ISSD Africa

Access and Benefit Sharing policies for climate resilient seed systems

Matching global commitments with national realities

Synthesis paper

12 September 2016

Contents

1. Introduction to the theme of matching global commitments with national realities

Several African countries have made commitments to international agreements and protocols that directly or indirectly affect their agricultural sector, including its key building blocks: seed and germplasm. A key question in this respect is: how can governments implement their international commitments in ways that foster a viable and pluralistic seed sector?

Many of the international commitments countries make (through bilateral, regional or global agreements) in the areas of economic development, trade, environmental conservation, intellectual property and climate change, pursue high level policy objectives without any explicit consideration of the contributions that different seed systems can make in providing farmers' access to quality seed. This is normal, given the high-level orientation of most of those agreements. However, it can happen that in the pursuit of their otherwise laudable objectives – e.g., economic development, consumer protection, promotion of innovation through securing property rights – they can also have inadvertent negative effects on the day-to-day functioning of seed systems, including formal, informal and mixed formal/informal (i.e. intermediary) seed systems (see Box 1). Consequently, one very important focus of Theme 3 was to identify flexibilities for countries to implement their existing international obligations in ways that support the practices and realities of the actors operating in the various seed systems, with a particular emphasis on farmers and their access to quality seed/reproductive materials.

Box 1: Multiple seed systems

> ISSD acknowledges the coexistence of multiple seed systems in any country, which all play their role in providing farmers with seed. The diversity of seed systems in African countries can be generalized into three clusters: informal seed systems; formal seed systems; and intermediary systems with facilitated loose or temporary linkages to the formal system. Examples of informal seed systems are the various forms of farm-saved seed use and exchange. Formal seed systems include public and private seed companies, which may operate at national and at international levels. Relief seed, community-based seed systems and market-oriented local seed businesses operate in the intermediary cluster. By recognizing that each seed system has its own benefits and limitations, and requires an unique approach in strengthening it, ISSD aims to foster pluralism and guide national policymaking in its design to strengthen multiple seed systems.

At the same time, countries in the region can benefit from increased awareness of the potential benefits from integrated seed system development in the context of their negotiations of future international agreements, to ensure that they include the 'policy space' and support for integrated seed sector development from the very beginning. To this end, the project has identified opportunities to encourage the adoption and implementation of policies that support a dynamic seed sector which integrates and takes advantage of multiple seed systems. This means policies that foster pluralism and build upon the recognition of the importance of the diversity of seeds systems on the ground, including informal and intermediary seed systems. For the purposes of this paper, 'policies' covers the whole spectrum of policies, laws, legislation, regulations, executive orders, administrative guidelines, and publicly funded programs and projects.

Our main hypothesis is that by cultivating an enabling policy environment for innovation and the coexistence of different seed systems, a wider range of farmers and seed entrepreneurs will benefit, enhancing farmers' access to quality seed of both improved and local varieties. An increased access to quality seed of varieties most preferred by farmers will support food and nutrition security, economic empowerment and development.

The ISSD approach has evolved as a response to the predominant and exclusive focus on formal seed systems in seed sector development policies, which operate with a linear perspective expecting that informal seed systems will gradually evolve into formal and commercial systems. Despite all past public and private efforts in seed sector development, informal or farmer-managed seed systems continue to dominate in most African countries, supplying more than 80% of the total food crop seed used by farmers (Louwaars et al, 2013). Smallholder farmers in particular rely on farmer-saved seed for many crops since seed is simply not available (or affordable) through other sources. Smallholder farms, when defined as being two hectares or less, represent 80% of all farms and are responsible for the bulk of food production in Sub-Saharan Africa, in some countries contributing up to 90% (Wiggins 2009).

ISSD aims to look for opportunities to strengthen the various seed systems through an integrated approach to seed sector development. So instead of an exclusive focus and support for the linear formal seed sector value chain (Figure 1), ISSD recognizes the co-existence and importance of the informal seed systems (Figure 2) and looks for opportunities to strengthen them both by identifying and supporting integrations that build on each system's strengths and opportunities (Figure 3; Figures reproduced from Louwaars and De Boef, 2012). A key question in this regard is: do the policy frameworks in countries allow for these integrations and how they can be supported?

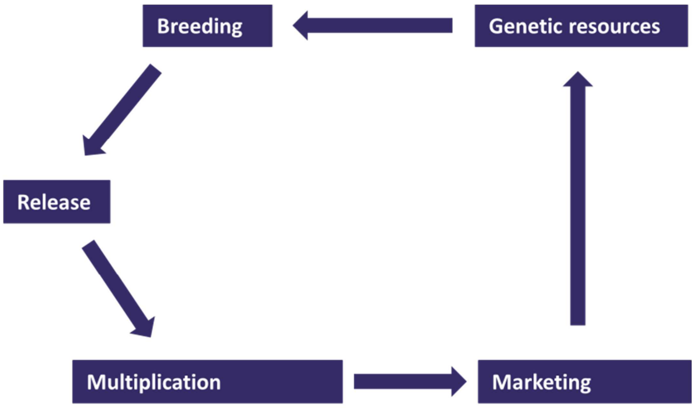

Figure 1: Formal seed systems

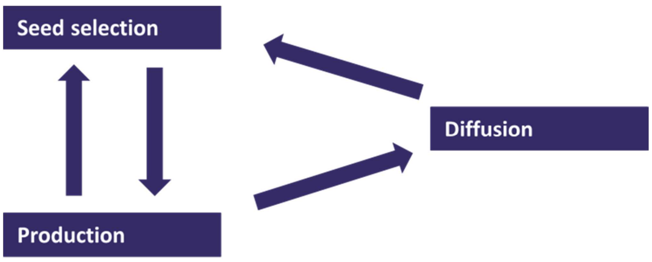

Figure 2: Informal seed systems

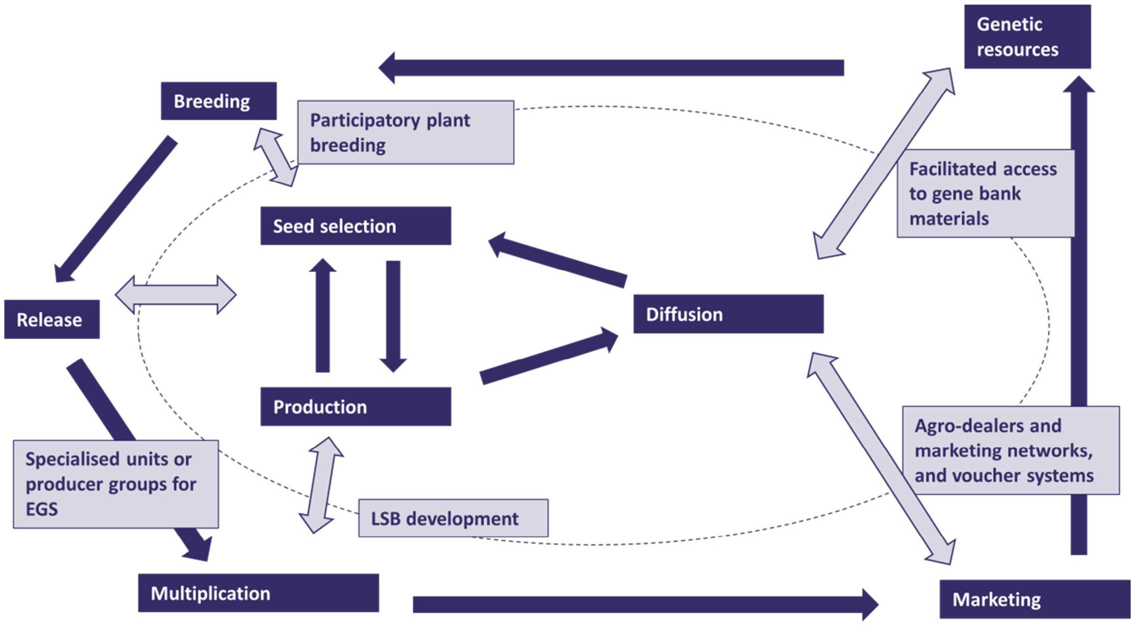

Figure 3: Interactions between formal and informal seed systems

It is against this background that the ISSD Africa thematic working group 3 started to discuss the various international agreements that African countries are involved in and which impact their national policies in relation to seed and farmer livelihoods. After several discussion and meetings, the following three Action Learning Questions (ALQs) were selected for analysis during the 24-months piloting phase:[1]

1. *How can national and regional seed laws support the development of a robust, integrated seed sector that supports smallholder farmers' needs?*

2. *How can room be created for informal and intermediary seed systems in a UPOV '91 informed Plant Variety Protection system?*

3. *How can Access and Benefit-Sharing policies make valuable contributions to seed systems that promote farmers' resilience to climate change?*

This paper presents the synthesis of ALQ 3 describing the background to the topic/challenge of ABS, the activities undertaken and rationale, the main outcomes and lessons learned, and possible next steps to focus on.

2. Background to the topic of Access and Benefit Sharing

The International Panel on Climate Change (IPPC) estimates that that the global mean temperature will increase between 1.4 to 5.8 degrees centigrade between 1990 and 2100, and that precipitation patterns will change considerably across the globe (IPPC 2014). Broad scale modelling studies predict that these changes will have deleterious impacts on the productivity of a number of crops in Sub Saharan Africa (Lobell et al, 2015; others). One frequently mentioned strategy for adapting to climate changes is to exploit genetic sources of resistance to the abiotic and biotic stresses that attend climate changes (IPPC 2014). Both inter and intra crop genetic diversity is useful for climate change adaptation. Farmers may adapt by switching to crops that are more resilient under the current and predicted conditions (e.g., from maize to millets under rain-stressed areas) or using better adapted varieties of the same crops through

[1] See TWG 3 Scoping Paper for more information. Given the available time and resources for this 2-year inception phase, the group had to make some strategic decisions on what issues to focus on and which to leave aside for now.

farmer selection, or formal sector crop improvement programs. In all cases, access to quality and diverse seed/reproductive materials important for enhancing and improving crop productivity and food security.

As climates migrate across the globe, many countries future climates will be similar to other countries' current climates (Jarvis et al, 2015). It is likely therefore that plant populations that have been developed/adapted in some parts of the world will possess traits that are adapted to future climate conditions in other parts of the world. Countries are already extremely interdependent on plant genetic resources for food and agriculture (Palacios 1997; Khoury 2016). It is predicted that climate change will make countries even more interdependent (Fujisaka et al, 2013), with the concomitant need to access and exchange ever higher numbers of genetic resources across international borders.

In recent years, the international community has negotiated international laws related to the conservation and sustainable use of genetic resources, and to accessing those genetic resources and sharing benefits associated with their use. These include the Convention on Biological Diversity (CBD), the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), and the Nagoya Protocol (to the CBD) concerning access and benefit sharing. In theory, these agreements should provide useful policy support for the exchange and use of genetic resources as part of countries climate change adaptation strategies.

This study analyses what is actually happening at the national and subnational levels in terms of climate change, its impacts on particular crops, what experiences countries have had to date in terms of accessing, using and sharing benefits derived from genetic resources for climate change adaptation, and what kinds of ABS policy initiatives or reforms could help those countries to make better use of genetic diversity for climate change adaptation in the future. This study is designed to analyze how these different 'threads' come together at national and subnational level in a few countries, at higher levels of granularity than is possible with the global modelling referred to above. From an ISSD Africa perspective, this information is critical to identifying potential future interventions at a regional or sub-regional level, to make farmer seed system more climate resilient.

3. Activities undertaken

The research was conducted by four individual country case study teams from Rwanda, Uganda, Zimbabwe and Zambia. The researchers followed common terms of reference, which were developed in consultation with them. In short, each country team agreed to:

b. Identify climate changes in their country, and existing and possible future impacts on cropping systems;
c. Review programs to respond to climate changes (diversification, breeding, etc.);
d. Look at past, current and future predicted germplasm flows within, into and out of countries, noting, where possible if those flows are associated with climate change adaptation strategies;
e. Select two communities within each country for in depth, participatory research and training to identify: local climate changes, impacts on local crops, potentially adapted germplasm (suited to the changing climate) that is currently hosted in the national gene bank of the country concerned, and also from collections outside the country, including those hosted by CGIAR centers, USDA and European national gene banks (for which accession level information is available in a publicly accessible databank Genesys). More details concerning the methodology for these exercises are included below;
f. Analyze the state of ABS policies and evidence of their influence on germplasm flow and benefit sharing; and
g. Propose ways forward to implement the global ABS agreements so that they can support climate resilient seed systems.

Early versions of the four papers were presented at national and international meetings of interested stakeholders and experts in Addis Ababa in November 2015, South Africa in March 2016; Zambia in April 2016 and Uganda in May 2016. The papers were subsequently revised based on comments received. The lead researchers/authors from the four country teams and the ISSD Africa Theme 3 facilitator met together in November 2015 to discuss cross-cutting themes, lessons learned, insights, recommendations based on a comparative analysis of the four papers. The four individual country studies will be published on the ISSD website, along with this synthesis paper.

4. Outcomes and lessons learned

1. *Climates are changing, and these changes are negatively effecting key food security crops in Uganda, Rwanda, Zambia and Zimbabwe*

All of the four countries – and all of the eight case study communities within those four countries – are already experiencing climate changes. Consistent with the global and regional level information and forecasts, the four countries' minimum temperatures have been increasing, and most importantly, at least for now, the seasonal rains – which define/characterize cropping seasons – are increasingly irregular and unpredictable. The result has been shortened growing seasons, longer periods of drought, harsher rain storms, and in some areas, reduction from two growing seasons per year down to one growing season as the seasonal rains 'merge' the previously distinct growing seasons. When the seasonal rains appear to start normally, farmers' plant their crops. However, with the rains suddenly stop within the first few days of planting, most of the germinating seeds die off. By that time, the farmers' seed reserves are used-up, and, if they existed, the government's store stores are also often depleted. In other cases, the droughts hit mid-way into the growing season before any harvest can be made. Both scenarios, with the common denominator of irregular, unpredictable rain, lead to total crop failure and serious consequences for the farmer. Worldclim data[2] confirms that temperatures will rise in each of the communities between now and 2050. Overall, annual precipitation will increase in some of the communities, and decrease in others during the same period. More data concerning the climate changes in each of the eight communities, and the impacts of those changes on food security crops grown by farmers in those communities, are included in Annex 1.

2. *Countries are embracing (inter and intra specific) crop diversification as a means to adapt to climate changes. Crop diversification depends upon accessibility, availability and use of inter and intro specific crop genetic diversity from local, national and international sources*

In each of the countries, national agricultural research organizations, in partnership with international and regional research organizations (and sometimes with community and civil society organizations) are increasingly engaging in research and development projects which involve taking advantage of genetic diversity – between species and within species – to respond to challenges associated with climate change. These include plant breeding programs looking for genetic sources of resistance to climate change related biotic and abiotic stresses; introduction of new, different species in areas where previously planted crops are no longer performing well (e.g., moving from maize to millets or sorghum); exploring using mixtures of crops and or varieties that are, cumulatively, more resilient to climate shocks, and so on. Most of the projects and programs rely in part on accessing and using genetic resources/crop varieties that either were not present in local agricultural systems (or in the country as a whole), or were present, but underutilized. Details about these projects and programs are provided at length in the four country papers; some examples are also provided below. The four papers do not document farmer-level practices in terms of growing a diversity of varieties and crops as a risk-aversion strategy, but this is already well-documented in the literature.

3. *'Access to genetic resources' and 'access to seed' are overlapping issues, particularly in informal systems of innovation and exchange*

This Action Learning Question focused on issues related to the exchange and use of genetic resources, and to access and benefit sharing laws, particularly the ITPGRFA and the Nagoya Protocol. Farmers'

[2] Worldclim is a set of global climate layers (gridded climate data) with a spatial resolution of about 1 km^2. These data can be used for mapping and spatial modeling found at www.worldclim.org

access to seed and seed laws are addressed in ALQ 1, as set out above. Yet all four national research teams repeatedly raised issues related to farmers access to seed and unfair impacts of seed regulations on farmers ability to access, exchange and sell seed. In this way, the four papers highlighted the fact that the conceptual distinction between genetic resources and seed as separate objects of regulation – ABS laws for genetic resources, and seed laws for seed – is artificial in some contexts. It works when one conceives of ABS laws regulating uses of genetic resources as upstream inputs into formal sector plant breeding and research, and seed laws regulating access to formal sector produced seed. However, in informal seed systems, where farmers select and replant seed, exposing it to human and environmental selection pressures with each generation, the distinction between seed and genetic resources does not make much sense. Farmers use genetic resources as seed and vice versa. Viewed from the perspective of farmers in informal systems, seed laws (if they restrict what can be registered, exchanged, sold, accessed by farmers) can potentially create bottlenecks limiting farmers' roles in climate resilient seed systems. Indeed, all four of the country papers provided examples of how national seed laws were (i) threatening availability (and related exchanges of genetic resources/seeds) at the level of informal local markets, and between farmers; and (ii) undermining the full use of genetically diverse materials used and conserved by farmers at broader national scales.

The four country papers thereby highlighted the importance of looking at the entire length of different seed value chains to see how and where requisite genetic resources/seed can and should be introduced and made available, and where related benefits can be shared. Then, in this broader context, which captures the reality (and diversity) of seed systems, it is useful to analyze the impacts of both ABS and seed regulations (and other potentially relevant policies and regulations) on the use of genetic resources/seed along the various chains.

4. *In some cases, there are adapted, potentially useful materials in farmer seed systems (i.e. farmers' varieties), but they are not available for use. There are impediments to the wider-scale exploitation of those locally adapted varieties*

Community participants from each of the eight sites selected a single crop grown in their community to focus on for the purpose of the project's research, based on the criteria of importance to local food security, and perceived vulnerability to ongoing changes in climate. One of the first exercises in each site was to ask farmers to identify materials/varieties of those crops that they use – or are aware of others using – that perform better than other varieties under the current climate stresses. Some of the varieties that performed well did not represent a mix of the most desirable traits; for example, they performed better than others under drought stress, but they did not taste good. But in some cases, farmers reported that the main bottleneck to their using the materials was the absence of quality seed/planting materials. They also reported that they were encouraged to use other materials introduced by extension agents or companies. The authors of the country papers, and experts that they surveyed, acknowledged that there is inadequate (often none at all) public investment to enhance local varieties and multiply quality seed of those varieties. The four studies also provided examples of other disincentives/ bottlenecks for the development of quality seed of locally adapted varieties including national seed laws that prohibit marketing of farmers' varieties (unless they can satisfy strict registration criteria); lack of recognition of farmers' rights to be compensated in some way for the use of their varieties, and lack of engagement of farmers in identifying priorities for agricultural research and development programs.

5. *The proportion of PGRFA in the countries' national gene banks that is potentially adapted to that countries' changing climates is decreasing over time (as climates change more)*

After working with the farmers to identify potentially useful materials from their local agricultural production systems, the national research teams supported by this project looked for potentially adapted materials in (first) national genebanks, and (second) genebanks outside the countries concerned. To do this research, data concerning past, present and future climates for those eight sites was analyzed alongside passport of collections assembled from within and outside the country and climate suitability data. Through this method, it was possible to identify materials in those collections that are potentially adapted to (i) current climate conditions; and (ii) predicted climate conditions (in 2050), in the community reference sites.

For seven of the eight sites, the number of accessions of the communities' target crops in the respective national gene banks that are potentially adapted to the predicted climate conditions of the reference sites decreased significantly over time, as those climates changed. Details concerning the numbers of accessions in the national gene banks of the target crops for both current and 2050 climate conditions are included in Annex 2. While national gene banks are only one of the sources of genetic diversity that countries can and do access (more about alternative sources is written below), these research outcomes are none the less significant proxy-indicators concerning the extent to which countries are/will be increasingly reliant on genetic diversity from other countries as a result of changing climates (and even less able to rely on diversity which has evolved and been collected from within their own borders).

6. *There is a wide range of material in foreign genebanks that is potentially adapted to the four countries' changing climate conditions. Those materials were originally collected from many different countries and continents. The research confirms that countries are becoming increasingly interdependent on genetic resources as a result of climate change*

For information about potentially adapted materials in PGRFA collections outside the four countries, the research teams relied upon Genesys, an online, publicly accessible database which includes accession level information on all of the international PGRFA collections hosted by the CGIAR centers, national public PGRFA collections of European countries, and collections hosted by the United States Department of Agriculture. No other countries' gene bank accession-level information is included in Genesys (though it is hoped that eventually more countries will include such information in Genesys in the future).[3]

In all cases, the searches led to the identification of much higher numbers of potentially adapted accessions located in collections outside the country (though Genesys) than exist in the national genebank collections. This was the case for both current climate conditions and those predicted in 2050 in the reference sites. Details regarding the numbers of potentially adapted materials identified through this exercise are included in Annex 2.

It is important to underscore that for each crop in each of the eight locations, the potentially adapted materials that were identified in foreign gene banks were originally collected/accessed from a number of different countries, seven on average.[4] For example, the 537 accessions of finger millet that are potentially adapted for use in UMP Zimbabwe under current climate conditions were originally collected from eight different countries. The 331 accessions that are potentially adapted for use under 2050 climate conditions in the same location were originally accessed from seven countries. Annex 2 provides the number of countries from which the potentially adapted materials – for both current and 2050 climate conditions – for all eight sites were originally collected.

Since national PGRFA users will have access to less potentially suitable germplasm from their national gene banks for direct use or deployment in crop improvement programs, they will be increasingly reliant on germplasm obtained from outside their national boundaries for gene-based traits that are adapted to changing climate conditions. Subject to availability of resources, the national genebanks can also respond to this situation by becoming increasingly involved in identifying and obtaining such germplasm with or on behalf of PGRFA users in the future.

7. *There are significant constraints on ability to access, use and share benefits associated with materials in other countries as a result of the lack of on-line accession level documentation (and linked implementation of ITPGRFA and Nagoya Protocol)*

Ideally, our searches for potentially adapted PGRFA would have included collections held by organizations in neighbouring countries with contiguous agroecosystems, and other countries in the world where the same crops are grown, and may have evolved useful traits as a result of the interaction of genomic

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[3] In most cases, the researchers looked for potentially adapted materials originally collected (or improved) from anywhere in the world, including other continents. In one case, Uganda, the searches were confined to materials that were originally collected or improved in East African countries.

[4] Excluding Uganda, since their search was limited to east Africa only, and is therefore not comparable with the other country searches.

recombination, environmental selection, farmer selection and breeding. However, very few such countries publish such information at all, or in a format (or language) that is easy to use from outside the country. The lack of digitalized, published, accession level information about materials that are potentially available in countries represents a very significant constraint to their potential identification and use for climate change adaptation. It makes it impossible through research such as that supported by this project to find out if those organizations or countries (or communities) have potentially adapted materials. It also leads to increased reliance on traditional sources of conserved germplasm, that is, the CGIAR, USDA, and some particularly active European genebanks. Exchanges between countries in developing regions are necessarily limited by the lack of published, accession level information about materials hosted in their countries.

This latter point is closely linked to the state of implementation of the International Treaty on Plant Genetic Resources for Food and Agriculture, and the Convention on Biological Diversity's Nagoya Protocol on access and benefit sharing which will be considered in more detail below. All four countries have ratified both agreements. Ideally, to fully participate in the systems of exchange and benefit sharing that those two agreements support, the countries need to have well documented genetic resources. Otherwise, no one will know enough about what they have to want to access them, either under the ITPGRFA's multilateral system of access and benefit sharing, or via newly negotiated ABS contracts under the framework of the Nagoya Protocol.

Another closely related constraint has to do with climate data. Currently, Worldclim makes data available that can be used for the kinds of predictive, modelling work described above, but only for a limited number of future years, e.g. 2050. More detailed data for all years is available through private (for fee) services. Soil quality data which is also not easily available can and should be factored into this kind of modelling to facilitate more precise identification of potentially adapted materials. The best collections of such data are also subjected to restrictions and fees. A wide range of stakeholders especially in developing countries cannot afford access to this kind of data.

8. *International partnerships and programs are important mechanisms for the exchanges of genetic resources into and out of the four countries for agricultural research and development*

National agricultural research organizations – and some universities and a few companies – in each of the four countries are recipients of considerable quantities of improved lines of food security crops from CGIAR plant breeding programs.

Of the four countries, Zimbabwe has tended to receive the most such germplasm and Rwanda has received the least from the CGIAR centers. Total materials received by recipients in the four countries from 2007 to 2015 are set out below in Table 1. Further details about the numbers of samples of different crops are available in each of the four country papers. The most likely contributing factor to the relative amounts of germplasm countries received from the CGIAR is the size and capacity of the national agricultural research and breeding organizations. Where countries have the plant breeding requisite capacity, they are more likely to cross improved materials from the CGIAR with locally adapted materials with proven, desirable traits. If their breeding capacity is lower, countries will select from among the materials received and those lines that perform best under local conditions.

Table 1: Materials transferred from CGIAR centres to recipients in the four countries using the SMTA under the ITPGRFA, 2007-2015

Country	Number of samples
Rwanda	5,701
Uganda	9,818
Zambia	11,343
Zimbabwe	33,727

One example of a CGIAR crop improvement program that has developed a range of improved lines that have been transferred to the four countries is the Drought Tolerant Maize Project in Africa (DTMA) which is a partnership between CYMMIT, ICARDA and various national agricultural research organizations in 13 African countries[5]. DTMA has developed over 200 new varieties and distributed 27,720 of samples to recipients in these countries, the countries then select potential lines and develop them further through breeding with local maize breeding programs or they select promising lines which they then distribute. Through this project 14 varieties of drought tolerant maize were developed for Zambia, ten for Zimbabwe and six for Uganda. The four country-focused papers provide much more detail about the international projects in which their national agricultural research organizations participate, and through which they receive (and also provide) germplasm and associated knowledge.

The Pan African Bean Research Alliance (PABRA) is another example of a breeder's network which works in conjunction with CIAT and has exchanged varieties and improved lines of beans between 30 countries in sub-Saharan Africa. Uganda, Rwanda Zimbabwe and Zambia are also part of this network. Over 550 varieties of beans have been shared through this network between the 30 member countries.

The primary mechanism by which germplasm originally collected from the four countries is made available internationally is through the CGIAR genebanks. Table 2 shows the numbers of accessions of different crops and forages that were originally collected in the four countries that are currently conserved in international collections hosted by the CGIAR centers. Most of those materials were collected in the 1970s and 1980s. The centers make those materials available upon request under the standard material transfer agreement (SMTA) adopted by the ITPGRFA's Governing Body in 2006, (as they are directed to do by their agreements with the Governing Body that were also finalized in 2006). Organizations within the four countries also occasionally make material available to other countries through crop improvement and genetic resources networks in which they participate.

Table 2: Number of accessions of materials conserved and distributed by CGIAR centres that were originally sourced from the four countries

Country	Number of accessions
Rwanda	1,104
Uganda	6,049
Zambia	6,403
Zimbabwe	9,598

9. *A range of organizations can, and need to, function as intermediaries between farmers and genetic resources collections and formal sector crop improvement programs*

Direct distributions from international and national genebanks and formal sector crop improvement programs directly to farmers operating primarily in informal seed systems are relatively rare. Only approximately 1% of the materials distributed from CGIAR centres' genebanks is distributed directly to farmers (SGRP 2009). This reflects the fact that partnerships between communities and international organizations and NAROs are themselves relatively rare. And it means that farmers and communities are not being engaged as participants in projects to conserve and improve genetic resources. There are a few examples taken from the four country studies of organizations stepping into intermediary roles, linking farmers with gene banks and formal sector breeders. One such example concerns the Community Technology Development Trust (CTDT), an NGO that has been coordinating projects to bring together teams of farmers and national researchers and two CGIAR centers – ICRISAT and CYMMIT – to (i) access and (ii) evaluate on-farm PGR that has been developed by CGIAR breeders that are likely well adapted to niche conditions in the communities concerned. CTDT also works with farming organizations to identify farmers varieties which have been 'lost' by the communities, and works to have it restored from national and national collections. In this way, CTDT has also helped re-introduce lost varieties of millet and sorghum to over 600 farmers in four communities in Zambia and Zimbabwe.

[5] Angola, Benin, Ethiopia, Ghana, Kenya, Malawi, Mali, Mozambique, Nigeria, Tanzania, Uganda, Zambia and Zimbabwe.

Another example concerns the direct partnership of the Ugandan National Gene bank and the Kiziba community seed bank (CSB) established in 2010 in Kabwohe, Western Uganda. The national gene bank has supported the CSB by:

a. Restoring varieties to the community that the community used to have but 'lost';
b. Keeping custody of duplicates of the CSB's collections;
c. Providing technical support for the management /conservation of the materials both in the CSB and in situ and the production of good quality seed; and
d. Contributing indirectly to the protection of indigenous knowledge and farmers' rights by engaging farmers in documentation of their traditional practices and the management of their varieties in the community seed bank.

Today, the community seed bank supports over 900 farmers and in any particular season it will receive over 100 tons of good quality seed for distribution to farmers. As a result there have been exchange visits from other communities and 2 other CSBs have recently been established in two other agro-ecological zones in Uganda.

In the absence of these kinds of initiatives, farming communities' direct access to and participation in formal sector genetic resources conservation, improvement and sustainable use projects is limited. Consequently, their direct access to, and use of, genetic resources and information that might otherwise be available to them is also limited. And formal sector institutions are missing out on chances to benefit from farmer developed populations and knowledge. More proactive partnership building and engagement of farming communities is essential to ensure that genetic resources are being used by the people who need them most.

10. *Most international exchanges with formal sector organizations reported in the paper are under the SMTA which appears to provide a useful basis for exchange, although there is dissatisfaction with the benefit sharing*

Most of the exchanges between international organizations and organizations within the four countries were under the SMTA adopted by the Governing Body of the ITPGRFA. While some of the respondents interviewed expressed concerns that the ITPGRFA system for mandatory financial benefit sharing (through an international benefit sharing fund – see more details below) was not working, they also acknowledgement that exchanges under the ITPGRFA were in fact becoming streamlined, at least between international and national formal sector organizations. Outstanding concerns about unrealized mandatory benefit-sharing from commercial users – either because they are choosing not to access materials from the MLS or because their uses of those materials are not triggering the benefit-sharing formula – are also contributing to disincentives for more proactive national and sub-national implementation of the ITPGRFA in a number of countries.

11. *Very small numbers of exchanges between organizations within the countries, and between countries without international organizations as intermediaries. Little information on informal exchanges is available*

In all four countries, the reported or tracked numbers of exchanges within the countries between different users appears to be relatively small. This may be partly explained by the fact that 'informal exchanges' that take place without the use of MTAs (and the SMTA in particular) tend not to be reported, and many of the parties engaged in such exchanges would not have been contacted as part of the interviews. It may also be accounted for in part by the fact that many domestic organizations are able to obtain materials directly through the CGIAR centers, through regionally coordinated programs, such as those described above, and therefore don't acquire as much material from local sources. It may also be linked to the fact that the ITPGRFA and the Nagoya Protocol are not fully implemented at national levels in any of the four countries, with the result that rules for applying for, and approving access to genetic resources for food and agriculture are not in place. The combination of (i) high level political commitments to the principles in these agreements and (ii) no nationally endorsed systems to implement them, can create disincentives for both access seekers and access providers. The country papers provide examples of situations where approvals from national organizations for access to materials within and between countries have been subject to long delays, partly as a result of the lack of clear rules implementing these agreements.[6]

12. There is inadequate protection of the interests of farmers as providers of resources and TK

In all four countries, the authors highlighted the fact that there were inadequate systems in place to promote/protect the rights of farmers as providers of genetic resources and associated information. Collecting missions often take place in contexts where farmers don't know about their country's undertakings and policy commitments concerning access needing to be subject to farmers' prior informed consent on mutually agreed terms. And in three of the four countries i.e. Zambia, Zimbabwe and Rwanda; there are still not national laws in place that set out the standards and processes that access-seekers need to follow as part of the national strategy for implementing their policy commitments. (Uganda has a law requiring PIC at the community level.) In all four countries, there is inadequate support for strengthening the capacity of farmers and farmer organizations to be able to exercise PIC-related rights. A number of respondents also underscored concerns about the inability of farmers or farmer organizations to monitor uses of materials accessed from farmers to effectively enforce their rights in cases of suspected malfeasance by users. In some cases, farmers have been happy, honoured even, to be asked to provide samples and information about materials they use. In other cases, farmers and community organizations have expressed reluctance.

13. The ITPGRFA and Nagoya Protocol are not self-executing agreements. They need to be proactively implemented. And considerable investment in capacity building is necessary for stakeholders – including farmers – to be able to take advantage of them

The ITPGRFA and Nagoya Protocol are designed to address some of the issues/challenges flagged above. However, their contributions are not being realized since they are not yet being fully being implemented at national levels.

The ITPGRFA's multilateral system of access and benefit sharing is meant to provide an even, predictable, safe basis of exchanges of genetic resources between *all* users at individual farm, organizational, community, to national and international levels. Free facilitated exchange to all the materials – currently 2.3 million accessions – in the multilateral system is meant to be the biggest single benefit associated with the multilateral system. It is also supposed to generate financial benefits (generated by commercial users) to be shared through an international benefit sharing fund to help developing countries increase their capacity to sustainably use and conserve PGRFA.

However, none of the four countries have put systems in place to fully implement the multilateral system of access and benefit sharing.[7] In the absence of clear rules about who can provide materials, who can request materials, and that they should be transferred under the SMTA, some potential exchanges of materials are not taking place. It is necessary for governments to send clear signals to public organizations in the country that they can and should be operating under the ITPGRFA framework, using the SMTA.

It is equally important that national governments send clear signals to all potential users, at all levels, down to farm level, that (i) the multilateral system exists, (ii) it was created for their benefit, and (iii) they should be taking advantage of it. And national governments should be reinforcing that message to providers, so that when they receive requests for access – not only from formal sector organizations, but also from farmers, farmer organizations, community organizations – both from their own country and from other countries, they feel empowered to respond proactively and positively.

[6] That said, some implementation has taken place, with most countries' genebanks having supplied PGRFA on a few occasions under the SMTA in response to requests from international organizations.

[7] Uganda appears to have done the most, having recently developed an MoU between national agencies clarifying which agency is responsible for implementing Nagoya, and which is responsible for implementing the ITPGRFA. This is an important development, given that there is confusion/lack of clarity in many countries about the relative scope of both agreements, and how they should be implemented in mutually supportive ways. Other countries can – and some are – following Uganda's precedents in this regard.

It is also clear that many potential users will need considerable assistance to be able to take advantage of the multilateral system. This was underscored by this project's own research and capacity building activities in the eight communities. It is clearly not enough to inform farmers and community organizations (and many companies, even) about the existence of the multilateral system, and then expect them to use it. The requisite skills and resources can only be brought together through projects that allow farmers in the communities to work together with experts in climate science, in genebank curation, and in plant breeding. National agricultural research organizations, or CSOs acting as their agents, need to be empowered to convene such projects and activities, and to provide the requisite support for all stakeholders to be able to use the multilateral system.

Under the Nagoya Protocol, national governments undertake to promote the rights of indigenous peoples and local communities to exercise control over others' access to their genetic resources and traditional knowledge. However, the Nagoya Protocol is still relatively new, and most countries – including the four countries in this study – have not put policies, laws, administrative systems in place to implement it. Furthermore, as in the case of the ITPGRFA, while putting national and subnational laws and policies in place is a critical first step to implementation, which alone will not be enough for a range of stakeholders in the countries concerned to actually take advantage of the Nagoya Protocol. Considerable additional capacity building and support will be necessary, particularly at the farmer and community level, to raise awareness of PIC and MAT related rights, and to support communities to get organized to collectively exercise those rights.

14. Considerable effort will be required to overcome historical division between formal and informal seed systems, and to integrate them where useful for climate change adaptation

With a few remarkable exceptions, the patterns of germplasm exchange and use, and the partnerships involved in crop variety enhancement and seed multiplication, distribution, and exchange documented in the four papers generally conformed to the traditionally understood separation/division between formal and informal sector seed systems (Louwaars and de Boef, 2012). They also highlighted the inefficiencies and challenges associated with attempting to implement international legal agreements concerning access and benefit sharing (the ITPGRFA and CBD/Nagoya Protocol) and seed harmonization laws that reflect formal sector innovation models in countries where the informal and mixed seed systems are the norm. In many ways, perhaps inadvertently, these international agreements reinforce the distinction and separation of formal and informal seed systems. Our research in the eight communities in the four countries attempted to address this situation, supporting research and development interventions that cut across, and challenged the formal/informal seed sector and genetic resources/seed divides. It demonstrates the importance of being able to work across these divides in the future, to ensure that all actors in seed systems are able to access and use genetic resources/seeds to respond to challenges associated with climate change.

5. Next steps

Based on the four papers and this comparative analysis, the researchers involved in addressing this ALQ recommend developing pilot programs and projects to boost the capacity of national and/or African regional organizations to provide technical backup for stakeholders in their countries/region, to:

a. Implement the ITPGRFA, Nagoya Protocol and national/regional seed laws in mutually supportive, contiguous ways that reflect the reality and diversity of different seed systems, with the objective of ensuring that all actors involved in formal, informal and mixed seed systems – especially farmers – are able to access and use quality reproductive materials (genetic resources/seeds) to adapt to climate changes;
b. Identify, and request materials located locally, nationally, and in collections around the world that are potentially adapted to climate changes in the countries concerned;
c. Seek and obtain access to genetic resources/seeds under existing laws implementing the ITPGRFA, Nagoya Protocol, and regional seed harmonization agreements or in the vacuum that may exist if laws are not in place to implement them.

These efforts could be supported or coordinated at sub regional or regional levels. A regional approach makes sense given the realities of contiguous climates and agro-ecosystems spanning across international borders, and the likelihood that adapted germplasm will be located across each other's borders. Regional level coordination of such capacity building would also help build the shared sense of purpose and trust necessary for actors concerned to be willing to share materials and benefits associated as part of climate change adaptation strategies. Furthermore, given the scarcity of resources to be able to support 'stand-alone' national programs, it could be much more effective to coordinate activities at a sub-regional or regional scale.[8] Regional centers of excellence and regional crop evaluation networks have demonstrated how countries can work together sharing germplasm, sharing evaluation data, etc. These can be built on to regularize systems for regional exchanges. Analyze initiatives within the regional organizations (COMESA, SADC, EAC, AU, and ARIPO) and regional research and development programs (SMIP, DTMA, EAPP, ASARECA, PABRA, Rice networks, Cassava networks) and how they may impact on ABS in countries.

[8] One example of an efficiency that can be achieved at a sub-regional level concerns accessing and using climate and soil data. As stated above, some of the best climate and soil data is privately held, and costs to get access to. Perhaps a regionally organized program could negotiate a preferential PPP to get reduced cost or free access to requisite data for the purposes of a regional 'seeds without borders' programme.

6. References

Fujisaka, S., Williams, D. and Halewood, M. (eds) (2011). The impact of climate change on countries' interdependence on genetic resources for food and agriculture. Background Study No 48, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

IPCC (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R. K. Pachauri and L. A. Meyer (eds)], IPCC, Geneva, Switzerland. Available at: http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap22_FINAL.pdf

Jarvis, A., Upadhyaya, H., Gowda, C. L. L., Aggarwal, P. K., Fujisaka, S. and Anderson, B. (2015). Plant genetic resources for food and agriculture and climate change, in Coping With Climate Change – The Roles of Genetic Resources for Food and Agriculture, FAO, Rome, Italy.

Khoury K., Achikanoy H.A., Bjorkman A.D., Navarro C., Giarino L., Palacios F. X., Engels J.M.M., Wiersema J.H., Dempewolf H., Sotelo S., Ramirez-Villegas J., Castaneda A., Fowler C., Jarvis A., Reiseberg L.H. and Struik P. (2016). Origins of Food crops connect countries worldwide. Proceedings of the Royal Society B Proc. R. Soc. B 2016 283 20160792; DOI 1098/rsbp.2016.0792. Published June 2016.

Louwaars, N.P. and De Boef, W.S. (2012) Integrated Seed Sector Development in Africa: A Conceptual Framework for Creating Coherence Between Practices, Programs, and Policies. Journal of Crop Improvement, 26, 39–59.

Louwaars, N. P., de Boef, W. S. and Edeme, J. (2013). Integrated Seed Sector Development in Africa: A Basis for Seed Policy and Law. Journal of Crop Improvement, 27(2), 186-214.

Palacios, X.F. (1998). Contribution to the estimation of countries' interdependence in the area of plant genetic resources, Rep. 7, Rev. 1, FAO Comm. Genet. Resour. Food Agric. FAO, Rome, Italy.

Wiggins, S. (2009). Can the smallholder farmer model deliver poverty reduction and food security for a rapidly growing population in Africa? Paper for the FAO expert meeting on how to feed the world in 2050, 24-26 June, Rome; Livingston, G., Schonberger, S., & Delaney, S. 2011. Sub-Saharan Africa: The state of smallholders in agriculture. Paper presented at the IFAD conference on new directions for smallholder agriculture, 24-25 January. Rome: IFAD.

Annex 1: Climate related stresses in the study sites

The climate related stresses on key crops each of the eight sites across the four countries.

Country	Site	Crop	Summary climate challenges	Impact of climate challenges on the specific crop	Temperature (2050's) degree Celsius	Precipitation (2050's) mm
Uganda	Hoima	Beans	Shifting growing season, higher temperature erratic rainfall	Loss of diversity, increased pests and diseases, low productivity	+1.5	Increase
	Mbarara	Beans	Shifting growing season, shortening of the rainy season, higher precipitation and prolonged dry spells	Increased incidences of pests and diseases and loss of diversity	+1	Increase
Rwanda	Bugesera	Beans	Lower precipitation, higher temperatures and shifting seasons	Loss of diversity, increased pests and diseases, low yields	+2	Decrease
	Rubaya	Beans	Unpredicted weather patterns, higher temperatures	Increased incidences of pests and diseases, specifically birds. Loss of diversity and lower productivity and food security	+1.5	Increase
Zambia	Rufunsa	Sorghum	Erratic rainfall, shorter growing season, higher temperatures	Lower productivity, increased fungal diseases, loss of diversity	+2	Increase
	Chikankata	Maize	Shorter growing season, erratic rainfall and higher temperature	Loss of diversity, low yields and fungal diseases	+2	Increase
Zimbabwe	Tsholotsho	Sorghum	Shifting seasons, erratic rainfall, higher temperatures	Increased incidences of pests i.e. aphids, fungal diseases and lower yields	+1.5	Increase
	Uzumba, Maramba, Pfungwe (UMP)	Millet	Erratic rainfall, higher temperatures and shifting seasons	Low yields and increased incidences of pests and diseases	+2	Increase

Annex 2: Genebanks and numbers of accessions

Numbers of accessions in (a) national gene banks, and (b) gene banks in other countries and international organizations, that are potentially adapted to (i) current and (ii) predicted 2050 climate conditions in the 8 community reference sites across the 4 countries.

Reference site, country	**crop**	**Total accession of crop in national gene bank**	**Number of potentially adapted accessions from national gene banks for present climate conditions**	**Number of potentially adapted accessions from national gene bank for 2050 conditions**	**Number of accessions of crops in foreign gene banks (included in Genesys)**	**Number of potentially adapted accessions in foreign gene banks for present climate conditions**	**Number of countries from which the materials for present conditions were collected (or were improved)**	**Number of potentially adapted accession in foreign gene banks (under Genesys) for 2050 conditions**	**Number of countries from which the materials for 2050's conditions were collected (or were improved)**	**Number of local varieties identified by farmers**
UMP, Zimbabwe	Finger millet	90	29	6	2,279	537	8	331	7	7
Tsholotsho, Zimbabwe	Sorghum	178	11	20	23,941	514	9	242	9	7
Bugesera, Rwanda	Beans	109	21	15	64	10	5	10	3	8
Rubaya, Rwanda	Beans	109	28	16	64	13	5	16	4	11
Chikankata, Zambia	Maize	300	48	11	2,800	125	5	87	8	6
Rufunsa, Zambia	Sorghum	176	25	21	23,941	300	8	195	5	-
Hoima, Uganda	Beans	-	-	-	64	9	2	29	6	14
Mbarara, Uganda	Beans	-	-	-	64	11	5	7	-	23

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