Germplasm flows in and out of Kenya and Uganda through the CGIAR:

a case study of patterns of exchange and use to consider in developing national policies

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1. Introduction: the potential relevance of a study of exchanges of PGRFA for the purposes of national policy development

1.1. A highly charged political context

In recent years, national decision-makers have come under increasing pressure from a wide range of stakeholders to make laws and policies affecting the conservation, use, ownership, management, and exchange of plant genetic resources for food and agriculture (PGRFA). The atmosphere within which they must make decisions is politically highly charged, animated by appeals to national sovereignty, human rights, neo-liberal economic development theory, property rights, and duties to future generations. On one hand, national policy makers are being urged from some quarters to establish strict mechanisms of control over the genetic resources (GR) within their borders, including PGRFA. On the other hand, they are also urged to pursue policies that support their own nationals getting access to a broad range of PGRFA from outside the country to support their breeding programs, crop production, and conservation efforts.

1.2. Existing international and national policy/legal context

Of course, national policy makers are not considering these issues in a policy vacuum. At the international level, the Convention on Biological Diversity (CBD) affirms that all countries have the sovereign right to regulate access to the genetic resources within their borders for which they are the countries of origin. The Bonn Guidelines (non-binding) adopted by CBD Convention of the Parties (COP) VI encourage states to put in place bilaterally-oriented regulatory mechanisms to facilitate the negotiation of terms and conditions for allowing access to their genetic resources. The CBD's Ad Hoc Open-ended Working Group on Access and Benefit Sharing (Working Group on ABS) has a mandate to consider elements to be included in what has the potential to be a new internationally binding regime (or regimes) addressing access and benefit sharing under the framework of the CBD. The Working Group on ABS met for the first time in the exercise of this mandate on February 14-18, 2005, and many countries were pressing for international mechanisms that would tighten up national controls along bilateral lines. Some developing countries are creating their own versions of *sui generis* forms of intellectual property rights (IPR) for farmers varieties and traditional knowledge, and are pushing for international harmonization of their domestic efforts by proposing amendments to the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement in the context of the Doha global trade negotiations. Similar demands for *sui generis* IPR for farmers varieties and associated traditional knowledge are being made within the context of the meetings of the World Intellectual Property Organization's (WIPO) Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore. The International Treaty on Plant Genetic Resources for Food and Agriculture (the International Treaty), which came into force on June 29, 2004, creates a framework for national strategies and international cooperation regarding the conservation, use and exchange of PGRFA. The Treaty creates a multilateral system of access and benefit sharing (MLS) for a list of 35 crops and 29

forage genera, which are listed in Annex 1 of the International Treaty. Pursuant to that MLS, member states (as well as the International Agricultural Research Centers (IARC) of the Consultative Group on International Agricultural Research (CGIAR) and other organizations that join) will enjoy facilitated, low cost, access to all of the other members states' Annex 1 materials.[1] As of May 2005, 68 countries were parties to the International Treaty, including Kenya and Uganda.[2] Those same countries will be involved in ongoing discussions about the content of the standard Material Transfer Agreement (MTA) to be used for all distributions of PGRFA in the MLS. They will also need to start thinking about implementing the International Treaty, including the MLS, into national law.

Some countries already have national access laws that establish bilaterally-oriented systems to screen applications for access to GRs and to negotiate agreements on a case-by-case basis. Many more countries are in the process of developing drafts of such laws. Often, these laws do not treat PGRFA any differently from other forms of GRs. As far as regulating access to PGRFA is concerned, it appears that national policy makers often feel there are just two possibilities: membership in the MLS created by the International Treaty for the listed crops and/or bilaterally-oriented treatment of everything else. National policy makers must be made to realize that they have many more choices than this. The CBD does not require countries to implement a bilaterally oriented system. The CBD simply says that countries have the right to regulate access in the way they choose. They can do so through creation of the kinds of bilateral laws described above, or through membership in the MLS of the International Treaty (the International Treaty explicitly states that it is in harmony with the CBD) or through other arrangements, such as subregional accords for multilateral access and benefit sharing for materials of particular importance within the subregions that are not currently included in Annex 1 of the International Treaty.

1.4. The potential contribution of this study

Policy makers need information from a wide range of sources to be able to 'think through' their options in terms of regulating access to, control over, use of, and benefits derived from PGRFA. One subset of very important information in this regard concerns the patterns of exchange of PGRFA in which their countries have already participated in and benefited from. National genebank curators and managers of national breeding programs have a general sense of the quantum of PGRFA coming into, and going out of a country. However, generally speaking, it appears that high-level political representatives often do not appreciate the nature of patterns of exchange in which their countries participate and the benefits those exchanges currently provide, and therefore they are much less likely to identify ways in which their countries could take still more advantage of what is available to them internationally.

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[1] Subject, of course, to other conditions of materials being included in the MLS, for example, that they are in the control of the state party and in the public domain, etc.

[2] For updates on countries that are parties to the International Treaty, see http://www.fao.org/Legal/TREATIES/033s-e.htm last accessed, May 10, 2005.

Another, directly related subset of information concerns the economic valuation of different uses of PGRFA within national contexts, including the value uses of material that is introduced into the country from outside. In the absence of data concerning the movements and uses of germplasm, and their economic valuation, there is a risk that policy makers will put regulations in place that could have negative consequences on existing (and potential future) beneficial activities, relationships, and patterns of exchange. Frameworks for conducting economic valuations are set out in a companion paper entitled, "Economic Methods for Estimating the Value of Crop Genetic Resource Transfers".[3]

In this paper, we will focus primarily on patterns of exchange of PGRFA. In particular, we will focus on the exchanges (or flows) of PGRFA in and out of two 'case study countries': Kenya and Uganda. Still more particularly, we will focus on those PGRFA flows that were facilitated by a few of the IARCs of the CGIAR. In so doing, we hope to provide Kenyan and Ugandan parties engaged in policy making processes with data that will be useful in 'thinking through' their options. Furthermore, by providing a significant amount of detail about our research methodology and data sources, we hope that policy makers in other countries, faced with similar policy choices, will follow more or less the same steps to collect and analyze their own data concerning flows of genetic resources in and out of their own borders and that of the regions within which their countries are located.

The point here is not to emphasize the continued facilitated access to CG Centers' collections in particular (though of course we do think that is very important). As stated in section 1.5., above, the Food and Agriculture Organization of the United Nations (FAO) In Trust agreements currently create a system of facilitated access to the CG Centres' collections, and in the relatively near future, that access will continue to be facilitated through the operation of the International Treaty. Instead, our purpose in this paper is to demonstrate that a system that has historically been 'open' has proven to constitute an enabling environment for extremely high volume of valuable exchanges of material around the world. More particularly, we seek to demonstrate the 'multiplier' effect from which individual state members can benefit through membership in a multilateral system of access and exchange. This is particularly important when one considers the fact, as demonstrated in Table 1 below that the IARCs of the CGIAR hold only a relatively small proportion of the world's *ex situ* collections of a number of very important crops.

1.5. The regulation of CG Centres ex situ collections in the past, present and future: facilitated access and a global public goods approach

In 1989, the CG Centres issued a policy statement to the effect that they were holding their *ex situ* collections as 'trustees' for the world community. In 1994, to legally

[3] Smale, M., 2004. "Economic Methods for Estimating the Value of Crop Genetic Resource Transfers" [Rockefeller URL – Please insert Meridian]

entrench that commitment, the CG Centres entered into agreements with FAO pursuant to which their collections were brought within the FAO International Network of *Ex-Situ* Collections (the FAO-CGIAR In Trust Agreements). The agreements, which are still in force today, stipulate that the materials are "in trust for the benefit of the international community" and that they are to be made available along with related information "without restriction," for the purposes of scientific research, plant breeding, or conservation. The CG Centres can not take out IPR on designated material and they must pass on that same obligation to recipients to whom they distribute germplasm. Furthermore, pursuant to the agreements, the CG Centres recognize the authority of Commission on Genetic Resources for Food and Agriculture (CGRFA) to set policies for the International Network of *Ex Situ* Collections. Most of the transfers of material that are considered in this paper – and reflected in the data below -- took place within this relatively open system of facilitated access.

In June 2005, the International Treaty came into force. Article 15 of the International Treaty calls on the IARCs of the CGIAR to 'sign agreements with Governing Body" pursuant to which all of their in trust materials that are listed on Annex 1 will be included in the MLS and transferred pursuant to the same standard MTA that will also be used by state parties for distributions of Annex 1 materials. The International Treaty specifies that no parties will be able to take out IPRs on materials received from the MLS "that limit the facilitated access to the plant genetic resources for food and agriculture, or their genetic parts or components, in the form received from the Multilateral System". Along with the PGRFA itself, parties will also provide passport data, and subject to applicable law, associated available non-confidential descriptive information. If a recipient develops a new PGRFA that incorporates material received through the MLS and commercializes it and prevents others from using for the purposes of research, they will be obliged to pay into an international financial mechanism created by the International Treaty "an equitable share of the benefits arising from the commercialization of that product".[4] Article 15 of the International Treaty further stipulates that the non-Annex 1 materials held in CG Centres in trust collections should be distributed by an MTA that is substantially very similar to the MTA for Annex 1 materials. This MTA should be adopted by the Governing Body at its second meeting.
Meanwhile, at its 6th Extraordinary Session, the FAO CGRFA requested the preparation of an interim MTA to be used by the CG Centres, to reflect the terms and conditions of the MTA, as far as was possible, until the International Treaty came into force and the CG Centres could make agreements with the Governing Body. The text of the interim MTA was endorsed and CG Centres started using it in May 2002.[5]

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[4] Since the International Treaty came into force there have been a number of international meetings during which member states of the CGRFA have worked towards a common understanding of a number of the terms of the International Treaty, including what an "equitable share" actually constitutes. If these meetings stay on schedule, the standard MTA will be approved at the first meeting of the Governing Body of the International Treaty, which may be as early as March 2006. It is hoped that at that same meeting the Governing Body will endorse the text of the agreement between the CG Centres and the Governing Body.
[5] The text of the interim MTA is reproduced in the "Booklet of CGIAR Centre Policy Instruments Guidelines and Statements on Genetic Resources, Biotechnology and Intellectual Property Rights". http://ipgrihq15/intranet/Documents/SGRP/Policy/Policy%20Booklet%20Version2PrintNOTICE.doc

CG Centres will sign a agreements with the Governing Body as envisaged in Article 15, probably in the first half of 2006. At that point, the FAO-CGIAR In Trust Agreements will cease to be effective, and the CG Centres' in trust materials will be distributed according to the rules of the International Treaty, which will maintain the tradition of facilitated access for research, conservation and education, with the added obligations regarding benefit sharing. Again, for the purposes of this paper, the most relevant fact is that the transfers reflected in the data below took place within a system of relatively open facilitated access for the purposes of research, conservation and education.

1.6. Interdependence: the global spread of, and reliance on, crop germplasm

It is important to situate this study of PGRFA flows in and out of Kenya and Uganda within broader historical context.

It is well established that most of the crops that are relied upon today all over the world were developed over millennia in areas of the world that are now considered to be developing countries.[6] It is also well established that over the course of European colonial expansion, most of those crops were transferred around the world. Consequently, while the primary centers of diversity for most crops are still located in southern countries, secondary centers of diversity are now spread widely around the world, with some of them in developed countries. As a result of the proliferation and uptake into national/regional diets of once foreign foods, today the majority of countries in the world are dependent upon main food crops that originated from outside their borders, and in many cases subregions and continents.[7]

For example, Kenya is 89-98 % dependant upon main food crops that originated outside its borders; Uganda is 76-88% dependant.[8] "The median level of minimum dependence on non-indigenous major crops in SSA is 73%."[9] A table setting out the food energy supplied per day by different crops in Kenya and Uganda is included in Appendix 2.

FAO reports that most of the existing landraces of most of these crops have been collected and are stored in *ex situ* collections.[10] As a result, a researcher would be more likely to go now to the ICRISAT genebank in India for landraces of groundnut than to the countries which are the centers of *in situ* diversity for that crop. In this context, it is interesting to note that ICRISAT obtained 67% of the accessions it holds that were originally collected in Uganda and Kenya from non-Kenyan and non-Ugandan sources.

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[6] Harlon., J., 2002. *Crops and Man (2nd ed.).* American Society of Agronomy, Madison, Wisconson, USA.
[7] Palacios, X.F., "Contribution to the Estimation of Countries' Interdependence in the Area of Plant Genetic Resources," Background Study Paper No. 7, Rev. 1. Rome: FAO, Commission on Genetic Resources for Food and Agriculture.
[8] Palacios, X.F., *supra* note 7 at 12.
[9] Fowler, Smale, Gaiji, 2001. "Unequal Exchange? Recent Transfers of Agricultural Resources and Their Implications for Developing Countries," Development Policy Review 19(2) 2:181-204.(hereinafter "Unequal Exchange")
[10] FAO. 1998. *The State of the World's Plant Genetic Resources for Food and Agriculture.* Rome: FAO.

2. Methodology[11]:

2.1. General

In this paper, we primarily studied the flows of PGRFA into and out of both Kenya and Uganda *through* the genebanks of the IARCs of the CGIAR.. The genebanks of the CG Centres collect (or otherwise obtain) and hold PGRFA from all over the world, including Uganda and Kenya. They distribute that material upon request, around the world, including to other CG Centres, national programs, and in a limited number of cases, private companies. As such, the CG Centres' genebanks act as clearing houses, or pumps, for providing access to, and the distribution of, PGRFA around the globe. Genebank data for this study was collected from numerous sources, including the System-wide Information Network on Genetic Resources (SINGER)[12], the ICRISAT genebank, INIBAP transit Centre, INIBAP Uganda and France, and IITA-ESARC.

We also relied, but to a much lesser extent, on data from the breeding programs of INIBAP and ICRISAT concerning the introduction of improved bananas to Uganda and improved sorghum, finger millet, pigeon pea and ground nut to both Uganda and Kenya.[13] We will make it clear when we are relying on data from these breeding programs.

2.2. World-wide and CG Centres' ex situ collections

In Table 1, for a number of crops we have provided information about total number of accessions held in *ex situ* collections world-wide, and the proportion of those held by the IARCs of the CGIAR. It is important to note that most of the materials held 'in trust' by the CG Centres are farmers' varieties (or landraces) and as a consequence, most of the transfers recorded in SINGER are of unimproved materials. Some data about introductions of improved materials has been compiled by colleagues at ICRISAT, INIBAP and IITA for this paper, and they are set out in sections 3.3 and 3.4 below. Data about introductions of improved materials makes a still stronger case overall about the importance of putting in place policies that facilitate such transfers.

Table 1: World wide and CG Centre collections of materials studied in this paper[14]

Crop	IARC gene bank holdings	Total world holdings
Bean *phaseolus*	41,061	268,369

[11] We want to acknowledge the earlier work on analyzing germplasm flows through the CGIAR as completed in "Unequal Exchange," supra note 9.

[12] http://singer.cgiar.org/insert

[13] It is important to note that introductions of breeding lines through the Centres are not well documented. In "Unequal Exchange," supra note 9, Fowler, Smale and Gaiji stated that "the number of IARC-produced varieties released underestimates total improved germplasm flows, however, because it does not take into account the number of breeding lines furnished to national programs."

[14] FAO. 1998. *The State of the World's Plant Genetic Resources for Food and Agriculture*, Appendix 2.

Sorghum	35,186	168,550
Millet *Eleusine* (finger millet)	2,848	14,660
Pearl millet *Pennisetum*	21,191	36,806
Groundnut *Arachis*	14,957	81,186
Pigeon pea *Cajanus*	12,885	24,938
Forage crops		
Legumes *Various*	36,289	66,676
Clover *Trifolium*	3,401	78,405
Medicago *Medicago*	8,456	52,764
Vicia *Vicia*	5,353	26,244
Pea *Lathyrus*	1,682	13,253
Grasses *Various*	3,619	38,891
Millet *Panicum*	1,232	21,183

2.3. Concerning SINGER data

We were careful to exclude transfers between the CG Centres themselves, as this data would create an imbalance in the perceived rates of receipt, or donation of PGRFA on the part of the countries within which a CG Centre genebank is located.[15] Instead, we focused exclusively on the following transfers of materials:

1. those originally collected in Uganda and Kenya and accessed through CG Centres by
   a) other countries in SSA Africa (excluding CG Centres) and,
   b) the rest of the world (excluding CG Centres), and,

2. those originally collected in:
   a) other countries in SSA, and
   b) the rest of the world,
   accessed through CG Centres by Kenya and Uganda (excluding CG Centres).

We conducted analyses of 1 and 2 with respect to three different combinations of material:

i) all of the collections of all of the crops held by the CG Centres
ii) each of four crops (sorghum, pigeon pea, finger millet, groundnut) and tropical forages considered separately.[16]

We focused primarily on the crop specific data.

[15] For example, we did not count transfers of bananas originally collected in Latin American countries but held in the IITA genebank in Uganda as counting as transfers of germplasm from Uganda.
[16] For data on these crops we looked at transfers from CIAT, ILRI and ICRISAT.

For each crop, we generated three separate tables for 1) transfers of unique accessions, 2) transfers of samples of those accessions (because there are often repeat requests for the same accession), and 3) the rates of 'intensity' of exchanges (expressed as a function of the number of samples distributed divided by the number of accessions). Also included are details about the number of accessions from the country, region or world that are included in the collection concerned. In addition, we traced the transfers to Kenya and Uganda to the recipient institutions. We also obtained more generic data on whether or not the recipients of material originally collected from the two countries were public organizations, farmers or private organizations. The three tables generated for the ICRISAT ground nut collection are provided here by way of example.

ICRISATGN - Groundnut Collection

Accession

	K & U	SSA	World	Holding
K & U	108	147	208	300
SSA	283	1323	3240	4510
World	213	4737	8479	10908

Samples

	K & U	SSA	World	Holding
K & U	109	200	1384	300
SSA	305	1721	13529	4510
World	252	6560	48112	10908

Intensity

	K & U	SSA	World
K & U	1	1.4	6.7
SSA	1.1	1.3	4.2
World	1.2	1.4	5.7

The data for each crop generated in this way tells a slightly different story. Our interpretation, crop-by-crop is set out below.

2.4. Concerning data supplied by ICRISAT

The ICRISAT data complements the SINGER data in as much as it reconfirms data about numbers of transfers held in its collections to Uganda and Kenya from the rest of the world, and transfers from its collections to the rest of the world of materials originally collected from those two countries. More importantly, the ICRISAT data includes details about:
a) the purposes for which Kenya and Uganda sought the material they received;
b) whether the materials they received were landraces, advanced cultivars or breeding materials;
c) the comparative level of diversity of the materials that Uganda and Kenya were able to obtain from other countries (relative to their own materials);
d) how ICRISAT added value to the collections to which Kenya and Uganda have access through identifying materials with valuable traits (including details on the relative importance of materials from Kenya and Uganda vis-à-vis that from other countries), and
e) introductions into Kenya and Uganda of improved materials created by ICRISAT.

2.5. Concerning INIBAP data

INIBAP data includes details of 1) introductions through its International Transfer Centre (ITC) of banana landraces, hybrids and wild relatives from around the world into Uganda, and b) the distribution of Ugandan banana varieties to the rest of the world.

3. Data analysis

3.1. The big picture

Over the course of twenty years, from approximately 1974 -- 2001, Kenya and Uganda together received, from all of the CG genebanks, a total of 12,000 unique accessions that were originally collected from other countries. During the same period of time, the CG genebanks distributed 4,000 unique accessions originally collected in Kenya and Uganda to other countries in the world. Kenya and Uganda therefore gained access to 300% more accessions than they distributed. As our subsequent analysis on a crop-by-crop basis below makes clear, the data requires a much closer reading than simply comparing raw data on the number of exchanges between the two countries (together or separately) and the rest of the world. Nonetheless, the 300% figure provides a convenient starting point for our analysis.

To Kenya

To Uganda

Collection name	Accessions
ICRISATPP - Pigeonpea Collection	2813
ICRISATSO - Sorghum Collection	1644
ICRISATFM - Finger millet Collection	1484
ILRI - Genetic resources collection	974
IRRI - Oryza sativa Collection	511
CIAT - Tropical forages collection	391
CIAT - Bean collection	265
ICRISATPrM - Proso millet Collection	163
ICRISATFxM - Foxtail millet Collection	162
ICRISATPM - Pearl Millet Collection	137
ICRISATGN - Groundnut Collection	118
ICRISATCP - Chickpea Collection	73
IRRI - Wild rice Collection	60
ICRISATBM - Barnyard millet Collection	20
CIP - Potato collection	20
CIAT - Cassava collection	17

Collection name	Accessions
ICRISATSO – Sorghum Collection	2315
ICRISATPP – Pigeonpea Collection	1666
CIAT - Bean collection	1388
ICRISATGN – Groundnut Collection	439
ILRI - Genetic resources collection	394
ICRISATFM - Finger millet Collection	299
ICRISATBM - Barnyard millet Collection	100
ICRISATFxM – Foxtail millet Collection	100
ICRISATKM - Kodo millet Collection	100
ICRISATLM - Little millet Collection	100
ICRISATPrM - Proso millet Collection	100
CIAT - Tropical forages collection	56
IRRI - Oryza sativa Collection	5
CIP - Potato collection	3
IPGRI-INIBAP Transit Center Banana and Plantains	154

3.2. Crop-by-crop analysis

3.2.1 Groundnut (ICRISAT)

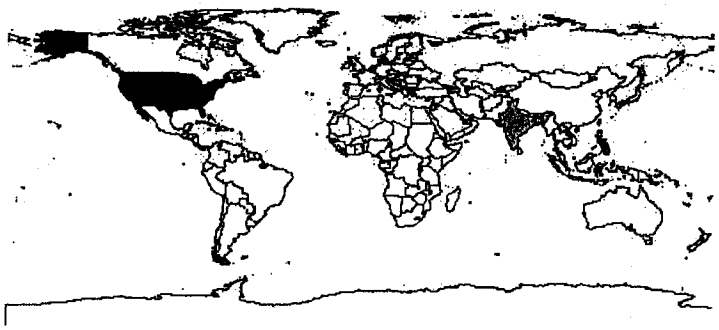
We will start with groundnut, given that the relevant tables are set out in Section 2 above, and can assist in demonstrating our analysis.

Over approximately 20 years Kenya and Uganda asked for 108 unique accessions of material that had originally been collected within their borders. Over the same period of time, they accessed 283 accessions from other countries in the subregion, and an additional 213 from sources outside the subregion (for a total of 496 accessions from

other countries). In total, 82% of the unique accessions the two countries sought came from other countries, with about 60% (of that 82%) coming from within the subregion.

Conversely, holdings originally from Kenya and Uganda represented only 10% of the total amount transferred among other countries in SSA, and only 1.7% of the amount of the groundnut germplasm transferred globally through the ICRISAT genebank. In short, it is not unreasonable to state that 'the world' would hardly notice if Kenya and Uganda took their combined 1.7% 'off the open market'. Kenya and Uganda, however, would suffer considerably if they could not get access to materials in the subregion and around the globe.

Sources of unique accessions of groundnut from the world (including SSA) to SSA



All of the material going to Kenya and Uganda went to a combination of just 10 public research stations and universities.

3.2.2. Finger millet (ICRISAT)

80% of the finger millet accessions requested by Kenya and Uganda from the ICRISAT genebank came from other countries. Conversely, 20% of the material distributed to other countries in SSA and 20% of the material distributed to countries in the rest of the world (beyond SSA) came from Kenya and Uganda.

For the purposes of comparing the groundnut and finger millet results, it is important to take into account the fact that South America is the centre of diversity for groundnuts and that East Africa is the centre of diversity for finger millet.[17] This fact is reflected in part in the number of accessions of Kenyan and Ugandan origin in the ICRISAT genebank: just 308 accessions of groundnut and 1375 accession of finger millet. It also accounts for the higher proportion of reliance of both SSA and the rest of the world on Kenyan and Ugandan finger millet (both 20%) than on Kenyan and Ugandan groundnut (10% for the SSA; 1.7% for the rest of the world). But even in the case of a crop that has its centre of diversity in East Africa, Kenya and Uganda are disproportionately more reliant (four times) on material from the region and the rest of the world, than *vice versa*.

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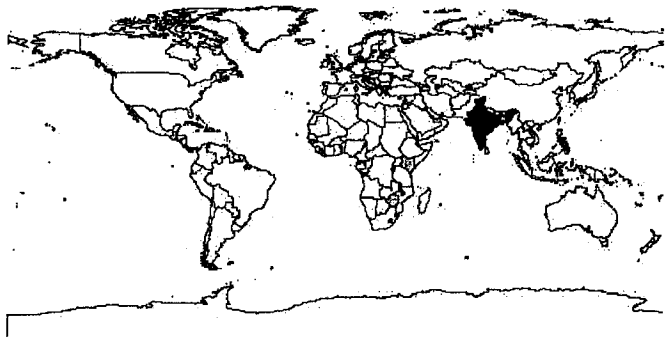
[17] FAO. 1998. *The State of the World's Plant Genetic Resources for Food and Agriculture,*

It is interesting to note that 69% of the material requested by the SSA was originally collected within SSA, a pattern of access and distribution which is reflected in the following diagram.

Unique finger millet accessions from the world (including SSA) to SSA

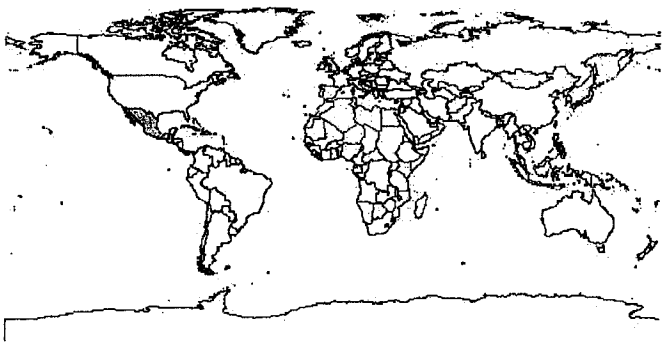


All of the material going to Kenya and Uganda went to a combination of just 5 public research stations and universities.

3.2.3. Beans (Phaseolus) (CIAT)

Not surprisingly, the data on *phaseolus*, which has its centre of diversity in South America (and a secondary centre of diversity in southern Africa), is very different again, from that concerning finger millet. Holdings of accessions from Kenya and Uganda is very small (165), constituting just .5% of CIAT's *phaseolus* collection. 96% of the *phaseolus* accessions to Kenya and Uganda from CIAT's genebank were from other countries: 17% coming from other countries in the region, and 79% from countries outside SSA. The recipients in Kenya and Uganda were just four public sector research stations.

Sources of bean requested by Uganda and Kenya from CIAT genebank



3.2.4. Pigeon Pea (ICRISAT)

85% of the pigeon pea from ICRISAT to Kenya and Uganda came from other countries: 40% from SSA and 45% from the rest of the world. Despite the fact that the centre of origin is East Africa, the number of holdings in the ICRISAT genebank from Uganda and Kenya is quite small: 421 out a total of 13632.

All Ugandan and Kenyan requests for accessions came from 14 public research institutions, universities, and/or charities.

3.2.5. Sorghum (ICRISAT)

97% of the accessions requested by Kenya and Uganda of sorghum were originally collected in other countries.

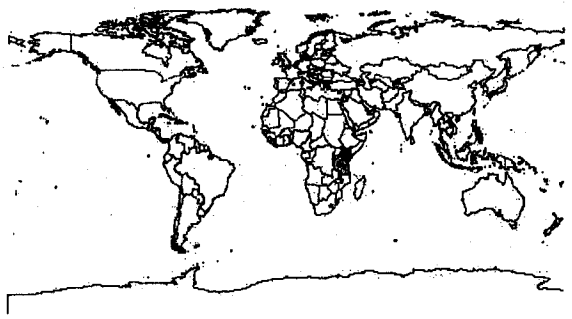
One of the most interesting aspects in the case of sorghum is the degree to which the SSA region relies upon its own materials (76%) and serves as the main source of accessions for Kenya and Uganda (74%) (in both cases, as requested through the ICRISAT genebank). Accessions originally collected from SSA constitute 65% of the unique sorghum accessions held in the ICRISAT genebank.

Twelve public sector research organizations, charities requested the materials.

3.2.5. Tropical Forages (CIAT) and Genetic Resources collection (forages) (ILRI)

80% of the accessions requested by Kenya and Uganda from the CIAT tropical forages collection are from other countries, with 47% coming from outside the subregion, mostly from South America (see the map below). Conversely, accessions originally collected from Kenya and Uganda constituted only 2.5% of the accessions that were distributed around the world from the CIAT tropical forages collection.

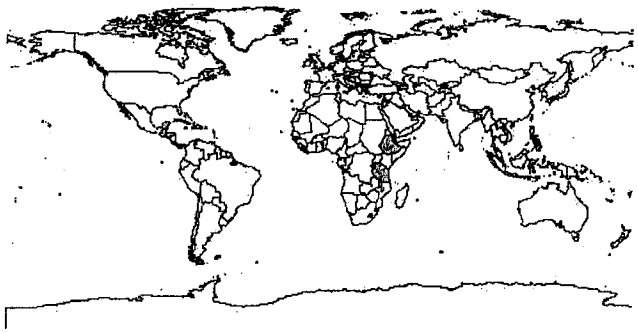
Sources of tropical forages requested by Uganda and Kenya from CIAT genebank



98% of the accessions requested by Kenya and Uganda from the ILRI genetic resources collection (forages) were from other countries, as shown on the map below. Conversely, accessions originally collected from Kenya and Uganda constituted only 2% of the

accessions that were distributed around the world from the ILRI genetic resources collection.

Sources of forages requested by Uganda and Kenya from ILRI genebank



3.3. *Deepening the analysis based on improvements and uses of materials*

In the previous section of the paper, we focused on a quantitative analysis of the degree of use of unique accessions of materials in CG Centre's genebanks (particularly those of ICRISAT, CIAT and ILRI). In this section, we will deepen our analysis of uses of material from ICRISAT which account for some of the largest transfers of accessions from CG Centres to both Kenya and Uganda. Here we will focus on Kenya's and Uganda's access to value added/improved materials. Obviously, access to value added and improved materials is more valuable to Kenya and Uganda than unevaluated landraces, so this is important information when assessing the overall value of the system of facilitated access in which the two countries are participating.

We broaden our focus in this section to include a few additional crops for which data was made available by colleagues at ICRISAT.

3.3.1. Access to improved material

Perhaps most significantly, over the course of the last twenty years, 20% of the sorghum, 23% of the pigeonpea, 30% of the groundnut requested by Kenya and Uganda from ICRISAT was breeding material. In addition they requested approximately 280 advanced cultivars of the same crops. Further details are provided in the following table.

Types in exotic germplasm supplied to Kenya and Uganda - 1974 to Aug 2004

Crop	Landrace	Advanced cultivar	Breeding material	Wild	Total
Sorghum	10536	45	2719	61	13361
Pearl millet	687	4	25	1	717
Chickpea	35	25	23		83
Pigeonpea	3703	102	1144		4949

Groundnut	256	134	163	4	557
Finger millet	3959	240	43		4242
Foxtail millet	262				262
Proso millet	267				267
Little millet	100				100
Kodo millet	100				100
Barnyard millet	120				120
Total	**20025 (80.9%)**	**550 (2.2%)**	**4117 (16.6%)**	**66 (0.27%)**	**24758**

Figures in parentheses refer to proportion of each type.

3.3.2. Access to more diverse materials

One of the values of the materials requested by Kenya and Uganda from ICRISAT was that they were, in general, significantly more diverse with respect to the expression of a number of key characteristics than the materials that had originally been collected in Kenya and Uganda, as demonstrated in the following two tables.

Traits with higher diversity[1] in supplied samples than present in native accessions and in entire collection – Kenya

Crop	No of Traits studied		No of traits in supplied accessions superior to			
			Native collection		Entire collection	
	Qualitative	Quantitative	Qualitative	Quantitative	Qualitative	Quantitative
Sorghum	11	10	7	7	4	9
Pearl millet	10	12	9	6	6	8
Groundnut	18	25	13	19	10	6
Pigeonpea	17	16	14	12	14	4
Finger millet	9	14	7	6	3	7
Foxtail millet	10	11	9	11	3	7

1. Assessed using Shanon-Weaver diversity index

Traits with higher diversity[1] in supplied samples than present in native accessions and in entire collection – Uganda

Crop	No of traits studied		No of traits in supplied accessions superior to			
			Native collection		Entire collection	
	Qualitative	Quantitative	Qualitative	Quantitative	Qualitative	Quantitative
Sorghum	11	10	8	4	3	5

Groundnut	18	25	12	6	6	3
Pigeonpea	16	16	12	6	12	1
Finger millet	9	14	7	2	4	4

1. Assessed using Shanon-Weaver diversity index

3.3.3. Access to 'promising' accessions, disproportionately collected from other countries

ICRISAT has screened tens of thousands of its accessions of sorghum, pearl millet, pigeonpea and groundnut accessions for reactions to biotic and abiotic stresses, disease and pest resistance and protein levels. On average, only 7% of the promising accessions were originally collected from Uganda or Kenya. Uganda and Kenya have access to all of the other 93% of the materials collected from other parts of the world that ICRISAT has identified as promising. For more details, see the following table.

Summary of cultivated germplasm evaluation of ICRISAT mandate crops for biotic and abiotic stresses and quality analysis and extent of native and exotic promising accessions

Crop	Constraint (in order of importance)	*No. of accessions screened*	*Promising accessions*	*Kenya origin accn.*	*Uganda origin accn.*	*% Exotic Kenya*	*% Exotic Uganda*
Sorghum	Biotic stresses						
	Diseases						
	Grain mold	8008	31	1	-	96.8	-
	Anthracnose	6925	76	4	5	94.7	93.4
	Rust	7078	61	3	6	95.1	90.2
	Leaf blight	8478	92	-	6	-	93.5
	Striga	7388	254	1	8	99.6	96.8
	Pests						
	Shoot fly	16888	844	6	32	99.3	96.2
	Stem borer	19112	1352	105	116	92.2	91.4
	Midge	11096	121	1	10	99.2	91.7
	Headbug	5122	62	-	1	-	-
	Quality analysis						
	Seed Protein[1]	10937	1030	31	13	97	98.7
	Lysine[2]	9918	201	31	8	84.6	96
Pearl millet	Biotic stresses						
	Diseases						
	Downy mildew	4727	54	10	5	81.5	90.7
	Rust	2229	332	1	2	81.5	99.4
	Quality analysis						
	Seed protein[3]	1266	94	-	17	-	82
Pigeonpea	*Biotic stresses*						

	Diseases						
	Wilt	2494	210	8	-	96.2	-
	Sterility Mosaic	5883	527	16	-	96.7	-
	Phytophthora blight	2738	73	1	-	98.64	-
	Quality analysis						
	Seed protein[4]	12105	175	-	-	-	-
Groundnut	Biotic stresses						
	Diseases						
	Early leaf spot	13840	1	-	1	-	-
	Late leaf spot	8571	40	-	1	-	97.5
	Rosette virus	13794	136	-	2	-	98.5
	Rust	8577	22	-	2	-	90.9
	Pests						
	Jassids	139	49	-	1	-	98
	Quality analysis						
	Seed protein[6]	5501	108	1	5	-	99.1
	Oil[7]	7989	390	2	5	-	99.5

1. Protein values above 12% are considered as promising.
2. Lysine% 3 and above is considered as promising.
3. Protein values above 15% are considered as promising.
4. Protein values above 26% are considered as promising.
5. Protein values above 25% are considered as promising.
6. Protein values above 30% are considered as promising.
7. Oil values 48 and above are considered as promising.

3.3.4. Conclusions regarding improved materials

The ICRISAT genebank holds 5077 accessions of eight crops originated from Kenya and Uganda. These accessions have been assembled from various donors from national programs, international centers, and through joint collection trips. About 90% of these accessions belong to landrace category. About 17810 exotic and native accessions of 88 countries for 11 crops (sorghum, pearl millet, groundnut, pigeonpea, chickpea, finger millet, foxtail millet, proso millet, little millet, kodo millet and barnyard millet) have been distributed to Kenya and Uganda. The proportion of exotic accessions supplied to Kenya was 87% and 97% to Uganda. An analysis of mean, variance, range, and diversity analysis by Shannon-Weaver diversity index in the supplied accessions of 11 crops revealed that the values for various agronomic traits in the exotic accessions were much higher for the supplied accessions to these countries, compared to the native accessions. Value addition has been achieved for the native accessions of Kenya and Uganda origin by extensive screening for various biotic stresses, agronomic traits, and nutritive value, and promising accessions of Kenya and Uganda origin have been identified. The percentage of exotic accessions with resistances to various biotic constraints far exceeded the samples distributed to Kenya and Uganda, compared to the native accessions. Kenya

and Uganda have benefited by the release of new cultivars of sorghum, pearl millet , pigeonpea, chickpea, and groundnuts.

3.4 Bananas in Uganda[18]

The Uganda national banana program started in 1989 with a launch of collecting activities for local varieties for a national collection. The program started in response to the spread of diseases in the country in 1960s and 70s and a concomitant reduction in diversity. Early evaluation confirmed that many of the Ugandan varieties were low in resistance to local diseases. As a result it was decided to engage in a program of introductions of materials from outside Uganda. By 1990s new material started coming in. The INIBAP transit Center acts as the germplasm exchange platform for Bananas & plantains to guarantee the exchange of healthy germplasm (virus-free) and avoid the dissemination of disease in producing countries. The data we present in this paper are from INIBAP's International Transit Centre (ITC), starting from 1992. Since 1992, the ITC has distributed four unique accessions (= 50 plantlets) of Ugandan farmer varieties to other countries. During the same period of time, Uganda has received through ITC 23 hybrids (=105 plantlets), 108 farmers varieties (= 606 plantlets), and 23 wild species (185 plantlets). This material was coming from 21 donor countries (see hereunder table)

The material received from ITC was multiplied by the National Agricultural Research Organization (NARO) for dissemination within the country to national research programs or to farmers. Between 1999 and 2003, NARO distributed 8194 plantlets of non Uganda farmer's varieties and 28137 plantlets of improved varieties provided by the breeding programs.

A farmers'variety issued from Zaire seems to be very popular according to the level of request in certain districts. The reason is because this is a multipurpose cultivated variety (juice, dessert and cooking type). Its suckering ability is very high and it is a hardy plant i.e. can survive in poor conditions, hence the popularity. Since the 1980's, this variety became well known for its resistance against the 'Black Sigatoka' disease.

The hybrids coming from Honduras are often requested in the banana beer producing districts (e.g Kasese, Kabarole, Kibale).because, beside their good performance in disease resistance and yields, they are used to produce juice and beer for sale.

Table: Donor countries of the germplasm sent to Uganda by ITC:

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[18]With respect to this section in particular, we want to acknowledge the contributions of Elizabeth Arnaud, IPGRI-INIBAP, Montpellier; Dr. Deborah Karamura, INIBAP-Barnesa office, Kampala; Ines Van den houwe, IPGRI-INIBAP Transit Center, Leuven; Kepha, NARO-KARI, Kawanda; David Talengera, IITA-ESARC, Dept of Crop Science. Much of the data supplied was not integrated into this first draft of the paper.

Donor Country/origin	Farmer's variety	Improved varieties	Wild species
Australia	125		70
Austria	5		
Belgium	5		10
Brazil	20	15	
Burundi	15		
Cameroon	0	5	
Colombia	15		
Comoros	5		
Costa Rica	30		20
Cote d'Ivoire	5		
Cuba	20		
Guadeloupe	225		20
Gabon	15		
Honduras	75	35	15
Malaysia	5		
Nigeria	15	45	5
Philippines	10		
Sri Lanka	10		
Tanzania	25		
Thailand	30		
Taiwan	0	15	

Data extracted from the *Musa* Germplasm Information system (MGIS).

4. Summary and Conclusions

The analysis demonstrates that Kenya and Uganda have both gained access to an extraordinary range of accessions from both SSA and the rest of the world by participating in the relatively open system of facilitated access in which the CG Centres *ex situ* collections are located. Whether or not Kenya and Uganda are actually the centre of diversity of the crop in question, their proportionate gain in access to accessions of that crop far outstripped the region's, or the rest of the world's gain as a result of their participation in the open system. This result is not deep and mysterious; it reflects the logic of participation in a multilateral system, where through contributing ones' own resources into a common pot, one gains access to the resources of all of the other contributors.

The analysis also demonstrates that these benefits are not hypothetical. For each crop examined, over the course of the last 20 years, Kenya and Uganda have actively sought out accessions originally collected from other countries held at the ILRI, CIAT, ICRISAT, INIBAP and IITA/ESARC genebanks in numbers that far outstripped accessions from their own countries: on average, seeking 500% more materials from other countries than from themselves. The analysis also demonstrates that as a result of the relatively open and facilitated regulatory environment within which the CG Centres

operated during the times under consideration, Kenya and Uganda were able to get access to a significant proportion of improved materials, either by virtue of their having been evaluated and identified as having particularly useful traits, or as breeding lines, or new cultivars.

Overlaying systems of bilateral access or intellectual property rights that add conditions that need to be considered on a case-by-case basis before providing access to those materials has the potential to have negative impacts on these patterns of exchange.

We would like to conclude with the following observation. On average, despite the fact that through the CG genebanks, Kenya's and Uganda's access to unique accessions sometimes multiplies exponentially, their demand for materials from outside their country tends to maximize at approximately 500% that of materials originally collected from their own countries. The reason for this does not appear to be lack of interest in the materials. Instead, it appears to be linked to an inability to absorb and use any additional material. On average, only approximately five organizations from within each of the two countries were requesting the accessions analyzed. We would argue that there is no question that facilitated access to PGRFA through multilateral means is proven to be worthwhile. The next logical question concerns what can be done to boost the capacity of developing countries to take even better advantage of such a system.