

What may constitute a major collection could be:

- Good sampling of diversity
- Good characterization and evaluation information available and accessible
- Good accessibility and availability of material and related information

The ICRISAT Hyderabad (FAO in-trust collection) and USDA collections are the major collections based on their size, international sampling of sorghum's diversity, storage facilities, documentation, accessibility of collection data and willingness to share germplasm (as at September 2006). The collections in P.R. China and in the NBPGR in India (secondary centres of diversity) are large collections but, based on the survey results and subsequent attempts to access the data, are lacking in data accessibility. At the time of the surveys, the collection from China are conditionally (subject to "International Law") available for distribution.

Of course, the above does not diminish the significance of the remaining collections particularly those in the primary and secondary centres of diversity. The ILRI (very few accessions) and Brazil (not unique and relatively small) collections are lowest priority. The Americas' and Australia contribute no Sorghum Section diversity although the Australian indigenous sorghum species are considered to be a tertiary centre of diversity. All other collections need to be retained including the broomcorn collection in Serbia. Table 1 lists the collections of the respondents to the survey September 2006.

Table 1: Collections of sorghum according to replies of the Sept, 2006 survey

Country	Institute	no of accessions	% of total holdings (194,250 acc.)
USA	USDA-ARS-PGRCU	43,104	22.2%
Global	ICRISAT	36,774	18.9%
India	NBPGR	18,853	9.7%
China	CAAS	18,250	9.4%
Ethiopia	IBC	9,772	5.0%
Brazil	EMBRAPA	8,017	4.1%
Russia	VIR	7,335	3.8%
Zimbabwe	NPGRC	7,009	3.6%
Australia	DPI	5,403	2.8%
Sudan	PGRU-ARC	4,191	2.2%
Mali	IER	2,975	1.5%
France	CIRAD	2,690	1.4%
Kenya	NGBK	1,320	0.7%
Zambia	NPGRC	1,005	0.5%
South Africa	NPGRC	428	0.2%
Malawi	NPGRC	401	0.2%
Nigeria	NCGRB	159	0.1%
Serbia	Inst. Field and Vegetable crops	152	0.1%
Global	ILRI	52	0.0%
	TOTAL 19 institutes	**167,890**	**86%**

In addition to the above collections, the expert group identified the following collections (Table 2) for which more information would be needed in order to assess their status: To date attempts to gather information from these institutes (with the exception of the VIR in Russia) have been unsuccessful.

Table 2: Additional collections identified by the experts at the ICRISAT meeting in February 2007 as potentially valuable

Country	Institute	no of accessions (1)
Russia	VIR	7335
Mexico	INIFAP	3,990
Argentina	INTA	3,251
Uganda	Serere Ag. & Animal Prod, Res. Inst.	2,635
Japan	NIAR	2,583
Philippines	IPB/UPLB	2,285
Thailand	Dept. of Ag, Univ. of Kasetsart	1,500
Colombia	CORPOICA	1,290
Rwanda	ISAR	1,144
Hungary	Institute for Agrobotany	1,013
Guatemala	ICTA	823
Bulgaria	Institute for PGR "K.Malkov"	569

Country	Institute	no of accessions (1)
Pakistan	Inst. of Ag. Biotech. and GR	492
Burkina Faso	INERA-Saria and Bobo Dioulasso	Unknown
Ghana	PGR Centre, Crops Res. Inst.	67
El Salvadore	Centa	406
Eritrea	Unknown	Unknown
Honduras	Escuela Agricola Panamericana El Zamorana	2,000
Morroco	Center de Production des Semeneces Pastorals	1
Nicaragua	REGEN, Universida Nacional Agraria	30
Somalia	Central Agricultural Research Station	94
Yemen	American Sorghum Project	4,000

(1) With the exception of Russia these data are from the Bioversity Germplasm Database as at January 2006.

167,890 accessions are reported in the 19 respondent collections which is 86% of the total 194,250 accessions listed in the Bioversity Germplasm Database (Jan 2006). The number of accessions in the ICRISAT and USDA-ARS collections collectively represent approximately 42% of the total number of accessions.

For ICRISAT collection, 76% of accessions are from 90 countries outside India, 7% from India NPGRA and 1% from Asia. For the USDA-ARS collection, 73 % of the collection is from countries outside the USA, including key collections from Ethiopia, Sudan and Mali. It is likely that there is a high degree of duplication between the ICRISAT and the USDA collections and also between the ICRISAT and USDA collections and those in Ethiopia, Sudan and Mali. The Chinese collection comprises 73% landraces and other Chinese material. It is thought that the vast majority of Chinese landraces are not duplicated in other collections.

Interpreting this data is complicated by the undoubted duplication of accessions. As just one of many examples, the relatively low availability of passport data makes it impossible to determine which of the very large number of accessions "from abroad" are common in the country of origin, ICRISAT Hyderabad and USDA-ARS collections. Probably many are.

There is a total of 159 "wild related species" in the 19 collections represented with 1,240 accessions (Table 3). Once again duplication is rife and this is complicated by the varying definitions of what constitutes a "wild related species". The literature cited in the Taxonomy section above, suggest that *S. bicolor (L.)* Moench (or *Sorghum bicolor* subs. *bicolor*) was derived from *S. verticilliflorum* and S. drummondii (or *Sorghum bicolor* subs. *verticilliflorum* and *Sorghum bicolor* subs. *drummondii*)in Africa and from *S.halepense* and S. *propinquum* in Asia. Consequently, it is important that these four wild species are adequately sampled in their various environments. This literature could be interpreted differently so the data above represents a liberal interpretation of the information in the surveys.

Table 3: Sorghum collections of wild relatives, landraces and cultivars – survey Sept. 2006

	Country	Wild related species	Wild species accessions	Land-races	Cultivars etc.
1.	Global - ICRISAT	30	458	31,347	4,969
2.	Global - ILRI	1	10	25	17
3.	Australia - DPI	20	344	161	4,897
4.	Brazil - EMBRAPA	Unknown	Unknown	Unknown	8,017
5.	China-CAAS	13	39	11,328	6,770
6.	Ethiopia-IBC	2	12	9,760	Unknown
7.	France - CIRAD	50	Unknown	910	1,780
8.	India - NBPGR	2	237	12,186	6,430
9.	Kenya - NGBK	4	61	1,169	79
10.	Malawi - NPGRC	0	0	385	16
11.	Mali? IER	Unknown	Unknown	Unknown	Unknown
12.	Nigeria - NCGRB	2	0	Unknown	117
13.	Russia VIR	Unknown	Unknown	Unknown	Unknown
14.	Serbia - Inst. Field & Veg. crops	2	5	403	20
15.	South Africa - NPGRC	0	0	22	130
16.	Sudan - PGRU-ARC	9	Unknown	2,539	1,652
17.	USA, USDA-ARS	7	75	2,269	28,256
18.	Zambia - NPGRC	0	0	1,005	Unknown
19.	Zimbabwe - NPGRC	17	0	724	6,285
	Total	**159**	**1,241**	**74,233**	**63,005**

3.2 Information and documentation

Passport data

Overall, according to the 2006 survey data, the passport data is documented and stored electronically at a high but variable level. However, the nomenclature used varies between collections making the identification of unique accessions difficult, at best. It is evident that a standard nomenclature and taxonomy of sorghum has not been used – this issue has been raised above.

Characterization data

Characterization data is documented and stored electronically at a reasonable level but could be much improved for this very important aspect with respect to utility.

Evaluation data

Few collections have significant evaluation data. For example, 50% of the Chinese collection has been "evaluated" with the data stored electronically, but this is not readily accessible. CIRAD has significant evaluation data as does the USDA-ARS collection. The improvement of this situation needs to be targeted with respect to traits (including molecular information) of key importance in

breeding and other research programs. Collaboratively, protocols for testing key traits should be developed to ensure standard reporting.

Availability of data

With the possible exception of ICRISAT Hyderabad, most data from the various world collections are not available on the Internet. Partial data is available from the Australian, Chinese, CIRAD, South African and USDA-ARS collections. The data from the remaining 12 collections are not available. Accessibility of data is an essential component of a global strategy for the conservation and use of sorghum's genetic diversity. Clearly addressing the current situation is high priority.

Global information system for sorghum germplasm (GISSG)

It was proposed by the participants of the February 2007 meeting that the establishment of a global information system for sorghum germplasm (GISSG) would allow the analysis of the USDA and ICRISAT collections database and the identification of the overlap (duplication) between these 2 major collections. With the participation of all sorghum collections, it would allow for an assessment of duplications among collections globally, to identify gaps in the diversity in *ex situ* collections and to target geographical areas to sample missing diversity. Evaluation data would be a key element and best done at the national level (origin of the materials). It will also allow for a better understanding of the level of safety duplication.

To establish such a system, it will require:

- Harmonization of the different collections at national level
- Harmonization of data with a focus on a minimum set of descriptors
- Strengthening the existing databases

3.3 Analysis of importance and uniqueness of collections

In order to assess the value and uniqueness of the collections, there is a need for information on the following:

- level of duplication between collections
- date of collections (pre-1992) – assumption is that a collection post -1992 is unique and has not been shared
- focus on the 5 major races
- use (e.g. roasting etc)
- data on the environment of origin of accessions (e.g. dry acid sandy soils, rain fall, temperature etc.)
- unique morphological traits
- use in breeding for specific purposes
- genetic stocks

It is acknowledged that most collections will have a sub-set varying in size having greater value based on:

- Unique combinations of races
- Agronomic traits
- Availability of material and of information associated to it including feedback information from users
- Good representation of diversity

Considered by respondents in the September 2006 survey as:

- Fully unique –China, South Africa, Sudan, Mali, Serbia and Zimbabwe
- Mostly unique - Ethiopia IBC, ICRISAT Hyderabad, Malawi and Zambia
- Partly unique – Australia, France-CIRAD, ILRI, India-NBPGR, Nigeria and USDA-ARS
- None unique – Brazil

In general the African, Indian, Chinese and Australian collections are the most likely to contribute unique genetic material, they being the primary, secondary and tertiary centres of diversity. However, many of the unique accessions in these collections are duplicated in other collections such as the USAD-ARS and ICRISAT Hyderabad collections. Some, but patently insufficient, passport data is available to identify all of the duplications.

The accessions in the 19 collections provide a good sample of potential materials from Africa, India, China, and Australia. It could be strengthened with the inclusion of data from the additional collections who did not respond to the Survey (Attempts to access this data are currently under way). While accessions from these countries may be duplicated in other collections, every effort should be made to ensure their sorghum genetic diversity is sampled and conserved. However, any collections made after 1992 tend to be not duplicated outside the country of origin. These more recent collections merit specific attention for safety duplication, and documentation.

Analysis of duplicates

In order to assess the level of duplication between the major collections, the following process was proposed at the February 2007 meeting:

1. For USDA and ICRISAT to analyze their collection information and identify the probable duplicates between these 2 collections
2. Provide an easy to use and to consult datasheet to all relevant sorghum collection managers to first provide corrections on the data and second to assess the duplication between their collections and the USDA and ICRISAT collections
3. Over time, as the global information system gets developed and most collection information is included, it will be possible for all collections to identify probable duplicates in other collections worldwide.

Safety duplication (Table 4).

The situation on safety duplication varies from collection to collection. Some are safety-duplicated in one or both of the global collections (ICRISAT and USDA). These safety duplications are fully integrated into the collections and material is distributed and maintained with an agreement from the donors. However, most collections are looking at ensuring the safety duplication at the national level first, in different and distant sites and then to look at the possibility of an “out of country” site. USDA is safety duplicated in a different site in the USA. In the case of the Southern African countries, the national collections are safety duplicated at the regional SPGRC base collection in Zambia and SPGRC is backed up at the Nordic Genebank in Sweden. In Eastern Africa, the regional network EAPGREN is looking at a regional approach to conserve sorghum between Sudan and Ethiopia and these 2 collections be used for safety duplication of the regional material. The main implications regarding the safety duplication are political in nature. The decision to designate a safety duplication site and agreement remains a decision at national level.

Table 4: Sorghum collections and safety duplication– survey Sept. 2006

	Country	Institute	Backed up?
1.	Global	ILRI	yes
2.	Global	ICRISAT	yes
3.	Australia	DPI	no
4.	Brazil	EMBRAPA	no
5.	China	CAAS	Yes long-term
6.	Ethiopia	IBC	no
7.	France	CIRAD	yes
8.	India	NBPGR	no
9.	Kenya	NGBK	3 accessions
10.	Malawi	NPGRC	SPGRC
11.	Mali	IER	Yes
12.	Nigeria	NCGRB	IAR, Zaria, Nigeria
13.	Russia	VIR	Unknown
14.	Serbia	Inst. Field & Veg. crops	no
15.	South Africa	NPGRC	SPGRC
16.	Sudan	PGRU-ARC	no
17.	USA	USDA-ARS	Yes, Fort Collins?, long-term
18.	Zambia	NPGRC	SPGRC
19.	Zimbabwe	NPGRC	ICRISAT

3.4 Gaps in diversity (Table 5)

In order to fully assess the gaps in collected and conserved diversity, it will be necessary to analyze the database of all of the collections with sufficient passport data to allow for this analysis (identification numbers, collecting site information etc.). There is also, generally in most collections, gaps in wild and weedy forms.

Some gaps in geographical coverage of genetic diversity were indicated in:

- West Africa particularly in Liberia, Ivory Coast, Guinea, Zaire, Ghana, Nigeria and along the Niger River Delta
- Central America
- Central Asia and the Caucasus
- Sudan particularly in the Darfur and South part of the country

Twelve respondents considered their collections needed greater species coverage of the crop. Five considered the sample did not represent the species and eight considered the ecological sampling was deficient. See Table 5.

Table 5: Possible gaps in diversity in sorghum collections – survey Sept. 2006

	Country	Institute	Gaps in Species coverage	Gaps in Sample per species	Gaps in Ecological sampling
1.	Global	ICRISAT	**yes**	**yes**	**yes**
2.	Global	ILRI	**yes**	**yes**	**yes**
3.	Australia	DPI	no	**yes**	no
4.	Brazil	EMBRAPA	**yes**	**yes**	**yes**
5.	China	CAAS	**yes**	**yes**	**yes**
6.	Ethiopia	IBC	**yes**	no	**yes**
7.	France	CIRAD	**yes**	no	**yes**
8.	India	NBPGR	no	no	no
9.	Kenya	NGBK	**yes**	no	no
10.	Malawi	NPGRC	**yes**	no	**yes**
11.	Mali	IER	Unknown	Unknown	Unknown
12.	Nigeria	NCGRB	**yes**	no	no
13.	Russia	VIR	Unknown	Unknown	Unknown
14.	South Africa	NPGRC	no	no	no
15.	Serbia	Inst. Field and Veg. crops	no	no	no
16.	Sudan	PGRU-ARC	**yes**	no	**yes**
17.	USA	USDA-ARS	**yes**	no	no
18.	Zambia	NPGRC	**yes**	**yes**	no
19.	Zimbabwe	NPGRC	no	no	no

The collections mentioned were made of special materials/genetic stocks, mapping population etc include the USDA-ARS, CIRAD, NBPGR, ICRISAT Hyderabad, Serbia (broomcorn) and Australia (Australian indigenous sorghum species).

3.5 Conservation status (Table 6)

The expert group discussed the standards for long-term conservation but no clear recommendations were made. Some collections aim for 10,000 seeds for the long-term conservation samples while others will aim at 4,000 seeds.

Table 6: Conservation status and storage conditions– survey Sept. 2006

	Country	Institute	Storage long-term	Storage medium term	Storage short term
1.	Global	ILRI		100%	
2.	Global	ICRISAT	90%	99%	5%
3.	Australia	DPI	100%		

4.	Brazil	EMBRAPA	10%	90%	
5.	China	CAAS	100%		
6.	Ethiopia	IBC	94%	6%	
7.	France	CIRAD	40%	100%	100%
8.	India	NBPGR	100%		
9.	Kenya	NGBK	97%	57%	
10.	Malawi	NPGRC	100%	100%	
11.	Mali	IER	Unknown	Unknown	Unknown
12.	Nigeria	NCGRB	75%		50%
13.	Russia	VIR	Unknown	Unknown	Unknown
14.	Serbia	Inst. Field & Veg. crops		100%	
15.	South Africa	NPGRC	100%	100%	
16.	Sudan	PGRU-ARC	100%		
17.	USA	USDA-ARS	70%		58%
18.	Zambia	NPGRC	60%	100%	
19.	Zimbabwe	NPGRC		100%	

Storage Conditions (Table 6)

The objective is to have all accessions involved in conservation stored under long-term conditions and backed up under secure and long-term conditions. Only 9 of the 19 collections are stored under long term storage conditions or close to it and 8 are backed up under secure conditions. Storage is evidently a significant issue.

Of the two major collections,

- ICRISAT Hyderabad has none of their accessions backed up and reports that there are no backups of other collections in their facility, although Zimbabwe ICRISAT reports that their collection is backed up at ICRISAT Hyderabad. (Note: it is highly likely that at least most of the ICRISAT Hyderabad collection is contained – and therefore backed up - in the USDA collection - this will be checked). Their collection has 5% of its collection stored under short-term conditions but 90% and 95% under long-term and medium term respectively. The Mali part of the collection is backed up at the regional genebank in Niger, also Mali received a sample of its collection in 1996. 1775 accessions backup at ICRISAT Hyderabad, OSTOM (France) and USDA.
- The USDA-ARS collection is backed up at NCGRP (presumably at Ft Collins). The collection has 70% under long-term and 58% under short-term.

The SADC countries have backup storage at the SPGRC in Zambia and at least some of which are backed up in Svalbard under an agreement with the Norwegian government.

3.6 Regeneration Status (Table 7)

Based on the survey results this is a major issue and potentially expensive to fix.

Table 7: Regeneration requirements – survey Sept. 2006

	Country	% Requiring regeneration	No. requiring regeneration	Regeneration period - yrs
1.	Global - ICRISAT	12 to30	9000	10
2.	Global - ILRI	Unknown	5	10 to 15
3.	Australia - DPI	15-20	70	20-50
4.	Brazil - EMBRAPA	10	800	5
5.	China-CAAS	100 wild spp, ca 30 0thers	30 wild spp, 700	8 to 10
6.	Ethiopia-IBC	45 Landraces	4400 landraces	5 to 7
7.	France - CIRAD	0	0	<60% germ
8.	India - NBPGR	25 to 100 wild spp	5000	15
9.	Kenya - NGBK	0.03 to 11	100	
10.	Malawi - NPGRC	60 of LR	200 landraces	10
11.	Mali	90 Landraces, 50 Obsolete varieties, 70 Breeding/research materials	1553 LR, 25 obsolete, 840 breeding/research materials	5-10
12.	Nigeria - NCGRB	100	159	
13.	Russia VIR			
14.	Serbia - Inst. Field & Veg. crops	0	0	2
15.	South Africa - NPGRC	0	0	12
16.	Sudan - PGRU-ARC	5	200	
17.	USA, USDA-ARS	low, 25LR	600 landraces	varies
18.	Zambia - NPGRC	40	450	5
19.	Zimbabwe - NPGRC	50	3500	

There are a total of 27,754 “accessions” in urgent need of regeneration. Priority of material for regeneration may be given to old and historical material with low viability and to unique accessions (not duplicated elsewhere). Which of these accessions are duplicated across collections is impossible to calculate based on the survey results and information accessible electronically but this task could be undertaken when a global information system for sorghum collections is developed. Accessions in the following collections make up the majority of these: Ethiopia IBC (4400), ICRISAT Hyderabad (9000), NBGRC (5000), Mali (2400) and the ICRISAT collection in Zimbabwe (3500). Each of these collections is important with respect to conserving sorghum genetic diversity. They clearly need regeneration, preferably at one location under short days to allow expression of their taxonomic, plant type and desirability characteristics in the absence of the effects of photoperiod. However for materials with highly specific adaptation, a regeneration in environments that resemble the environment of origin would be most preferable, to avoid loss of intra-accesion diversity due to drift and natural selection. Factors determining such a location include quarantine regulations, sufficiently short days, labour costs, availability of skilled staff (in

sorghum taxonomy, plant characterization, knowledge of internationally agreed protocols/descriptors etc), excellent agronomic conditions, seed handling and at least temporary storage facilities etc.

On the positive side, such a regeneration exercise would provide the opportunity to partly rationalize the duplication issue. It would also be an opportunity to collect readily accessible characterization and some evaluation data which is lacking in the current sorghum collection world.

Regarding the regeneration process, it was proposed by the expert group that 50 panicles be selfed (bagged), sampled and then bulked to best preserve the genetic diversity and to make up the samples for long-term conservation. There was a discussion on the viability % triggering regeneration. It varies from 65% in the USDA collection to 85% in the ICRISAT (China with 75% and Ethiopia also about 65%). The percentage of germination will also vary according to the types and the season during which seed was produced.

3.7 Distribution status

Each of the collections reported no difficulties in the distribution of material, except for government policy mainly with respect to the International Treaty on Plant Genetic Resources for Food and Agriculture (IT-PGRFA). Each, with one exception, of the collections will provide material under a Material Transfer Agreement (MTA). Nearly all collections had sufficient seed for distribution. Those that were limited were so because of regeneration issues. The exception is Australia who is still dealing with the ratification of the IT-PGRFA and is still trying to decide who the owner of the Australian indigenous wild sorghums is. The USDA-ARS's policy/attitude considers the global sorghum genetic diversity is the property of all mankind and hence freely available.

The other emerging factor is commercialization and not only of breeding program products. At least for the Australian collection, since 1989, germplasm from the QDPI&F breeding program are tagged "not for distribution to the private sector and available to the public sector only under an MTA".

However, there have been relatively few accessions distributed and most only nationally. There are two notable exceptions to this and they are ICRISAT Hyderabad (2084 nationally, 62 regionally and 152 internationally), but especially USDA-ARS with 12,203 nationally and 1047 internationally. It is interesting to note that 68% of the USDA-ARS distributions went to public sector breeders and 27 % to researchers. Overall, by far breeders, particularly public sectors breeders, are the major users, which is encouraging. For ICRISAT Hyderabad the most utilized accessions were used for in-house R&D which is mostly aimed at crop improvement, nationally and internationally.

3.8 Effectiveness of links with users

Good and easy access to information on useful traits and the importance of the use of standard identifiers (such as the International Sorghum numbers – IS) is essential to ensuring links with users. Some of the constraints on the use of the collections mentioned at the February meeting are:

- There are fewer and fewer sorghum breeding programmes and breeders's are working on narrow groups of genes and it is more cost effective to use advanced material. They also have their own working collections. In West and Central Africa, there are mainly working collections.
- Low quantity and viability of seeds for exchange and distribution

- Problem in accessing the information and the use of different descriptors
- Collection curators may not be specialists in sorghum
- Poor feedback from scientist/breeders on evaluation, back to the genebank

The links with users could therefore be strengthened with the following activities:

- Development of a global information system with easy access to reliable information on user friendly formats and publication of available information. The system should allow access to good passport data to identify duplicates, races and working groups and characterization of useful traits. Users should be able to select and focus on specific characters for evaluation at multi-locations.
- Strengthen the links between genetic resources programmes and scientists for evaluation work, by regional needs
- Pre-breeding is key to ensure increased use
- Form core and mini- core collections for evaluation and to increase use. Collections could focus on specific adaptive material with superior agronomic traits. Material could be selected to form a sub-set of nationally, regionally and globally interesting material according to specific traits such as: height, maturity, GXE, grain colour, agronomic suitability (by regions) and specific races or working groups.
- Consideration should also be given to developing "mini-core" populations which comprise the key overall genetic variation and/or for particular purposes.
- Increase the use of unique elite (could be breeding materials, landraces) exotic material in a small nursery for evaluation of adaptation and specific traits.
- Ensure good links with agricultural research institutes and national programmes to participate in evaluation – replicated trials
- Need to address the different groups of users – NGOs, civil society group – focus on ecological adaptation
- Need to ensure trust between partners for exchange of germplasm and ensure due recognition of the material used and ownership of national programmes
- Provide good examples of positive impact on use of material through field visits and demonstration
- Publicize the global conservation strategy for sorghum

4. Synthesis of conservation and distribution

The collections were assessed for meeting the standards for conservation and distribution i.e. for sampling, number of accessions, storage conditions, backup, documentation, regeneration and numbers distributed, each of which are discussed individually elsewhere in the strategy.

Overall comments for each of the collections – based on the survey data. Overall, regeneration is a major common issue.

- ICRISAT Hyderabad: good for all categories although the major issues are backup storage, uniqueness, sampling the available genetic diversity for users.
- USDA-ARS: good for all categories except for accessibility of data.
- China: major problem issues are sampling wild sorghums, sampling available diversity, accessibility of data and number of users.

- India – NBPGR: the major issues are backup storage, documentation, accessibility and numbers of users but also uniqueness, wild species and sampling.
- Ethiopia - IBC: the most critical deficiencies are: backup storage, collecting wild sorghums and number of users. Other issues are sampling the probable genetic diversity, size, documentation and access to material (needs rationalizing with other collections containing Ethiopian material.)
- Sudan: The most critical deficiency is the number of users. Other issues are size, wild species, land races, sampling and access, all relating to collecting. Needs rationalizing with other collections containing Sudanese material.
- Mali: the major issues are backup storage, storage facilities, usage, trained specialists and operational funding. Needs rationalizing with other collections containing material from Mali.
- Nigeria: this is a relatively very small collection. This is an important region and all aspects of the collection need upgrading. It is currently funded by INTSORMIL. More collections may be required, once the identity of the samples in the collection is documented and analysed.
- Kenya national collection: major issues include sampling wild sorghums, data accessibility and number of users. Its relationship with the ICRISAT collection in Zimbabwe and Nigeria needs to be looked at.
- Zimbabwe ICRISAT collection: the major issue is the physical safety of the facility as well as storage facilities and number of users. This is a relatively large collection containing 724 landraces from this important southern African region. In general the SADC collections contain relatively few wild and land race sorghums, the key sorghums for capturing diversity. Their importance includes that 'kafir' is the major sorghum "race" in this region and it is a major heterotic group for hybrid cultivars.
- Malawi, Zambia and South Africa. In common they have major issues with size, sampling the diversity in wild sorghums and land races and utilization. More extensive collecting expeditions is clearly a priority for southern Africa. There is an opportunity for the SADC region to consolidate the collections into the SPGRC, in Zambia. This is a network with apparently a backup arrangement with Svalbard. There is apparently a culture of cooperation already existing amongst the member states. Botswana, Mozambique and Tanzania who did not respond to the survey and need to be approached.

5. Key elements of an Effective and Efficient Global Sorghum Diversity Conservation Program

"There is a difference between the ideal and the doable". The below is aimed more at the ideal situation, and in some cases this will need to be altered according to the degree to which it can be implemented. The ideal is presented as a goal to be aimed at. An effective strategy is one that adequately samples, stores and uses the available diversity. Basically, conserving genetic diversity is of no use if it is not done such that diversity can be readily used in crop improvement programs. To ensure this, a strategy must include:

- Extensive eco-sampling of the wild progenitors and landraces of *S. bicolor* in each of the primary, secondary and tertiary centres of diversity.

- Accessions should be identified by passport data that allows their uniqueness to be established. For example, each should have the appropriate passport data to establish its uniqueness. The goal is an official "World Collection of Unique Sorghums Accessions".
- Extensive characterization and evaluation of the unique accessions using internationally agreed protocols/descriptors. This needs to be done not only for utility purposes but also to aid in establishing uniqueness.
- A database containing the above data should be established which is readily available and useful to crop improvement programs. For example, data when it becomes available could be routinely posted on a dedicated web-site. Every effort should be made to post existing data on this web site using globally agreed descriptors.
- Accessions should be readily available internationally but at the same time recognizing international law (eg the International Treaty on Plant Genetic Resources for Food and Agriculture) and commercial implications.
- Accessions should be securely stored under internationally agreed conditions (eg those of FAO/IPGRI 1994) for long term storage.
- The agreed "World Collection of Unique Sorghums Accessions" should be duplicated/backed-up and stored at least two sites chosen on the basis of long term security.
- Collections should be staffed with suitably trained dedicated staff eg with advanced knowledge of seed storage protocols, data management skills, a practical understanding of the sorghum plant, its diversity, taxonomy, breeding etc and a commitment to being a part of an internationally collaborative culture.
- Development of Core and mini-Core Collections based not only on sampling the available genetic diversity but also on the basis of traits. The use of molecular markers, rather than by phenotypes, to gauge the extent of genetic diversity needs to be accessed and utilized if determined useful.

6. Conclusions and plan of action

The Experts Consultation Meeting at ICRISAT proposed that the overall coordination of the strategy and its future development and implementation be overseen by ICRISAT and Dr H. Upadhyaya as coordinator. The "global sorghum group - GSG" participating in the ICRISAT meeting would form the main part of a strategy consultation group but would be inclusive to anybody who has an interest in this development. The group identified the following areas for global collaboration as priority:

6.1 Development of a global information system for sorghum genetic resources
6.2 Development of a joint evaluation programme
6.3 Ensure that urgent regeneration needs are addressed adequately

The storage and long term secure backup also are priority issues and were discussed at the meeting. No immediate plan of action was developed though.

Task Forces and Plans of Action were developed at the meeting and are discussed in the following summary (Annex 5).

6.1 Development of a global information system for sorghum genetic resources

Clearly the establishment of a Global Information System on Sorghum Germplasm is the starting point for a plan for the global conservation of sorghum genetic diversity. With such a system in place, many of the issues that need to be addressed will fall in place e.g. duplication, regeneration, documentation and accessibility of data and materials, assist staff training, increased utilization of accession etc. This is very high priority.

This area of work to include the following related activities:

A. Work on sorghum descriptors
B. Sorghum taxonomy
C. Analysis of duplicates
D. Development of a global information system
E. Identification of gaps in collection of genetic diversity

A. Descriptors

It was agreed that the first task in the process of developing the global information system is to minimize the number of duplicates. This is dependent on agreeing on and using descriptors for passport, characterization and evaluation data. This would include agreeing on and assigning a unique name to each of the established unique accessions (including future accessions) e.g. an IS = International Sorghum number.

Descriptors Task Force: Drs Jeff Dahlberg, Darrell Rosenow, Upadhyaya, Seetharama, Bob Henzell, Jacques Chantereau.

Proposed tasks:

- Review the IPGRI/ICRISAT 1995 Sorghum descriptors
- Propose a minimum set of descriptors
- Propose a revision of the classification
- Link with Bioversity International and ICRISAT for publication and dissemination

Proposed process (to take place mainly electronically):

1. Task Force to submit to the Global Sorghum Group (GSG) a proposed draft – End of April 2007
2. GSG to provide feedback including national consultation with sorghum experts to the Task Force – End of July 2007
3. Task Force to review the draft descriptors and in collaboration with ICRISAT and Bioversity International, circulate for wider consultation – September 2007
4. Finalization of approved and revised list – January – February 2008
5. Publication and distribution – March – April 2008

B. Sorghum taxonomy

This would also include using an agreed form of sorghum taxonomy. Included in this Strategy is a section on Taxonomy (Section 5 above). This section was developed by Drs Dahlberg and Henzell and will no doubt be developed further before final agreement. To assist in the classification of accessions (and training of staff) high quality photographs for accessions which illustrate taxonomic issues including species, races and working groups will be provided by Drs Dahlberg, Rosenow and Upadhyaya.

C. Analysis of duplicates

Duplicate analysis Task Force: Drs Gary Pederson(Leader), and Upadhyaya, Seetharama, El Tahir and M Beyenne

Proposed tasks and process (to take place mainly electronically):
1. USDA and ICRISAT collections analysis and send a first file to Ethiopia and Sudan for testing the approach – June 2007
2. Ethiopia and Sudan to provide feedback to the Task Force – July-August 2007
3. Produce a spreadsheet and sent to all survey respondents – September to December 2007
4. Generate a report of the status of duplication of sorghum accessions in collections worldwide – January - February 2008

D. Development of Global Information System for Sorghum Germplasm (GSSG)
GISSG Task force: Dr Seetharama (leader) and represenatives from USDA (to be nominated), J. Atoyebi, Wang Shumin, J.Chantereau.

Proposed tasks and process (to take place mainly electronically):
1. Initiate discussions among the GSG and other groups working on similar initiative for other crops such as the CGIAR
2. Propose a process to the GSG
3. Act as focal group for feedback

It was noted that most national programmes would be willing to contribute information to a global system but will require national consultation. The countries parties to the International Treaty are committed to make the public domain material and the information associated to it available through a global information system.

D. Gaps analysis
To assist in communication (and therefore utilization) and completeness an invitation to participate in GISSD exercise will be circulated to the sorghum collection curators who did not respond to the initial survey to obtain more information on additional collections on content and origin. Those collections are listed in Table 2. This would be lead by Bob Henzell in collaboration with ICRISAT and the Trust. It was also agreed that communication and completeness would be improved by "advertising", internationally, the development and benefits of the Sorghum Strategy. These two tasks could be done by the Gaps Analysis task force. The effective operation and utilization of the various global e.g. CGIAR, regional and national networks is an issue evident from the surveys. This is an issue that was considered at the meeting and could be pursued by the Trust and ICRISAT.

The use of GISSG to minimize the number of duplicates will also assist future directed sampling of wild related races and landraces. This is a priority issue raised in the surveys. It is particularly so for related wild sorghums and land races. The targeted collection of further diversity needs to be implemented particularly in Ethiopia, Sudan, Nigeria and each of the SADC countries. These are each primary centres of diversity. This needs to be a well targeted exercise, for example, identifying physical and ecological regions and specific types e.g. the transplant sorghums of NW Africa. This

issue was discussed at the meeting and it was agreed that further action is dependant on the development of the GISSG - see Annex 5 for more details.

6.2 Global and regional evaluation program

The biggest issue highlighted in the surveys was the low level of utilization of accessions with the exception of the USDA-ARS collection. This was discussed at the meeting and agreed that the reasons for this include the disturbingly low level of sorghum breeding effort internationally, and the lack of communication between the collections and potential users and identification of accessions with useful traits. The latter is a characterization and evaluation issue. An evaluation task force was formed at the meeting to pursue this. Once again the development of the GISSD will help, it having characterization and evaluation data readily accessible.

Evaluation Task Force: Drs Eva Weltzien-Rattunde (leader), Darrell Rosenow, Upadhyaya, Seetharama, M. Beyenne and El Tahir Ibrahim Mohamed.

Proposed process (mainly electronically):

1. Develop a draft concept note to circulate to the GSG – September/October 2007
2. Feedback from the GSG and review – December 2007
3. Submission to potential donors – January 2008

6.3 Address urgent regeneration needs

Accessions needing urgent regeneration (25,184) is a large issue. The collections needing most regeneration attention (with respect to numbers and likelihood of including the relatively largest amount of genetic diversity) include Ethiopia IBC (4400), ICRISAT Hyderabad (9000), ICRISAT collection in Zimbabwe (3500) and Mali (2,400). A regeneration task force was formed to progress this – see Annex 5 for details. To minimize effort, plantings involved in regeneration could be combined with those for identifying duplicates, staff training etc, the latter, plus level of staffing being a priority issue raised in the surveys.

Regeneration Task Force: Drs Jeff Dahlberg, Upadhyaya and M. Beyenne

Proposed process (mainly electronically):

1. Identification of priority materials based on the analysis of duplicates and on indicated needs by collection managers
2. Assess the available regeneration guidelines from USDA, ICRISAT and Ethiopia, identify the agreed procedures and discuss with the GSG and other experts the areas of differences in procedures – End of May 2007
3. Develop regeneration guidelines including sampling and long-term conservation methodology

Annex 1. Sorghum collections from the Bioversity Germplasm Database – January 2006

	No of Acces.	Institute Code	Institute name	City	Country
1.	30500	USA0016	PGRCU, Southern Regional Plant Introduction Station, USDA-ARS-SAA	Griffin, GA	USA
2.	27522	IND0002	International Crops Research Institute for Semi-Arid Tropics	Andhra Pradesh	India
3.	15315	CHN0001	Institute of Crop Germplasm Resources (CAAS)	Beijing	China
4.	10539	USA0005	National Seed Storage Laboratory USDA, ARS	Fort Collins, Colorado	USA
5.	9174	IND0002	International Crops Research Institute for Semi-Arid Tropics	Andhra Pradesh	India
6.	7260	ETH0001	Biodiversity Conservation and Research Institute	Addis Ababa	Ethiopia
7.	7215	BRA0001	Centro Nacional de Pesquisa de Milho e Sorgo (CNPMS), EMBRAPA	Sete Lagoas, Minas Gerais	Brazil
8.	4016	AUS0048	Australian Tropical Crops & Forages Genetic Resources Centre	Biloela, Queensland	Australia
9.	4000	YEM0003	American Sorghum Project	Tihama	Yemen
10.	3990	MEX0008	Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP)	Col. San Rafael, México D.F.	Mexico
11.	3895	FRA0202	Lab. Ress. Genetiques et Amelior. des Plantes Tropicales, ORSTOM	Montpellier Cedex	France
12.	3587	BRA0003	EMBRAPA, Recursos Geneticos e Biotecnologia (CENARGEN), EMBRAPA, Recursos Geneti	Brasilia, DF	Brazil
13.	3550	KEN0015	National Genebank of Kenya, Crop Plant Genetic Resources Centre, KARI	Muguga	Kenya
14.	3251	ARG0017	Banco Base Nacional de Germoplasma, Instituto de Recursos Biológicos,INTA	Castelar, Prov. de Buenos Aires	Argentina
15.	3145	SDN0001	Plant Breeding Section, Gezira Agricultural Research Corporation	Wad Medani	Sudan
16.	3000	MEX0022	Programa de Recursos Genéticos, Centro de Invest. Forestales y Agropecuarias	Chapingo, Mex	Mexico
17.	2767	IND0182	National Research Centre for Sorghum	Hyderabad, Andhra Pradesh	India
18.	2635	UGA0048	Serere Agricultural and Animal Production, Research Institute	Serere	Uganda
19.	2583	JPN0003	Genetic Resources Management Section, NIAR (MAFF)	Tsukuba, Ibaraki	Japan
20.	2500	MEX0001	Estación de Iguala, Instituto Nacional de Investigaciones Agrícolas	Iguala	Mexico
21.	2338	RUS0001	N.I. Vavilov All-Russian Scientific Research Institute of Plant Industry	St. Petersburg	Russian Federation
22.	2285	PHL0016	National Plant Genetic Resources Laboratory, IPB/UPLB	Laguna	Philippines
23.	2095	PHL0005	Institute of Plant Breeding, College of Agriculture UPLB	College, Laguna	Philippines

	No of Acces.	Institute Code	Institute name	City	Country
24.	2000	FRA0014	Centr. de Coop. Int. en Recherche Agronomique pour le Développement	Montpellier Cedex 1	France
25.	2000	HND0005	Escuela Agrícola Panamericana El Zamorano	Tegucigalpa	Honduras
26.	2000	IND0055	NATIONAL RESEARCH CENTRE FOR SORGHUM	Rajandranagar, Hyderabad	India
27.	1716	BRA0023	Empresa Pernambucana de Pesquisa Agropecuaria	Serra Talhada, Pernambuco	Brazil
28.	1716	FRA0002	CIRAD, Département des Cultures Annuelles	Montpellier Cedex 5	France
29.	1500	THA0090	Department of Agronomy, Faculty of Agriculture, University of Kasetsart	Bangkok	Thailand
30.	1290	COL0029	CORPOICA, C.I. La Selva	Rionegro, Antioquia	Colombia
31.	1277	THA0009	National Corn and Sorghum Research Center, Kasetsart University	Nakhon Ratchasima	Thailand
32.	1168	IND0001	National Bureau of Plant Genetic Resources (NBPGR)	New Delhi	India
33.	1144	RWA0002	Institut des Sciences Agronomiques du Rwanda (ISAR)	Butare - Rwanda	Rwanda
34.	1013	HUN0003	Institute for Agrobotany	Tápiószele	Hungary
35.	943	RUS0001	N.I. Vavilov All-Russian Scientific Research Institute of Plant Industry	St. Petersburg	Russian Federation
36.	912	COL0002	Instituto Colombiano Agropecuario - ICA	Bogota	Colombia
37.	823	GTM0001	Instituto de Ciencia y Technología Agrícola (ICTA)	Villa Nueva, Guatemala	Guatemala
38.	792	VEN0908	Hibridos Mejorados (Compañia Anónima)	Magdaleno, Estado Aragua	Venezuela
39.	776	RUS0001	N.I. Vavilov All-Russian Scientific Research Institute of Plant Industry	St. Petersburg	Russian Federation
40.	722	MWI0002	Malawi PGR Centre c/o Chitedze Agricultural Research Station	Lilongwe	Malawi
41.	656	YUG0002	Institute Of Field and Vegetable Crops	Novi Sad	Yugoslavia
42.	633	ZMB0001	Mount Makulu Agric. Research Station	Lusaka	Zambia
43.	614	FRA0051	Collection Nationale Céréales à Paille, Unite experimentale du Magneraud GEVES	Surgeres	France
44.	589	BGR0001	Institute for Plant Genetic Resources "K.Malkov"	Sadovo, Plovdiv district	Bulgaria
45.	523	KEN0033	International Livestock Research Institute	Nairobi	Kenya
46.	523	KEN0051	National Dryland Farming Research Station, Kenya	Machakos	Kenya
47.	509	IND0027	Indian Grassland and Fodder Research Institute (IGFRI)	Jhansi, Uttar Pradesh	India
48.	500	COL0009	Centro de Investigacion Nataima ICA-CORPOICA	Tolima	Colombia
49.	500	FRA0001	Station d'Amélioration des Plantes Fourragères, INRA	Lusignan	France
50.	492	PAK0002	Institute of Agricultural Biotechnology and Genetic Resources	Islamabad	Pakistan
51.	456	ZAF0001	Division of Plant and Seed Controol, Department of Agriculture Technical Service	Pretoria	South Africa

	No of Acces.	Institute Code	Institute name	City	Country
52.	410	JPN0013	National Agricultural Research Centre (NARC)	Tsukuba, Ibaraki-ken 305-8666	Japan
53.	410	JPN0019	National Institute of Livestock and Grassland Science	Nasushiobara, Tochigi 329-2793	Japan
54.	406	SLV0001	Centro Nacional de Tecnología Agropecuaria y Forestal (CENTA), MAG	Arce, San Andrés, Dept La Libertad	El Salvador
55.	330	AUS0008	CSIRO Townsville Division of Tropical Crops and Pastures	Townsville, Queensland	Australia
56.	300	MDG0002	Department de Recherches Agronom. de la Republique Malgache	Antananarivo	Madagascar
57.	284	BEN0005	Station de Recherche sur les Cultures Vivrières d'INA	Bembereke	Benin
58.	269	BGD0009	Genetic Resources Centre Bangladesh Agric. Research Inst.	Gazipur	Bangladesh
59.	240	ISR0002	Agricultural Research Organisation, The Volcani center	Bet Dagan	Israel
60.	228	TGO0014	Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières	Lomé	Togo
61.	195	DEU0001	Federal Centre for Breeding Research on Cultivated Plants (BAZ)	Braunschweig	Germany
62.	166	BWA0001	Sebele Agricultural Research Station, Department of Agricultural Research,	Gaborone	Botswana
63.	160	GHA0004	University of Ghana	Legon, Accra	Ghana
64.	143	FRA0109	Equipe Génétique et Amélioration des Plantes, INRA Antilles-Guyane	Pointe-a-Pitre Cedex	France
65.	120	SYR0003	General Commission for Scientific Agricultural Research	Damascus	Syria
66.	120	UKR0005	Institute for Maize	Dniepropetrovsk	Ukraine
67.	120	VEN0907	Semillas Aragua (Compañia Anónima)	Maracay, Estado Aragua	Venezuela
68.	115	NGA0010	National Centre for Genetic Resources and Biotechnology, FMST	Ibadan	Nigeria
69.	110	FRA0041	Stat. de Genetique et Amelioration des Plantes, INRA C.R. Montpellier	Mauguio	France
70.	104	URY0003	Estacion Experimental Alberto Boerger, La Estanzuela, Banco Base de INIA	Colonia	Uruguay
71.	100	THA0032	Department of Agriculture, Min. of Agriculture and Cooperation	Bangkok	Thailand
72.	94	SOM0002	Central Agricultural Research Station	Lower Shabele Region	Somalia
73.	87	TUR0001	Plant Genetic Resources Dept. Aegean Agricultural Research Inst.	Izmir	Turkey
74.	73	ECU0001	Estacion Experimental Santa Catalina, DENAREF, INIAP	Quito, Pichincha	Ecuador
75.	71	ETH0013	International Livestock Research Institute (ILRI)	Addis Ababa	Ethiopia

	No of Acces.	Institute Code	Institute name	City	Country
76.	67	GHA0010	Plant Genetic Resources Centre, Crops Research Institute	Bunso, Eastern Region	Ghana
77.	61	PAK0011	New Seed Farm Fodder Research Institute	Sargodha	Pakistan
78.	52	LKA0003	Plant Genetic Resources Centre	Peradeniya	Sri Lanka
79.	50	TCD0004	Projet UNDP/FAO/CHD/91/004 Prod. des Semences en Zone Sahel.	N'Djamena	Chad
80.	50	ITA0004	CNR - Istituto di Genetica Vegetale	Bari	Italy
81.	49	ROM0002	Research Institute for Cereals and Technical Plants Fundulea	Calarasi	Romania
82.	44	ALB0007	Forage Research Institute, Food and Agriculture Ministry	Fushe-Kruja	Albania
83.	42	ESP0004	Centro de Recursos Fitogeneticos, INIA	Alcala de Henares, Madrid	Spain
84.	34	EGY0002	Field Crops Institute Agricultural Research Centre (ARC)	12619 Giza	Egypt
85.	31	PAN0001	Instituto de Investigacion Agropecuaria de Panama, IDIAP	Panama 6A	Panama
86.	30	NIC0007	Programa Recursos Genéticos Nicaraguenses (REGEN), Universidad Nacional Agraria	Managua	Nicaragua
87.	30	YUG0001	Maize Research Institute Zemun Polje	Beograd - Zemun	Yugoslavia
88.	28	LKA0009	FCRDI	Maha-Illuppallma	Sri Lanka
89.	24	YEM0016	El-Kod Agricultural Research Centre, Dr. Res. & Extension	El-Kod	Yemen
90.	20	NPL0055	Central Plant Breeding and Biotec. Nepal Agricultural Research Council	Khumaltar	Nepal
91.	16	VNM0002	National Genebank Vietnam Agricul. Sciences Inst.	Hanoi	Viet Nam
92.	15	CHN0029	Grassland Research Institute Chinese Academy of Agric. Sciences	Huhehot, Inner Mongolia	China
93.	14	COL0003	Centro Internacional de Agricultura Tropical (CIAT)	Cali	Colombia
94.	11	CRI0001	Centro Agronómico Tropical de Investigación y Enseñanza (CATIE)	Turrialba, Costa Rica	Costa Rica
95.	10	AUT0005	Genebank Tyrol / Tyrolean Government	Innsbruck, Tirol	Austria
96.	10	SVK0035	Botanical Garden of the University of Agriculture in Nitra	Nitra	Slovakia
97.	9	BEL0097	Conservatoire Botanique de Ressources Genetiques de Wallonie	Genappe	Belgium
98.	9	GBR0004	Seed Bank, Seed Conservation Sect. Royal Botanic Gardens, Kew	Haywards Heath, W.Sussex	United Kingdom
99.	8	ALB0001	Plant Breeding/Seed Production Section, Dep. of Agronomy, Agricultural Univ.	Tiranë	Albania
100.	8	PER0017	Estacion Experimental El Porvenir, INIEA	Tarapoto, San Martin	Peru
101.	8	ZAF0058	Grassland Research Centre, Department of Agricultural Development	Pretoria	South Africa
102.	7	CUB0913	Instituto de Investigaciones Hortícolas LILIANA DIMITROVA	Quivicán, La Habana	Cuba
103.	5	IRQ0001	Plant Genet. Resources Unit,, State Board of Seeds	Baghdad	Iraq

	No of Acces.	Institute Code	Institute name	City	Country
			Testing		
104.	5	ROM0007	Suceava Genebank	Suceava	Romania
105.	4	ATG0006	Caribbean Agricultural Research & Development Institute (CARDI)	St. John's, Antigua	Antigua and Barbuda
106.	4	ARG0039	Estación Experimental Agropecuaria Anguil "Ing. Agr. Guillermo Covas", INTA	Anguil, Provincia La Pampa	Argentina
107.	4	KEN0052	Kenya Agricultural Research Institute, National Agric Research Centre, Kitale	Kitale	Kenya
108.	4	SVK0036	Istropol a.s.	Horne Myto	Slovakia
109.	3	CZE0122	Genebank Dept, Div. of Genet. & Plant Breeding, Res. Inst. of crop Production	Prague 6 - Ruzyne	Czech Republic
110.	3	MEX0006	Banco Nacional de Germoplasma Veget, Dep. de Fitotecnia, Univ. Aut. de Chapingo	Chapingo, Texcoco, EDO de México	Mexico
111.	2	CAN0122	Seeds of Diversity Canada	Toronto, Ontario M4T 2L7	Canada
112.	2	GEOi003	Protection Society of Agrobiodiversity, DIKA	Tbilisi	Georgia
113.	2	GRC0005	Greek Genebank, Agric. Res. Center of Makedonia and Thraki, NAGREF	Thermi, Thessaloniki	Greece
114.	2	ROMi009	University of Agricultural Sciences and Veterinary Medicine Timisoara	Timisoara	Romania
115.	2	GBR0016	Welsh Plant Breeding Station, Institute of Grassland and Environmental Research	Aberystwyth, Ceredigion, Wales	United Kingdom
116.	1	AUS0201	Australian Medicago Genetic Resources Centre, SARDI	Adelaide, South Australia	Australia
117.	1	CRI0007	Escuela de Ciencias Agrarias, Universidad Nacional	Heredia	Costa Rica
118.	1	ECU0002	Escuela Superior Politécnica de Chimborazo, Facultad de Ciencias Pecuarias	Riobamba, Chimborazo	Ecuador
119.	1	MAR0016	Centre de Production des Semences Pastorals	El Jadida	Morocco
120.	1	URY0002	Facultad de Agronomía, Universidad de la República Oriental del Uruguay	Montevideo	Uruguay

Annex 2. Participants of the Expert Consultation Meeting, March 2007

Expert Consultation Meeting for Developing a Strategy for the
Global Conservation of Sorghum Genetic Resources
12-14 March 2007, ICRISAT-Patancheru, Andhra Pradesh, India

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USA	Darrell Rosenow, Texas Agricultural Experiment Station 1102 E FM 1294, Lubbock, TX 79403-6603, USA Phone: +1-806-746-6101 x4018, Fax: +1-806-746-6528, Email:d-rosenow@tamu.edu
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ICRISAT-Patancheru	DVSSR Sastry, Senior Scientific Officer, GT–Crop Improvement Phone: Extn. 2582, Email: DVSSR.Sastry@cgiar.org

Annex 3. Sorghum Conservation Strategy Survey - September 2006

1. Background

The Global Crop Diversity Trust is undertaking a series of studies to support the development of international collaborative conservation strategies for different crops. As such strategies evolve, they will provide a basis for the allocation of resources from the Trust to the most important and needy collections. This questionnaire has been developed in order to seek the advice and input of representatives of the world's major sorghum collections in the development of the sorghum conservation strategy. In particular the questionnaire aims to assess the status of sorghum conservation throughout the world. As curator of a key sorghum collection, we kindly request you to complete the sections 1-17 of the questionnaire. We estimate that his procedure may take approximately 1 hour of your time. We appreciate your patience. If there are no *ex situ* sorghum collections in your institute, please can you complete sections 16-17 only. Dr. R.G. Henzell is responsible to coordinate the development of a global sorghum conservation strategy in order to support the efficient and effective conservation of sorghum germplasm. Please return the questionnaire to Dr. R.G. Henzell at Hermitage Research Station, no later than 8 October 2006.

The Global Crop Diversity Trust is keen to have your active participation in the development of the sorghum conservation strategy and will be pleased to keep your informed on its progress. If you have any questions about this questionnaire or about the proposed strategy in general, please contact:

Dr. R.G. Henzell, Principal Plant Breeder, Department of Primary Industries, Hermitage Research Station, Via Warwick, Queensland, Australia, Email: bob.henzell@dpi.gld.gov.au

2. Information about your organization

2.1 Name and address of your organisation holding/maintaining the sorghum collection			
Address:			
City:		Postal Code:	
Country:			
Web site:			
2.2 Curator in charge of the sorghum collection			
Name:			
Address:			
City:			
Telephone:		Fax:	
Email:			
2.3 Contact details of respondent to this questionnaire (only if he/she is not the curator of the sorghum collection)			
Name:			
Address:			
City:			
Telephone:		Fax:	

Email:	

2.4 Date of response of this questionnaire:

3. Additional key contacts for the sorghum germplasm collection

Name(s)	Title(s)/Function(s)	Email/Address

4. Description of your organization

4.1 Please describe your organization

1 Governmental organization
1 University
1 Private organization
1 Other (please specify):

4.2 Is the institution in charge of the sorghum collection the legal owner of the collection?

1 YES 1 NO

4.2.1 If NO, who is the owner (including no owner identified)?

4.3 Is the sorghum collection subject to the terms and conditions of the International Treaty on Plant genetic Resources for Food and Agriculture? 1 YES 1 NO

4.3.1 If NO, is expected to become under the International Treaty in the near future?

1 YES 1 NO

4.3.1.1 If YES, indicate expected date

5. Overview of your sorghum collection

5.1 Please describe the main objectives of the sorghum collection (long-term conservation, working collection, breeding collection etc**.):**

5.2 Indicate the species and the respective number of accessions from the sorghum germplasm types that are included in your collection (Please write the number of accessions in brackets after each species name, e. g. *S. bicolor* (30), *S. arundinaceum* (15), etc.):

Type of sorghum germplasm	**Species name** (number of accessions per species in brackets)
Wild related species of sorghum	
Landraces	
Obsolete improved varieties	
Advanced improved varieties	

Type of sorghum germplasm	**Species name** (number of accessions per species in brackets)
Breeding/research materials	
Inter-specific derivatives	
Unknown	
Other	

5.3 Please indicate the share (in %) from each specific type of germplasm that is AVAILABLE for distribution:

Type of sorghum germplasm (where known**)**	**% available for distribution**
Wild related species of sorghum	
Landraces	
Obsolete improved varieties	
Advanced improved varieties	
Breeding/research materials	
Inter-specific derivatives	
Unknown	
Other	

5.4 Origin of the sorghum collection: please indicate the proportion (%) of accessions on the total amount that were... *(Note: the sum should be 100 %!)*

Origin	**Proportion %**
...collected originally in your own country (national origin)	
...collected originally in your own region (regional origin)	
...introduced from a collection abroad	
...from other origin (please define the origin):	

5.5 Are there major gaps in your sorghum collection? Please indicate major gaps concerning your sorghum collection:

Species coverage of the crop: 1 YES 1NO
Population (sample) representation per species: 1 YES 1 NO
Ecological representation of the species: 1 YES 1NO
Other, please specify the gap concerning your sorghum collection:

5.5.1 If there are major gaps, please provide details on the plans to fill these gaps:

6. Aspects on the potential of the sorghum collection

6.1 What would you consider to be the most interesting aspects of your sorghum collection, making it unique? The collection of Australian indigenous species

6.2 Please describe the main potential/importance of your sorghum collection for use and breeding:

7. Conservation status (germplasm management)

7.1 Please indicate the proportion (in %) of the sorghum accessions maintained under different facilities: *(Note: if the same accessions are maintained under more than one storage condition the sum may exceed 100%)*	**Percentage %**
Short-term storage conditions	
Medium-term storage conditions	
Long-term storage conditions	
Other, please specify:	

7.2 Please indicate the proportion (in %) of the sorghum accessions conserved as: *(Note: if the same accessions are stored as different types of germplasm the sum may exceed 100%)*	**Percentage %**
Seeds	
Field accessions	
In vitro	
Cryopreservation	
Pollen	
DNA	
Other, please specify:	

7.3 Please describe the MAIN storage facility available for your sorghum collection:
*(If you have **more than one** facility, please use the fields for 'additional facilities' too)*

	Main Facility 1	**Additional facility 1**	**Additional facility 2**
Type of facility			
Temperature			
Relative Humidity (%)			
Packing material			
Other, please specify:			

7.4 Please mark for which activity you have established a genebank management system and/or have written procedures and protocols:

ı Acquisition (*including collecting, introduction and exchange*)
ı Regeneration
ı Characterisation
ı Storage and maintenance
ı Documentation
ı Health of germplasm
ı Distribution
ı Safety-duplication
ı Other please specify:

7.5 In case you have procedures and protocols, are you able to provide the Global Crop Diversity Trust with this information (i.e. provide a copy)?

ı YES ı NO have procedures, but not documented

7.6 Please describe your quality control activities, in terms of frequency, protocols/methods and actions upon results:

Activities	Description of quality control
Germination tests:	
Viability testing:	
Health testing:	
True-to-typeness of *in vitro* plantlets:	
Other, please specify:	

7.7 Is the sorghum collection affected by diseases that can restrict the distribution of the germplasm? 1YES 1 slightly, only few accessions 1NO

7.7.1 If you indicated YES or slightly above, are knowledge and facilities available at your institution for eradication of these diseases? 1 YES 1 limited 1 NO

7.8 What is the normal regeneration interval to maintain the viability of your sorghum collection?

7.9 Indicate the proportion (%) of each germplasm type that requires urgent regeneration, apart from the routine regeneration:

Type of sorghum germplasm	% of sorghum accessions with urgent regeneration need
Wild related species	
Landraces	
Obsolete improved varieties	
Advanced improved varieties	
Breeding/research materials	
Inter-specific derivatives	
Unknown	
Other, please specify:	

7.10 Please indicate the current situation of the sorghum collection with respect to the following conditions: (*where: 1 = high/good, 2 = adequate/moderate, 3 = not sufficient/bad, NA = not applicable*)

Condition	Current situation	Expected situation in 2010
Funding for routine operations and maintenance		
Retention of trained staff		
Interest for Plant Genetic Resource Conservation by donors		
Genetic variability in the collection as needed by users/breeders		
Access to germplasm information (passport, charact., evaluation)		

Condition	Current situation	Expected situation in 2010
Active support/feedback by users		
Level of use by breeders		
Other factors (please specify):		

8. Safety duplications in other institutions

(Safety duplication: defined as the storage of a duplicate/copy of an accession in another location for safety back-up in case of loss of the original accession.)

8.1 Are sorghum accessions safety-duplicated in another genebank? 1 YES 1 NO

8.1.1 If YES, please specify in the table:

Name of institute maintaining your safety duplicates:	Number of accessions	Storage conditions (short, medium, long term)	Nature of the storage (e.g. black box, fully integrated in host collection, etc.)
1.			
2.			
3.			

9. Institutions storing safety duplicates of sorghum in your genebank

9.1 Is there any sorghum germplasm of other collections safety-duplicated at your facilities?

1 YES 1 NO

9.1.1 If YES, please specify in the table:

Name of holder of the original collection:	Number of accessions	Storage conditions (short, medium, long term)	Nature of the storage (e.g. black box, fully integrated in host collection, etc.)
1.			
2.			
3.			
4.			
5.			

10. Further issues on duplication of sorghum collection

10.1 To what extent do you consider the sorghum accessions in your collection to be unique and not duplicated extensively elsewhere (i.e. EXCLUDING safety-duplication)?

1 Fully unique

1 Mostly unique

1Partially unique

1 Fully duplicated elsewhere

10.2 Are there any constraints to duplicating the sorghum collection elsewhere outside your country? 1YES 1 NO

10.2.1 If YES, please specify: Australia has not yet resolved ownership of indigenous species

11. Information management

11.1 Do you use an electronic information system for managing the sorghum collection (data related to storage, germination, distribution, etc.)? 1YES 1 partly 1 NO

11.1.1 If YES, what software is used?

11.2 Please indicate the proportion (%) of the following types of data is: (1) documented and (2) the proportion that is available electronically:

Type of sorghum germplasm	Passport data		Characterization data		Evaluation data	
	Doc.	Electr.	Doc.	Electr.	Doc.	Electr.
Wild related species						
Landraces						
Obsolete improved varieties						
Advanced improved varieties						
Breeding/research materials						
Inter-specific derivatives						
Unknown						
Other, specify:						

11.3 In case the information on the sorghum collection is not computerised, are there plans to do so in the future?

1 No plans
1 Computerisation planned within 3 years
1 Other

11.4 Is information of the sorghum collection accessible through the Internet?

1 YES 1 partly 1 NO

11.4.1 If there is NO data available in the internet, do you produce a printed catalogue?

1 YES 1 NO

11.4.1.1 If YES, would you be able to provide the Trust with a copy? 1YES 1NO

If YES, please include a copy to Dr. R.G. Henzell (bob.henzell@dpi.gld.gov.au), when returning the completed questionnaire!

11.5 Are data of the sorghum collection included in other databases?

National 1YES 1 partly 1 NO
Regional 1 YES 1 partly 1 NO
International 1 YES 1 partly 1 NO

11.5.1 If YES or partly, indicate the database (e.g. SINGER, IRIS etc.):

12. Distribution and use of material

12.1 What proportion (%) of the total sorghum collection is AVAILABLE for the following distributions? Nationally: 100 % Regionally: 97% Internationally: 97%

12.2 Please fill in the number of sorghum accessions DISTRIBUTED annually, and indicate the expected change over the next 3-5 years, where: + = increasing, 0 = no change, - = decrease

	Number of accessions distributed annually (average of last 3 years)	**Expected change for the next 3-5 years**
Nationally		
Regionally		
Internationally		

12.3 Do you put specific conditions or requirements for distribution of sorghum accessions?

1 YES 1NO

12.3.1 If YES, please specify: _____

12.4 What is the proportion of sorghum germplasm sufficiently available in terms of QUANTITY for distribution?

Type of materials	**% of accessions sufficiently available**
Seeds:	
In vitro material:	
Cryopreserved material:	
Other, please specify:	

12.5 Is the distribution of sorghum germplasm limited because of its HEALTH status?

- Seeds: 1 YES 1 partly 1NO
- *In vitro* material: 1 YES 1 partly 1 NO
- Cryopreserved material: 1 YES 1 partly 1 NO
- Other, please specify:(_____ _____) 1 YES 1 partly 1 NO

12.6 Do you have adequate procedures in place for...

…Phytosanitary certification? 1 YES 1 NO

…Packaging? 1 YES 1 NO

…Shipping? 1 YES 1 NO

…Other, please specify: (_____) 1 YES 1 NO

12.7 Do you keep records of the sorghum accession distribution? 1YES 1 NO

(e.g. who received it, quantity, date of shipment, nature of distributed material etc.)

12.8 Please indicate the proportion (in %) of users who received sorghum germplasm from you in the past 3 years:

Type of users:	**Proportion of total distribution %**

Type of users:	Proportion of total distribution %
Farmers and Farmers' organisations	
Other genebank curators	
Academic Researchers and Students	
Domestic users	
Foreign users	
Plant breeders - public sector	
Plant breeders - private sector	
NGOs	
Others, please specify:	

12.9 Describe briefly how you inform potential users about the availability of sorghum accessions and their respective data in your collection?

12.10 Describe briefly what are the most important factors limiting the use of the sorghum material maintained in your collection?

12.11 Indicate if users have to pay money or not when they request material from you:

for **accessions**: 1 free 1 cost (in US$/accession):
for the **shipment**: 1 free 1 cost (in US$/accession):

12.12 Do you use a <u>Material Transfer Agreement</u> when distributing material?

1 YES 1 NO

12.13 Do you have any restrictions on who can receive sorghum materials? 1 YES 1 NO

12.13.1 If YES, please specify: some indigenous Sorghum accessions are restricted

<u>13. Networks of sorghum genetic resources</u>

13.1 Do you collaborate in (a) network(s) as a sorghum collection holder? 1 YES 1 NO

13.2 If you collaborate in (a) network(s) please provide the following information of them:

*(**A**) name, (**B**) type (national, regional or worldwide), (**C**) main objectives, and (**D**) a brief description of the main reasons to participate in the network.*

A Name of network	B Type of network National/Regional/Worldwide	C Main objectives of the network	D Brief description of the main reasons to participate in the network

<u>14. Additional crop collections maintained in your Institute:</u> please indicate additional crops and number of accessions in the table below:

	Crop or species	Number of accessions	% of wild relative species
1.	tropical forage legume		
2.	tropical forage grass		

3.	navybean		
4.	mungbean, cowpea, adzuki		
5.	soybean		
6.	rice		
7.	maize		
8.	millets		
9.	sunflower		
10.	fibre, kenaf, sesbania, sunn hemp		
11.	tomato		
12.	peanut		
13.	tobacco		
14.	cotton		
15.	pigeon pea		
16.	guar		
17.	sesame		
18.	amaranth		

15. Major constraints: Please list the 5 major limitations you are facing in the management of the sorghum collection:

16. Question concerning institutes NOT maintaining sorghum *ex situ* collections

16.1 If your institute does not maintain an *ex situ* collection of sorghum, please indicate to the best of your knowledge, the following:

Current sorghum conservation activities:	
Institute focal person to contact for further details:	
Plans for any sorghum *ex situ* conservation:	
Any other information:	

17. Please add any further comments you may have:

Thank you for your important contribution!!!

Annex 4: List of respondents to the survey September 2006

Country	Institute	Survey reply Sept. 2006	Total no of accessions
Global	ICRISAT	Yes	36,774
Global	ILRI	Yes	52
Australia	DPI	Yes	5,403
Brazil	EMBRAPA	Yes	8,017
China	CAAS	Yes	18,250
Ethiopia	IBC	Yes	9,772
France	CIRAD	Yes	2,690
India	NBPGR	Yes	18,853
Kenya	NGBK	Yes	1,320
Malawi	NPGRC	Yes	401
Mali	IER	Yes	2,975
Nigeria	NCGRB	Yes	159
Russia	VIR	Yes	7,335
Serbia	Inst. Field and Vegetable crops	Yes	152
South Africa	NPGRC	Yes	428
Sudan	PGRU-ARC	Yes	4,191
USA	USDA-ARS-PGRCU	Yes	43,104
Zambia	NPGRC	Yes	1,005
Zimbabwe	NPGRC	Yes	7,009
	TOTAL 19 replies		**167,890**

Annex 5: Summary of workplan and task forces

Task Forces:

1. Descriptors Task force: **Jeff Dahlberg** (Leader),D. Rosenow, HD Upadhyaya, N. Seetharama, B. Henzell, J. Chantereau, Dr Toure (*to be contacted*)
2. Duplicate analysis Task force: **Gary Pederson** (Leader), HD Upadhyaya, N. Seetarama, El Tahir Ibrahim Mohamed, M. Beyene
3. Global Information System Task force: **N. Seetharama** (Leader), USDA (*to be nominated*), J. Atoyebi, Wang Shumin, J. Chantereau
4. Evaluation Task Force: **Eva Weltzien-Rattunde** (Leader), D. Rosenow, HD Upadhyaya, N. Seetharama, M. Beyene, El Tahir Ibrahim Mohamed
5. Regeneration Task Force: **Jeff Dahlberg** (Leader), HD Upadhyaya, M. Beyene

	Tasks	**Timeframe**
	GLOBAL SORGHUM CONSERVATION STRATEGY DOCUMENT	
1.	B. Henzell to review draft presented during the meeting at ICRISAT based on outcomes of the discussions	April 2007
2.	Circulate to GSG for feedback	May 2007
3.	"Finalize" the draft strategy for wider distribution and consultation	June 2007
	DESCRIPTORS	
4.	Task Force to submit to the Global Sorghum Group (GSG) a proposed draft	April 2007
5.	GSG to provide feedback including national consultation with sorghum experts to the Task Force	May – July 2007
6.	Task Force to review the draft descriptors and	Aug – Sept 2007
7.	In collaboration with ICRISAT and Bioversity International, circulate draft for wider consultation	Oct. - Dec. 2007
8.	Finalization of approved and revised list of descriptors	Jan. – March 2008
9.	Publication and distribution of revised sorghum descriptors	March-April 2008
	DUPLICATES ANALYSIS	
10.	USDA and ICRISAT collections analysis and send a first file to Ethiopia and Sudan for testing the approach	June 2007
11.	Ethiopia and Sudan to provide feedback to the Task Force	July – Aug. 2007
12.	Produce a spreadsheet and sent to all survey respondents	Sept. Dec. 2007
13.	Generate a report of the status of duplication of sorghum accessions in collections worldwide	Jan. Feb 2008
	GLOBAL SORGHUM INFORMATION SYSTEM	
14.	Initiate discussions among the GSG and other groups working on similar initiative for other crops such as the CGIAR	April – July 2007
15.	Propose a process to the GSG and Act as focal group for feedback	July – Dec. 2007
	GAPS ANALYSIS	
16.	A first step in initiating this activity would be to obtain more information on additional collections on content and origin: Bob (leader), ICRISAT and Trust.	April – June 2007

	Tasks	Timeframe
	GLOBAL SORGHUM CONSERVATION STRATEGY DOCUMENT	
17.	A second step would be to use the analysis report on duplication and a global sorghum information system for further analysis.	Jan – Feb 2008
	GLOBAL and REGIONAL EVALUATION PROGRAMME	
18.	Develop a draft concept note to circulate to the GSG	Sept – Oct. 2007
19.	Feedback from the GSG and review	Nov. – Dec. 2007
20.	Submission to potential donors	January 2008
	REGENERATION	
21.	Compare the regeneration guidelines from USDA, ICRISAT and Ethiopia: identify the agreed procedures and discuss with the GSG and other experts the areas of differences in procedures	May 2007
22.	Develop regeneration guidelines including sampling and long-term conservation methodology	
23.	Identification of priority materials based on the preliminary analysis of duplicates and on indicated needs by collection managers	

Annex 6. References

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Annex 7. Acronyms

Acronym	Name
AusPGRIS	Australian plant genetic resource information system
Bioversity	Bioversity International, formerly known as IPGRI, Rome, Italy
CGIAR	Consultative Group on International Agricultural Research
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement
DNA	Deoxyribonucleic acid
FAO	Food and Agriculture Organization of the United Nations
GISSD	Global Information System on Sorghum Germplasm
GRIN	Germplasm Resources Information Network, Beltsville, MD, USA
IBC	Institute of Biodiversity Conservation
ICAR	Indian Council for Agricultural Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ILRI	International Livestock Research Institute
INTSORMIL	The International Sorghum and Millet Collaborative Research Support Program
IPGRI	International Plant Genetic Resources Institute, Rome, Italy
ISTA	International Seed Testing Association
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
MTA	Material Transfer Agreement
NBPGR	National Bureau of Plant Genetic Resources
NCGRP	National Center for Genetic Resources Preservation, Ft. Collins, Colorado, USA
SADC	Southern African Development Community
SMTA	Standard Material Transfer Agreement
SPGRC	SADC Plant Genetic Resources Centre
Trust	Global Crop Diversity Trust
USDA-ARS	United States Department of Agriculture-Agricultural Research Service
WG	Working Group