Global Strategy for the Conservation of Cowpea (*Vigna unguiculata* subsp. *unguiculata*)

Contents:

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Disclaimer

This document, developed with the input of a large number of experts, aims to provide a framework for the efficient and effective *ex situ* conservation of globally important collections of cowpea (*Vigna unguiculata* subsp. *unguiculata*).

The Global Crop Diversity Trust (the Trust) provided support for this initiative and considers this document to be an important framework for guiding the allocation of its resources. However, the Trust does not take responsibility 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 (dated May 2010) is expected to continue to evolve and be updated as and when circumstances change or new information becomes available.

Global Strategy for the Conservation of Cowpea (*Vigna unguiculata* subsp. *unguiculata*)

Background

In 2008, IITA, the International Institute of Tropical Agriculture, was commissioned by the Global Crop Diversity Trust to lead the development of a global conservation strategy for genetic resources of cowpea and its wild relatives, with an emphasis on Africa.

The strategy involved**:**

1. A survey on cowpea genetic resources conservation and use (collections, facilities, human resources, ongoing research, networks).
2. An international expert consultation to discuss the state of cowpea conservation and use in Africa and draw recommendations.
3. The writing up of the present document, which captures survey results and experts' recommendations on key elements of a global conservation strategy.

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1. Introduction

Cowpea (*Vigna unguiculata* subsp. *unguiculata* (L.) Walp.) grain is a major source of protein in the diets of sub-Saharan Africa, where the bulk of it is produced and consumed. The plant is also used as a fodder, and dual purpose varieties are increasingly important in Nigeria. Cultivated cowpea is also known as black eye pea or southern pea (USA), and *niebe* (West Africa), as well as crowder pea, marble pea or China pea in other parts of the world. In Nigeria, the biggest producer worldwide, it is called *wanke* and *ewa* respectively in the northern and southwestern parts of the country.

Cultivated cowpea is found in a wide range of agro-ecologies, ranging from the humid savannah to the dry Sahelian region of tropical Africa. Significant diversity in *V. unguiculata* is also encountered in India, where it was known in Sanskritic times (Purseglove 1977). According to Ng and Marechal (1985), cowpea was introduced to India through East Africa approximately 2,200 BP. In India and South East Asia the diversification gave rise to the cultigroup Biflora which is used as a pulse,cover crop as well as consume green as yard-long-bean (var. *sesquipedalis*). The early Romans and Greeks also used cowpea, then referred to as *phaseolus*.

Cowpea is a member of the family Leguminosae, subfamily Papilionoideae, tribe Phaseolineae, genus *Vigna*. It belongs to the section *Catiang* of the subgenus *Vigna* (Savi) Verdc. Padulosi and Ng (1997) postulated that the immediate progenitor of

cultivated cowpea is *V. unguiculata* ssp. *dekindtiana* sensu Verdc. (*V. unguiculata* var. *spontanea* (Schweinf.) Pasquet). This is an idea shared by Pasquet (1999). The classification and nomenclature of cowpea and its wild relatives (*V. unguiculata*) are presented in Table 1.

Table 1: Classification and nomenclature of the wild *Vigna unguiculata* species complex.

Verdcourt (1970)	Marechal et al (1978)	Mithen (1993)	Padulosi (1993)	Pasquet (1993/98)
V. unguiculata ssp. *unguiculata* ssp. *sesquipedalis* ssp. *cylindrica*	*V. unguiculata* ssp. *unguiculata* cv.gr. Unguiculata cv.gr. Biflora cv.gr. Sesquipedalis cv.gr. Textilis	*V. unguiculata* ssp. *unguiculata* cv.gr. Unguiculata cv.gr. Sesquipedalis		*V. unguiculata* ssp. *unguiculata* cv.gr. Unguiculata cv.gr. Biflora cv.gr. Melanophthalmus cv.gr. Sesquipedalis cv.gr. Textilis
ssp. *dekindtiana*	ssp. *dekindtiana* var. *dekindtiana*	ssp. *dekindtiana* var. *dekindtiana*	ssp. *dekindtiana* var. *dekindtiana*	ssp. *unguiculata* var. *spontanea*
ssp. *dekindtiana*	ssp. *dekindtiana* var. *dekindtiana*	ssp. *dekindtiana* var. *huillensis*	ssp. *dekindtiana* var. *huillensis*	ssp. *dekindtiana*
ssp. *dekindtiana*	ssp. *dekindtiana* var. *dekindtiana*		ssp. *dekindtiana* var. *congolensis*	ssp. *alba*
ssp. *dekindtiana*	ssp. *dekindtiana* var. *dekindtiana*		ssp. *dekindtiana* var. *grandiflora*	ssp. *baoulensis*
ssp. *mensensis*	ssp. *dekindtiana* var. *mensensis*		ssp. *dekindtiana* var. *ciliolata*	ssp. *letouzeyi* ssp. *burundiensis*
ssp. *mensensis*	ssp. *dekindtiana* var. *mensensis*	ssp. *dekindtiana* var. *mensensis*	ssp. *dekindtiana* var. *ciliolata*	*ssp. pawekiae* *ssp. aduensis*
Vigna tenuis	ssp. *tenuis*	ssp. *dekindtiana* var. *Tenuis*	ssp. *tenuis* var. *tenuis* var. *oblonga* var. *parviflora*	ssp. *tenuis*
ssp. *dekindtiana*	ssp. *dekindtiana* var. *dekindtiana*	ssp. *dekindtiana* var. *kgalagadiensis*	ssp. *protracta* var. *kgalagadiensis*	ssp. *stenophylla*
var. *protracta*	ssp. *dekindtiana* var. *protracta*	ssp. *dekindtiana* ssp. *protracta*	ssp. *protracta* var. *protracta* var. *rhomboidea*	ssp. *stenophylla*
Vigna angustifoliolata	ssp. *stenophylla*	ssp. *dekindtiana* var. *stenophylla*	ssp. *stenophylla*	ssp. *stenophylla*
Vigna pubescens	ssp. *dekindtiana* var. *pubescens*		ssp. *pubescens*	ssp. *pubescens*

2. Accession-level information management

Among the 26 germplasm holders surveyed, 36 383 and 23 013 accessions of cowpea and other *Vigna* spp are respectively reported to be maintained in *ex situ* conditions (Annex 1, survey table 1). It is presently difficult to evaluate the level of duplication among collections as well as the overall gene pool coverage. There is an urgent need to consolidate the existing passport data of all *Vigna* accessions maintained *ex situ* and to create a global inventory. Such an inventory will allow investigation of the level of duplication among existing collections and facilitate further rationalization of conservation efforts (determination of uniqueness of accession, safe duplication and collection priority). According to Jeff Ehlers, who has done this kind of collation work for 3 collections (USDA, University of California Riverside and IITA), there are 9139 unique lines at IITA, 739 at USDA and 452 at UCR.

Only a few germplasm holders presently use a robust data management system (Annex 1, survey table 8). The Trust is supporting USDA and Bioversity International to develop and deploy modern genebank data management software based on USDA's GRIN system. Additionally, information systems developed by CGIAR Centres, which are international public goods, are already freely available. This is the case of IITA's genebank management system, which was recently deployed at CNRA (Côte d'Ivoire).

During the expert meeting, attention was drawn to the fact that information related to new cowpea variety releases is not readily available and would be useful to the user community.

Recommendation 1: Develop a pilot registry starting with 4 major collections: IITA, UC Riverside, USDA and NACGRAB. The first step will involve the compilation of existing passport data into a common format for further comparison. Depending on the output, the model may be extended to all *Vigna* accessions at regional or/and global level. There are presently 2 passport matching tools available. One developed within the framework of the Global Public Good project (GPG), the other one by UC Riverside.

Recommendation 2: Efforts should be made to deploy sustainable information systems at national level. The information within these systems should be stored in such ways that exchange/upload between existing global/center-own systems is easily achieved.

Recommendation 3: Make available information on improved lines, especially pedigrees and traits of interest, and consolidate it within the West African sub-region, at least initially.

3. Long term storage of germplasm

Twenty five percent of the germplasm holders reported conservation conditions not meeting international standards (Annex 1, survey table 9) and only half are presently safety duplicating their genetic resources (Annex 1, survey table 11).

Recommendation 4: Each accession not yet maintained in long term storage conditions should be safety duplicated in a genebank operating at international standard and backed up at the Svalbard Global Seed Vault. The curators of the NBG in Belgium, INIA in Spain, the Vavilov Institute in Russia and the South Korean genebank, as well as other germplasm holders for which information was not collected (India, Brazil), should be encouraged to safety duplicate their collections at Svalbard (Annex 1, survey table 11). Similarly, the UC Riverside germplasm should be merged with the USDA collection.

4. Taxonomy

The classification and nomenclature of the wild *Vigna unguiculata* complex has been reviewed by various authors (Table 1). The cowpea primary gene pool comprises members of *Vigna unguiculata* section *Catiang* (Marechal et al., 1978*)*. *V.*

unguiculata was initially sub-divided into four sub-species: *unguiculata* (the cultigen), *dekindtiana, tenuis* and *stenophylla* (Marechal et al., 1978). These cross with one another, including cowpea, and produce viable hybrids. However, crossing cowpea with some lines of ssp. *pubescens* remains difficult and the hybrids may require embryo rescue (Fatokun and Singh, 1987). Moreover, successful crosses between cowpea and var. *rhomboidea* are only recorded when cowpea is the female parent (Ng and Singh, 1997). More recently, Pasquet proposed the following key:

Unguiculata Key (Pasquet, 2010)

Domesticated cowpea progenitor, primary gene-pool
Close secondary gene-pool
Remote secondary gene-pool,

Keel twisted toward left, with a marked beak 6-8 mm long, calyx-lobe 2-5 mm long, flower 24-33 mm long, pod 13-15 ovuled — **subsp. dekindtiana (remote secondary)**
Keel twisted toward left with a short or without beak — 1
Keel twisted toward right with a short beak up to 3 mm long — 3
1 calyx-lobe 5-15 mm long, flower 20-32 mm long, pod 15-18 ovuled — **subsp. pawekiae (remote secondary)**
1 calyx-lobe 2-6 mm long, pod 10-14 ovuled, — 2
1 calyx-lobe 0.5-2 mm, pod 16-20 ovuled, pod black and smooth, flower 24-38 mm — **subsp. baoulensis (remote secondary)**
2 linear leaflets, flower 14-21 mm — **subsp. stenophylla var. stenophylla (close secondary)**
2 lobed leaflets, stem and pod scabrous, flower 14-21 mm — **subsp. stenophylla var. kgalagadiensis (close secondary)**
2 lobed leaflets, stem and pod pubescent, flower 16-28 mm — **subsp. stenophylla var. protracta (close secondary)**
3 pubescent stem, leaflet, and pod, long inflorescence internodes, calyx-lobe 1.5-5 mm, flower 17-24 mm, pod 13-17-ovuled — **subsp. pubescens (close secondary)**
3 scabrous or smooth stem and pod, short inflorescence internodes — 4
4 inflorescence 1-2-noded, calyx-lobe 1-4 mm, flower 14-22 mm, pod 12-17-ovuled — **subsp. tenuis (close secondary)**
4 inflorescence multinoded — 5
5 seed 2-3 mm long, calyx-lobe 0.5-4.5 mm, flower 17-23 mm, pod 15-22-ovuled — **subsp. alba (close secondary)**
5 seed 3-5 mm long, calyx-lobe 1.5-4 mm, flower 15-23 mm, pod 10-18-ovuled — **subsp. unguiculata var. spontanea (primary)**
5 seed 3-6 mm long, calyx-lobe 4-15 mm, flower 23-30 mm, pod 17-21-ovuled — **subsp. letouzeyi (remote secondary)**
1 long floral peduncle, — **cultivar-group Textilis**
1 short or medium floral peduncle — 2
2 pod 10-17-ovuled — 3
3 seed testa smooth and thick — **cultivar-group Biflora**
3 seed testa thin and often wrinckled — **cultivar-group Melanophthalmus**
2 pod 17-24-ovuled — 4
4 long pod, kidney shaped seed spaced within the pod — **cultivar-group Sesquipedalis**
4 not as above — **cultivar-group Unguiculata**

Author comments: The position of subsp. *dekindtiana* in the remote secondary gene-pool is

still only an hypothesis. The plant is only found above 1600 masl within an altitude range that fits montane forest, similar to the altitude range of ssp. *pawekiae*. The key assumes that subsp. *burundiensis* will be merged with subsp. *letouzeyi* and subsp. *aduensis* merged with subsp. *pawekiae*; and that ssp. *stenophylla* will be split into three varieties.

Recommendation 5: One of the priority taxonomy issues still to be resolved is the status of *subsp. dekindtiana sensu stricto* (i.e., not *sensu* Verdc.). To our knowledge, no accession of this subspecies is presently maintained/available in *ex situ* collections. It should be collected as a high priority (see below).

Recommendation 6: The following relatively minor taxonomic issues also need to be resolved, that is whether to

- Merge subsp. *letouzeyi* and susbp. *burundiensis*.
- Merge subsp. *pawekiae* and subsp. *aduensis.*
- Split current subsp. *stenophylla* and going back to the three classical taxa (subsp. *protracta,* subsp. *stenophylla sensu stricto*, and subsp. *kgalagadiensis).*

Recommendation 7: Five *Vigna* germplasm holders reported maintaining unknown species of *Vigna* (Annex 1 survey table, 4). The taxonomic identity of such accessions needs to be verified.

5. Collection gaps and collecting missions

The cowpea primary gene pool (*subsp. unguiculata var. unguiculata* and *subsp. unguiculata var. spontanea*) is already well represented in existing collections, but with some clear gaps for Mali, Nigeria, and Sudan. According to Remy Pasquet, 250 accessions of the secondary genepool (savanna subspecies) are presently maintained between IITA and NBGB (Belgium), versus 20 to 50 accessions for the tertiary gene pool (forest subspecies, *Vigna schlechteri*). Future collecting missions should focus on forest margins in eastern and central Africa mainly.

Following a GIS-based gap analysis of the cultivated cowpea collection held by IITA, the following countries were identified as priority for new germplasm acquisition: Angola, Burundi, Guinea-Bissau, Eritrea, Equatorial-Guinea, Namibia, Rwanda, Botswana, Congo, DR Congo, Gambia, Lesotho, Liberia, Madagascar, Sierra Leone, Sudan, Swaziland, and Uganda (Risavy, 2009). Part of these gaps may be filled simply by duplication of existing national collections at IITA, while specific collecting missions will allow capturing missing diversity.

Recommendation 8: Collecting missions should take place in the following four high priority regions**:**

- Angola for subsp. *dekindtiana sensu stricto*, as there are presently no accessions maintained *ex situ*. Unfortunately, country accessibility and security (mine fields) are major problems. The southern part of Angola is the region to explore as a priority (the good news is that as long as access to the area is difficult, the genetic erosion risk will remain relatively low).
- Nigeria for wild cowpea (mainly subsp. *unguiculata* var. *spontanea*), as it is underrepresented in *ex situ* collections. Moreover, there is a risk of genetic

contamination from the introduction of Bt-cowpea in the country (field trials started in 2009).
- Senegal – Mali – West Burkina Faso – Ivory Coast, mainly for *subsp. unguiculata* var. *spontanea*
- Eastern Chad, west, central and south Sudan mainly for *subsp. unguiculata var. spontanea*. Accessibility and security are also a serious limiting factor in these areas.

6. Genetic diversity, patterns and domestication

The question of the center of diversity/center of origin of cultivated cowpea still remains to be clarified. This would allow us to be more proactive in *Vigna* conservation (for example, concentrating vigilance of potential threats such as GMOs in high diversity areas).

The overall level of duplicate samples maintained in *ex situ* collection is likely to be high. According to Jeff Ehlers (see above), based on passport data a third of the IITA collection is duplicated in USDA and/or UC Riverside. Unfortunately, not all accessions can be screened based on passport data as for many of them such data are very poor.

Various tools are presently used to analyze *Vigna* diversity:
- Isozymes for wild *Vigna* (Remy Pasquet, IRD)
- SSR for primary gene pool (Charlottesville, Michael Timko)
- SNP for domesticated material (Jeff Ehlers, UC Riverside).

The SNP study done by UC Riverside focuses on domesticated cowpea: 640 cultivated accessions have been genotyped to date. A new study is being done to test the effectiveness of the 1536 SNP platform on a range of 90 accessions of wild species.

The cost of such tests is still too high (>$100 USD/sample) to be used in duplicate identification. Indeed, the cost of conserving duplicates does not justify the finger printing investment. It is recommended to wait untill molecular tools become cheaper to use them for duplicate identification, but to start with an approach based on passport-data.

The utility of SNP versus SSR markers needs to be assessed in cowpea also. In a study on maize by Hamblin et al. it was demonstrated that SSRs were better at clustering germplasm into populations than either individual SNPs or SNP haplotypes, and SSRs provided more resolution in measuring genetic distance based on allele-sharing. The authors concluded that large numbers of SNP loci will be required to replace highly polymorphic SSRs in studies of diversity and relatedness. Identification of duplicates may require many more SNPs than SSR and would not in addition provide as valuable information on genetic diversity.

Recommendation 9: There is need to develop a finger-printing tool to identify duplicates of cultivated cowpea. This would help to further rationalize conservation i.e. eliminate duplicates and guide new introductions. It would be interesting to run SNP-SSR pilot comparison test on a sub-sample of 1000 accessions (selected from

the IITA and UC Riverside collections). Additionally, to anticipate future genotyping work, leaf material could be collected during regeneration and stored in dehydrated form using silica gel.

7. Germplasm characterization and evaluation

More than half of cowpea germplasm holders use IPGRI/IITA descriptors (Annex 1 survey table 8). In many genebanks, only a fraction of the conserved germplasm is actually being used. For example, 40% of the cowpea germplasm maintained at IITA has never been distributed. Similarly, breeders seldom request germplasm from their national genebank, especially in Africa. This is likely due (at least partly) to a gap between the data that are available and those which users actually need (characterization/evaluation). A user-driven review of descriptors in some 22 crops, including cowpea, has been undertaken by Bioversity International with Trust support. On the other side, there are no mechanisms in place to encourage the breeder to feedback the germplasm provider with the valuable information gleaned while using the germplasm. In other words, a lot of useful information could be better shared within the genetic resources community.

Recommendation 10: As germplasm evaluation is important to both breeders and genebankers, it should be carried out jointly. The same applies to pre-breeding, as there is no clear understanding/consensus on who should take this responsibility. The following networks may provide support for collaborative evaluation involving different parties:

- IITA International Trials Network (presently used largely for evaluation of improved lines)
- Network for Genetic Improvement of Cowpea for Africa (NGICA)
- GRENEWECA regional PGR network in West Africa (although this network seems not very active)
- Centers of excellence in West and Central Africa (not active at present)
- SADC Plant Genetic Resources Network
- Community-based systems (see below)

Of possible relevance is the Gates-funded project to develop an online catalog of evaluation trial sites in Africa, including their environmental characterization as well as evaluation data from historical trials.

***Recommendation 11*:** The entire primary genepool needs to be screened for various specific traits of interest. The Generation Challenge Programme is presently funding a multi-location evaluation trial involving 4 countries (Senegal, Burkina Faso, Kano-Nigeria and USA). The trial involves the evaluation of the 374 minicore accessions of the international collection. The secondary and tertiary pools should also be evaluated for abiotic and biotic stress tolerance. In particular, the Zambezian group of the secondary genepool is of high interest for drought tolerance screening as it was partly collected from drought prone areas. It was suggested that genebanks create their own network for service exchange, i.e. evaluation on a reciprocal and collaborative basis.

8. Indexing, sanitation and germplasm health

Vigna species host an exceptionally high number (about 15) of seed-transmitted viruses in comparison to other crop species. Virus indexing is critically dependent on having basic knowledge of viruses in host species. Current indexing schemes are based on the information on seed-transmitted viruses in cultivated *Vigna* species, that is cowpea (*V. unguiculata*), mungbean (*V. radiata*), urdbean (*V. mungo*), adzuki bean (*V. angularis*) and bambara groundnut (*V. subterranea*). In contrast, knowledge of viruses infesting wild *Vigna* is limited. These species may carry viruses that are not considered under current procedures, and will therefore escape detection.

In most of the national/regional genebanks surveyed, indexing capacity is low or non-existent (Annex 1, survey table 13) and indexing procedures are rarely included in genebanking operations. Moreover, linkages between plant quarantine services and genebanks are often weak (Annex 1, survey table 13). This situation not only increases the risk of pathogen spread but also affects the vigor, viability and quality of seeds during storage and can lead to genetic erosion. A few places only have the capacity to index and clean *Vigna* germplasm: IITA (Nigeria), NBPGR (India) and USDA (USA).The IITA genebank maintains the largest collections of *Vigna* species. The phytosanitary status of many accessions is not known as they were banked nearly 30 years ago. At that time, germplasm was stored and distributed without germplasm health considerations. Adequate facilities are in place at IITA for ensuring phytosanitary health of *Vigna* germplasm. All collections are now systematically regenerated and virus indexed for conservation and distribution of healthy seeds. At present the focus is on the core collection of cowpea, but will eventually expand to the whole *Vigna* collection. Recent advances in knowledge of pathogens and diagnostic technologies should contribute to the establishment of robust strategies for conservation and exchange of pest-free germplasm.

Recommendation 12: There is an urgent need to identify viruses infecting wild *Vigna* in its centers of diversity. This will improve the baseline knowledge necessary to develop broadly applicable diagnostic tools for virus indexing and germplasm health.

Recommendation 13: It is necessary to create awareness of phytosanitary issues and upgrade facilities to ensure germplasm health. Efforts should focus on improving indexing capacity at regional level, with the idea of developing indexing platforms to serve different regions i.e. establish center(s) of excellence (regional or global platforms) for *Vigna* indexing. Moreover, the notion of safe distribution zones, where the same pathogens prevail, should also be considered. There is no need to clean material if it is then going to be used in field infested by the very same pathogens.

Recommendation 14: Effort should be made to develop simple, broad diagnostic tools that can easily detect a wide range of known viruses and related unknown viruses. Such tools increase the confidence of indexing results and dramatically reduce the risk of virus spread through germplasm.

Recommendation 15: Existing guidelines for safe conservation and distribution of *Vigna* germplasm need to be updated and disseminated widely to improve general

awareness among various stakeholders. On-line database of pests and pathogens of *Vigna* need to be developed.

Recommendation 16: The impact of pests and pathogens on potential genetic erosion of *Vigna* as well as germplasm health issues in community genebanks should be studied.

Recommendation 17: A strategy for developing virus-free germplasm of unique *Vigna* accessions should be put in place.

9. Genetic erosion

Genetic erosion in the field is one of the main reasons for *ex situ* conservation of diversity; ease of access being another one. Genetic erosion can be measured via re-collecting missions. This implies accurate original passport and collecting mission records. Such studies have been reported for pearl millet in Ethiopia and Niger. In both cases, limited genetic erosion was found. None of the 25 *Vigna* germplasm holders contacted during the survey reported involvement in genetic erosion studies for *Vigna*.

Recommendation 18: It would be interesting to measure the genetic erosion of cowpea taking place in Africa. Some the collecting missions records, especially the Stanford collecting mission that took place in Nigeria, could provide a solid base to evaluate such genetic erosion for domesticated cowpea. Indeed, according to Remy Pasquet, this document provides a very complete report on approximately 700 accessions collected in 1961. Dr Aladele (NACGRAB) may be able to source an original copy of the report.

Recommendation 19: Genetic erosion prediction studies on ecogeographical and economic data (adoption rate, population patterns, migration) should also be undertaken.

10. On farm conservation

Substantial diversity is maintained on farm by African farmers for many crops, alongside improved germplasm in some cases. The incentives for such a system are often linked to social prestige (specific local varieties may be necessary for special ceremonies). However, cowpea farmers in any one place mainly maintain germplasm with a limited range of diversity for particular traits (such as a specific preferred color, for example). As a result, the overall diversity and sustainability of such a conservation system are sometimes limited.

Recommendation 20: It would be interesting to have an inventory of community-based genebanks and to evaluate their diversity. Depending on their diversity, they may or may not be good candidates for duplication in international genebanks. However, sample “identity” will be difficult to assess precisely without genotyping. In many cases, accessions with the same name are very different and accessions with different names may be identical. Such communities could also be engaged in germplasm evaluation and be assisted in their conservation efforts.

11. Conclusion

The implementation of the cowpea and wild *Vigna* global conservation strategy requires effective, mutually beneficial cooperation and coordination between not only *Vigna* germplasm holders and users but the entire plant genetic resources community, including users. In such a partnership, each stakeholder should have a role based on comparative advantage (facilities, germplasm access, human resources, capacity development, etc.) and be seen as a reciprocity-based service provider, whether the service is conservation, evaluation, distribution, data cleaning or an information platform. While in the past national systems were encouraged to develop their own genebanks, the sustainability of this may be questioned. This is particularly true for genebanks maintaining small (in terms of number of accessions) but highly valuable (in terms of genetic uniqueness) collections. Small germplasm holders should be encouraged to delegate the long term storage of their unique samples to genebanks with international conservation standards, and this is more likely to be sustainable and safer.

The recommendations made in the present document represent the building blocks of the cowpea and wild *Vigna* conservation strategy. While some blocks are already being addressed by the Global Crop Diversity Trust, such as regeneration and safety duplication of unique germplasm in international genebanks and the development of a data management system, other initiatives are needed to strengthen the global conservation and use system. Amongst the recommendations not yet being addressed, efforts should be made in the following areas (not listed in priority order):

- Taxonomic stabilization
- Diversity and identity analysis of *ex situ* maintained samples
- Collection of *Vigna* diversity not yet captured in *ex situ* collections
- Evaluation and characterization
- Germplasm health and safe movement
- Genetic erosion studies

The present strategy is based on information collected via a survey (27 participants) and an expert meeting (13 participants). This document will be presented during the 'World Cowpea Conference' to be held in September 2010 in Senegal (see www.iita.org for more information). It is expected that more feedback from the *Vigna* community, including breeders and other users, will be gleaned during this event. This will further shape the strategy. The document is expected to evolve and should be updated on a regular basis.

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Annex 1– Survey Outputs

1.1 Partner solicitation and replies

The questionnaire was sent to 41 *Vigna* germplasm holders based in 34 countries (Annex 2). This includes the SADC regional genebank, which provided information for an additional 13 southern African countries (Angola, Botswana, Lesotho, Malawi, Mauritius, Mozambique, DRC, Namibia, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe). Out of the 34 countries/institutions contacted, the following fifteen holders replied to the questionnaire:

Belgium (National Botanical Garden), **Benin** (Institut National des Recherches Agricoles du Benin), **Côte d'Ivoire** (Centre National de Recherche Agronomiques), **Germany** (IPK Leibniz Institute of Plant Genetics and Crop Plant Research), **Kenya** (National Genebank of Kenya), **Nigeria** (National Center for Genetic Resources and Biotechnology), **Russia** (State scientific Centre N.I. Vavilov All-Russian Institute of Plant Industry of RAAS), **South Africa** (ARC-grain), South **Korea** National Agrobiodiversity Center, **Spain** (Instituto Nacional de Investigation y Technologia Agraria Alimentaria (INIA)), **Tanzania** (National Plant Genetic Resources Center of Tanzania), **Togo** (Institut Togolais de Recherche Agronomique), **USA** (USDA, PGR conservation unit, Griffin), USA (University of California, Riverside), **Taiwan** (AVRDC, the World Vegetable Center), **SADC** (SGGRC Plant Genetic Center) and **IITA** (International Institute of Tropical Agriculture). The SADC Plant Genetic Resources Centre provided information for 10 of their 13 country members (Angola, Botswana, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia).

2.2. Cowpea and wild *Vigna* holdings according to survey data

Among the 26 germplasm holders surveyed, 36,383 and 23,013 accessions of cowpea and other *Vigna* spp are respectively reported maintained in *ex situ* conditions (Table 1). Note that the 'Other *Vigna*' category includes wild *Vigna* as well as cultivated *Vigna* other than cowpea.

Table 1. Number of cowpea and other *Vigna* accessions reported maintained in *ex situ* condition by national, regional and international holders.

Genebank	Cowpea	Other *Vigna*
Angola (SADC)	172	9
AVRDC-Taiwan	322	10489
Belgium	331	873
Benin	155	0
Botswana (SADC)	49	34
Cote d'Ivoire	126	16
Germany	291	267
IITA	15276	3276
Kenya	875	669
Malawi (SADC)	83	64

Mauritius (SADC)	3	0
Mozambique (SADC)	29	14
Namibia (SADC)	57	41
Nigeria	384	0
Russia	1945	2092
South Africa	886	0
South Africa (SADC)	55	18
South Korea	910	15
Spain	466	5
Swaziland (SADC)	45	42
Tanzania	386	236
Tanzania (SADC)	39	26
Togo	100	0
USA (USDA)	8043	4802
USA (UCR)	550	25
Zambia (SADC)	305	100
Total	36383	23013

The oldest *Vigna* collections are likely to be held by the Vavilov Institute and USDA Griffin as their conservation activity started in 1921 and 1936 respectively (Table 2). Several collections were assembled in the 60s, 70s and 80s (Botanic Garden of Belgium, IITA, Kenya, Spain, Nigeria)

Table 2: Year of germplasm introduction in the collection

Genebank	Year of introduction
AVRDC-Taiwan	1984
Belgium	1965
Benin	1978
Côte d'Ivoire	1990
Germany	1922
IITA	1971
Kenya	1979
Nigeria	1987
Russia	1921
SADC	Non specified
South Africa	2005
South Korea	1987
Spain	1981
Tanzania	1993
Togo	2004
USA (USDA)	1936
USA (UCR)	1980

The National Botanic Garden of Belgium, USDA Griffin and IITA are maintaining the most diverse collections of *Vigna* in terms of number of distinct species (Table 3 and 4).

Table 3: Details on 'Non-cowpea *Vigna*' holdings

Genebank	No. of non-cowpea *Vigna* accessions	No. of distinct species
AVRDC-Taiwan	10489	13
Belgium	873	65
Benin	0	0
Côte d'Ivoire	16	2
Germany	267	9
IITA	3276	50
Kenya	571	10
Nigeria	0	0
Russia	2092	8
SADC	348	1
South Africa	0	0
South Korea	15	7
Spain	5	2
Tanzania	236	3
Togo	0	0
USA (USDA)	4802	23
USA (UCR)	25	2

Table 4: List of 'non-cowpea' species maintained *ex situ* condition as reported by surveyed partners

Species reported per genebank
BELGIUM adenantha, ambacensis, angivensis, angularis, antillana, aridicola, benuensis, andida, caracalla, comosa ,davyi, elegans, exilis, filicaulis, friesorum, frutescens, gentryi, gracilis, grandiflora, heterophylla, hirtella, hosei, juruana, kirkii, kokii, lanceolata, lasiocarpa, laurentii, linearis, longifolia, luteola, marina, membranacea, minima, monophylla, mudenia, multinervis, mungo, nakashimae, nepalensis, nigritia, nyangensis, o-wahuensis, oblongifolia, parkeri, peduncularis, phlebophylla, racemosa, radiate, adicans, reflexo-pilosa, reticulate, riukiuensis, schimperi, speciosa, stipulacea, subramaniana (?), tenuicaulis, trilobata, trinervia, triphylla, umbellate, venulosa, venusta, vexillata
COTE d'IVOIRE radiata and subteranea
GERMANY aconitifolia, angularis, caracalla, mungo, nakashimae, radiata, umbellata, unguiculata (subsp unguiculata, subsp sesquipedalis, cylindrica, dekindtiana)
KENYA aconifolia, luteola, menbranacea, parkeri,heterophylla, oblongifolia, vexillata, radiata,schimperi, reticulata, others
RUSSIA radiata, mungo, angularis, aconitifolia, umbellata, trilobata, vexillata, marina, macroptilium lathyroides
SPAIN mungo, adenantha, unknown
TANZANIA

frutescens, subteranea, vexillata
USDA-Griffin aconitifolia, adenantha, angularis, caracalla, glabrescens, lasiocarpa, linearis, longifolia, luteola, marina, membranacea, minima, mungo, oblongifolia, peduncularis, radiata, schimperi, speciosa, subterranea, trilobata, umbellata, vexillata, unknown
dekintiana, pubescens
SADC subterranea mostly
SOUTH KOREA caracalla, catjang, glabrescens, lancifolia, oblongifolia, reflexopilosa, vexillata, nakashimae
IITA adenantha, ambacensis, , angivensis, antillana, benuensiscandida, caracalla, comosa, davyi, dekindtiana, filicaulis, fischeri, friesiorum, frutescens, gentryi, glabrescens, gracilis, heterophylla, hosei, juruana, kirkii, lasiocarpa, laurentii, linearis, lobatifolia, longifolia, luteola, macrosperma, marina, membranacea, minima, monophylla, multinervis, mungo, nigritia, oblongifolia, parkeri, peduncularis, platyloba, racemosa, radiata, reticulata, subterranea, trilobata, triphylla, unguiculata, venulosa, vexillata, wittei, unknown
AVRDC-Taiwan aconitifolia, angularis, caracalia, glabrescens, luteola, marina, mungo, parkeri, radiata, trilobata, umbellate, vexillata, unguiculata subsp. sesquipedalis, unguiculata subsp. unknown

The majority (60%) of the cowpea germplasm maintained in *ex situ* conditions is recorded as farmer varieties/landraces (Table 5). Germplasm type was reported as not documented or unknown for up to 31% of the accessions.

Table 5: Cowpea germplasm type

Cowpea germplasm type	% accessions
Farmer varieties/landraces	60
Breeding lines	5.2
Wild	2.0
Others/unknown	31.1

Out of the 17 partners which provided data, 8 report an increased of cowpea consumption (Table 6). Within the African group's reply, more than 75% report an increased use of cowpea. Overall, cowpea is equally used as grain or as dual purpose crop (both grain and fodder).

Table 6: Cowpea consumption and use trend

Genebank	Is cowpea consumption increasing?	as grain	as fodder	dual purpose
AVRDC-Taiwan	Yes	Yes	no	No
Belgium	Not specified	No	No	Yes
Benin	Yes	Yes	No	No
Côte d'Ivoire	Not specified	No	No	Yes
Germany	No	No	No	Yes
IITA	Yes	No	No	Yes
Kenya	Yes	No	No	Yes
Nigeria	Yes	Yes	No	No
Russia	No	Yes	No	No
SADC	Yes	No	No	Yes
South Africa	No	No	No	Yes
South Korea	No	Yes	No	No
Spain	No	Yes	No	No
Tanzania	Yes	Yes	No	No
Togo	Yes	Yes	No	No
USA (USDA)	No	Not specified	Not specified	Not specified
USA (UCR)	No	Yes	no	No

2.3 Passport data

Almost all germplasm holders report recording germplasm georeferences (Table 7). However, when asked the actual % of accessions with georeferences, less than half of the partners provided information. The proportion of georeferenced accessions varies greatly from one collection to another (0 to 100%).

Table 7: Collection georeferencing.

Genebank	Georeference/location recorded	% of accessions with georefences
AVRDC-Taiwan	No	Non specified
Belgium	Yes	non specified
Benin	Yes	non specified
Côte d'Ivoire	Yes	95%
Germany	Yes	non specified
IITA	yes	50%
Kenya	Yes	5%
Nigeria	Yes	non specified
Russia	Yes	100%
SADC	yes	non specified
South Africa	Yes	Partly
South Korea	Yes	Partly
Spain	Yes	39%
Tanzania	yes	90%
Togo	yes	non specified
USA (USDA)	yes	23%
USA (UCR)	No	non specified

2.4 Characterization data

Most of the germplasm holders use IPGRI or IPGRI-based descriptors to characterize their germplasm (Table 8). The number of descriptors used varies from 5 to 52. All African national holders record their data on Excel spreadsheets while various database systems are used by regional/international and national holders outside Africa. On line access to germplasm related data has only been put in place by developed country and international genebanks (Table 8).

Table 8: Germplasm description, data record and access

Genebank	Descriptors used	Number of descriptors used	Data record	On line access	Web site
AVRDC-Taiwan	IPGRI	25	Access	Yes	http://203.64.245.173/avgris
Belgium	IPGRI + Self developed	21	Progress software	Yes	http://www.br.fgov.be/research/collections/living/phaseolus
Benin	Not specified	not specified	Excel + Books	No	Not applicable
Côte d'Ivoire	IPGRI	37	Excel	No	Not applicable
Germany	IPGRI + Self developed	not specified	Oracle based System	Yes	http://www.gbis.ipk-gatersleben.de/gbis_i/
IITA	IPGRI + Self developed	52	Self developed data base	Yes	http://www.iita.org
Kenya	IPGRI	not specified	Access	No	Not applicable
Nigeria	Not specified	not specified	Excel	No	Not applicable
Russia	Self developed	not specified	Excel + Paradox	Yes	www.vir.nw.ru
SADC	IPGRI + Self developed	not specified	Self developed data base	Yes	http://www.spgrc.org (ready by mid-2010)
South Africa	IPGRI	5	Excel	No	Not applicable
South Korea	Self developed	23	Self developed data base	Yes	www.genebank.go.kr
Spain	IPGRI	10	Access	Yes	www.inia.es
Tanzania	IPGRI	not specified	Excel + Books	No	Not applicable
Togo	Not specified	not specified	Excel	No	Not applicable
USA (USDA)	Self developed	32	GRIN + Excel+ Field books	Yes	http://www.ars-grin.gov/npgs/
USA (UCR)	Self developed	8	Access database	No	Not applicable

2.5 Conservation standard

The conservation standards varies greatly amongst germplasm holders (Table 9). As expected, high conservation standard are observed in developed countries and international/regional genebanks (Table 9). Several African holders are maintaining their germplasm in sub-optimal conditions (relatively high temperature and non-air tight containers).

Table 9: Temperature conditions and containers used for storage (Long term = below -15°C; Short term = Ambient; Medium term = below 8°C).

Genebank	Storage Type	Container
AVRDC-Taiwan	Medium and long term	Air tight
Belgium	Long term	Air tight
Benin	Short term	Non air tight
Côte d'Ivoire	Medium term	Non air tight
Germany	Long term	Air tight under vacuum
IITA	Medium and long term	Both air and non air tight
Kenya	Medium and long term	Air tight
Nigeria	Medium and long term	Both air and non air tight
Russia	Medium, short and long term	Non air tight and air tight under vacuum
SADC	Long term	Both air and non air tight
South Africa	Medium term	Non air tight
South Korea	Medium and long term	Both air and non air tight
Spain	Medium and long term	Air tight and Air tight under vacuum
Tanzania	Long and short term	Air tight under vacuum
Togo	Medium and short term	Non air tight
USA (USDA)	Medium and long term	Air tight
USA (UCR)	Long term	Non air tight

Only 60% of the germplasm holders check seed water content (WC) prior to storage (Table 10). Most of them (80%) check the initial germination rate of the seeds prior to storage, while only 66% monitor their viability during storage. The decision tool for regeneration is either empiric (every 4 to 20 years depending on holder) or based on actual seed viability (germination <85%) or both. The majority of the germplasm holders report following precise guidelines for the regeneration of germplasm.

Table 10: Details on germplasm handling as described by national, regional and international germplasm holders.

Genebank	Initial germination check	Initial WC check	Viability monitoring during storage	Stock monitoring	Regeneration frequency/ Decision	Regeneration guidelines available
AVRDC-Taiwan	No	Yes	No	Yes	Low stock	Yes
Belgium	Yes	Yes	Yes	Yes	low viability or low stock	Yes
Benin	Yes	Yes	No	Yes	None	No
Côte d'Ivoire	Yes	Yes	No	Yes	Every 5 years	Yes
Germany	Yes	No	Yes	Yes	Every 15-20 years	Yes
IITA	Yes	Yes	Yes (backlog)	Yes	Low stock or/and viability	Yes
Kenya	Yes	Yes	Yes	Yes	Viability<85%	Yes
Nigeria	Yes	No	No	Yes	Every 5 years	No
Russia	Yes	No	Yes	Yes	Every 5 to 20 years	Yes
SADC	Yes	Yes	Yes	No	Viability <85%	Yes
South Africa	not specified	Not specified	Not specified	Not specified	Not specified	Not specified

South Korea	Yes	Yes	Yes	Yes	low viability or low stock	No
Spain	Yes	Yes	Yes	Yes	Viability <85%	No
Tanzania	No	Yes	Yes	Yes	Viability <85%	Yes
Togo	No	No	No	No	Not specified	Yes
USA (USDA)	Yes	No	Yes	Yes	When needed	Yes
USA (UCR)	no	no	no	Not specified	Not specified	No

The main constraints reported by African holders for germplasm conservation are the reliability of electricity (40%), the lack of appropriate containers (40%), high humidity (20%), some pest and disease incidence (bruchids and fungus) and the lack and sustainability of funding (data not shown).

2.6 Safe duplication

Eight out of the 17 germplasm holders reported safety duplicating their germplasm (Table 11).

Table 11: Safe duplication and location

Genebank	Duplication of germplasm	Location of duplication
AVRDC-Taiwan	Yes	Svalbard and NPGRC
Belgium	Not specified	Not applicable
Benin	No	Not applicable
Côte d'Ivoire	No	Not applicable
Germany	Yes	Svalbard, Spitsbergen (Norway)
Kenya	Yes	Kew Gardens, IITA, CIAT. AVRDC, Svalbard
IITA	Yes	Svalbard, Saskatoon
Nigeria	No	Not applicable
Russia	Yes	Kuban National Seed store
SADC	Yes	SADC respective national genebank + Svalbard
South Africa	Yes	IITA
South Korea	No	Not applicable
Spain	No	Not applicable
Tanzania	Yes	SADC
Togo	No	Not applicable
USA (USDA)	No	Not applicable
USA (UCR)	Yes	USDA

2.7 Distribution

Five out of the 17 germplasm holders report free access to their entire collection. Where this is not the case, the %age of germplasm available for distribution varies between 4-85%. More than half of the germplasm holders report international distribution and most of them issue material transfer agreement. More than 80% of the surveyed institutes are aware of the International Treaty on PGRFA (data not shown). Germplasm is equally distributed to universities and NARS, while distribution to farmers and the private sector is less important (data not shown).

Table 12: Germplasm access and distribution

Genebank	Germplasm available without restriction	% available	International distribution	Seed shipment	MTA issued for distribution
AVRDC-Taiwan	Yes	85	Yes	Courier or regular mail	Yes
Belgium	Yes	100	Yes	Not specified	Yes
Benin	Yes	100	No	Not specified	Not specified
Côte d'Ivoire	No	Not specified	Yes	Not specified	Yes
Germany	No	8	Yes	Regular mail	Yes
IITA	Yes	100	Yes	all possible	Yes
Kenya	Yes	100	Yes	Courier	Yes
Nigeria	Yes	100	No	Hand	Yes
Russia	No	Not specified	Yes	Regular mail	Not specified
SADC	No	4	No	courier and hand	No
South Africa	No	Not specified	No	Not specified	Yes
South Korea	No	Not specified	No	Regular mail	Yes
Spain	No	Not specified	Yes	Mail, courier, hand	Yes
Tanzania	No	7	Yes	Courier and hand	Yes
Togo	No	Not specified	No	Not specified	Not specified
USA (USDA)	No	78	Yes	Courier or regular mail	Yes
USA (UCR)	No	85	Yes	Courier	No

2.8 Germplasm health

Only 6 germplasm holders report existing indexing procedures in place (Table 13). Amongst the others, 5 mentioned support from their plant quarantine services. When asked on *Vigna* importation conditions to their own country, 47% the germplasm holders report it as either strict or very strict, versus 29% as liberal.

Table 13: Germplasm health related information.

Genebank	Indexing procedures	Plant quarantine support available	Cowpea importation status
AVRDC-Taiwan	Not specified	Yes	Strict
Belgium	Not specified	Not specified	Not specified
Benin	Not specified	No	Not specified
Côte d'Ivoire	Not specified	No	Liberal
Germany	Yes	Yes	Very strict
IITA	Yes	Yes	Strict
Kenya	Yes	Yes	Liberal
Nigeria	Yes	Yes	Very strict
Russia	Not specified	Yes	Not specified
SADC	No	Not specified	Not specified
South Africa	Not specified	Yes	Very strict

South Korea	Yes	No	Liberal
Spain	Not specified	No	Liberal
Tanzania	No	Yes	Very strict
Togo	No	Yes	Strict
USA (USDA)	Yes	Yes	Strict
USA (UCR)	No	No	Liberal

2.9 Networking

A little less than half of the germplasm holders reported being linked to a conservation network (Table 14). In the case of West Africa, only one country out of the 4 reported a link with GRENEWECA, which probably reflects the low level of activity of the network.

Table 14: Conservation network and strategy

Genebank	Part of a conservation related network	Network Name	Regional conservation strategy
AVRDC-Taiwan	Not specified	Not applicable	Not specified
Belgium	No	Not applicable	No
Benin	No	Not applicable	No
Côte d'Ivoire	No	Not applicable	No
Germany	Yes	Eucarpia, ECPGR, National German communities	Yes
IITA	Yes	SGRP System wide genetic resources program	Yes
Kenya	Yes	EAPGREN	Yes
Nigeria	No	Not applicable	Yes
Russia	Yes	VIR.nw.ru	Yes
SADC	Yes	SADC	Yes
South Africa	No	Not applicable	No
South Korea	No	Not applicable	No
Spain	Yes	ECPGR, AEP, AEET, SEG, AEL, ISTA	Yes
Tanzania	Yes	SADC	Yes
Togo	Yes	GRENEWECA	No
USA (USDA)	No	Not applicable	No
USA (UCR)	No	Not applicable	No

Annex 2 - List of Institutes contacted for the Cowpea Conservation Strategy Survey

Institute full name	Institute address	Country	Contact	Telephone	e-mail
Institute of Crop Germplasm Resources	Chinese Academy of Agricultural Sciences	China	Wang Shumin		smwang@mail.caas.net.cn
Australian Tropical Crops & Forages Genetic Resources Centre	System, Locked Bag, Biloela, Queensland 7415	Australia	Australia Plant Genetic Resources Information	+61749929130	sally.dillon@dpi.qld.gov.au
Agricultural Research Council (BARC)	New Airport Road, Farmgate, Dhaka	Bangladesh	Mr M D. Khalequzzaman Akanda Chowdhury		md-cros@barc.gov.bd or kzarnancho55@yahoo.com
National Botanical Garden of Belgium	Domaine de Bouchout, Meise B-1860	Belgium		+3222693905	office@br.fgov.be
Institut National des Recherches Agricoles		Benin	Aly Djima National, PGR Programme Coordinator	+22921300264 +22995067763	Aldjim5@yahoo.fr
Ministry of Agriculture	Scrbithang, Thimphu	Bhutan	Mrs Asta Maya Tamang, Deputy Chief Biodiversity Officer	+9752351417	tamangasta@hotmail.com
Institute de l'Environment et des Recherches Agricoles		Burkina Faso	Dr Issa Drabo, Cowpea Breeder	+22650446510 +22670716621	idrab@yahoo.fr
Institute of Plant Genetic Resources "K Malkov"	Str Drujba 2 4122 Sadovo, Plovdiv district	Bulgaria	Ms Siyka Angelova	+35932629026	siika_angelova@yahoo.com
Institute of Plant Genetic Resources (Tsvetelina Dimitrova Stoilova)	Agricultural University & Institute of Genetics "Doncho Kostoff"	Bulgaria	Tsvetelina Dimitrova Stoilova	+3593118225111 9	tz_st@abv.bg
Centre National de Recherches Agronomiques		Côte d'Ivoire	Louise Akanvou		lakanvou@yahoo.fr
Cambodian Agricultural Research and Development Institute (CARDI)	National Road No3. Prateah Lang, Dangkor Phnom Penh	Cambodia	Mr Olu Makara Director	+85523219692	Ou.makara@card.org.jh
Georgia State Agrarian University	19, Petriashvili St., Tbilisi	Georgia	Prof. Dr Se Avandil Korakhashivili	+9957 406751	akoral@mail.ru akorakhashvili@yahoo.com
Genebank, Leibniz Institute of Plant Genetics and Crop Plant Research	Correnstrasse 3, Gatersleben 06466	Germany		+49394825220	graner@ipk-gatersleben.de
National Bureau of Plant Genetic Resources	Pusa Campus, New Delhi	India		+911125842495	director@nbpgr.ernet.in
Department of Genetic Resources	National Institute of Agrobiological Sciencesd, 2-1-2 Kannondai, Tsukuba-shi, Ibaraki-ken	Japan		0298387408	
Kenya Agricultural Research Institite	P. O. Box 30148, Nairobi	Kenya	Mr. Zachary Kithiniji Muthamia	+254202700462	ngbk@wananchi.com

Institute full name	Institute address	Country	Contact	Telephone	e-mail
National Agrobiodiversity Center		South Korea	Lee Jeongran		kongsarang@korea.kr
Instituto de Investigacao Agraria de Mozambique	Centro Nacional de Recursos Fitogeneticos, Av. das FPLM, P.O. Box 3658, Maputo	Moz.	Carla do Vale, Research Officer	+25821460130	cdovale080@gmail.com
NACGRAB	Ibadan	Nigeria	Sunday Aladele		sundayaladele@yahoo.com
Plant Genetics Resources Program, National Agricultural Research Center	Park Road, Islamabad	Pakistan	Dr Zahoor Ahmed	+92519255203	Zahmad51@hotmail.com
Instituto de Investigacion Agropecuari de Panama Ismael Camargo	Rio Hato, Provincia de Cocle	Panama	Ing. Emigdio Rodrigues	+9933253	icamargo@cwpanama.net erodriguezq15@yahoo.es
National Plant Genetic Resources Laboratory IPB/UPLB	Institute of Plant Breeding, University of the Philippines, Los Banos College, Laguna 4031	Philippines	Dr Jose E. Hernandes, Director, Crop Science Cluster	+63495362448	jehuplbca@yahoo.com
N.I. Vavilow Research Institute of Plant Industry (VIR)	42-44 Bolshaya Morskaya St., St Petersburg 190000	Russia	Dr. Sergey M. Alexanian, Vice Director for Foreign Relations	+7812314 4848	s.alexanian@vir.nw.ru
Agricultural Research Council	Vegetable and Ornamental Plant Institute, Private Bag X293, Pretorial,	South Africa	Lynelle	0128419611	lvemmenes@arc.agric.za
ARC-Grain Crop Institute	Potchefstoroom	South Africa	Jan Asiwe		
Embrapa Recursos Geneticos e Biotecnologia	CENARGEN SAIN Parque Rural, Av.Norte (Final), Brasilia DF	Brazil		+55614484700	chadm@cenargen.embrapa.br
Instituto Nacional de Investigacion y Technologia Agrarai y Alimentaria	Centro de Recursos Fitogenetics	Spain	Autovia de Aragon km 36, Apdo. 1045, Alcala de Henares, Mandrid	+34918819286	edurne@inia.es
Plant Genetic Resources Unit	Agricultural Research Corporation (ARC), P. O. Box 126, Wad Medani	Sudan	Dr El Tahir Ibrahim Mohammed	+249511840031 +249912 536114	eltahir81@yahoo.com
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