THE FUTURE OF FOOD: SEEDS OF RESILIENCE

A COMPENDIUM OF PERSPECTIVES ON AGRICULTURAL BIODIVERSITY FROM AROUND THE WORLD

GLOBAL ALLIANCE FOR THE FUTURE OF FOOD

This compendium of papers was commissioned by the Global Alliance for the Future of Food in collaboration with the authors for use by Global Alliance members to stimulate information-sharing, learning, and collective action. The Global Alliance has chosen to make it available to the broader community to contribute to thinking and discussion about sustainable food and agriculture systems reform. It constitutes the work of independent authors. Any views expressed in this report do not necessarily represent the views of the Global Alliance or of any of our members.

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The Global Alliance for the Future of Food cultivates healthy, equitable, renewable, resilient, and culturally diverse food and agriculture systems shaped by people, communities, and their institutions.

We are a unique collaboration of philanthropic foundations that have come together to strategically leverage resources and knowledge, develop frameworks and pathways for change, and push the agenda for more sustainable food and agriculture systems globally. Representing countries across the globe—with diverse interests and expertise spanning health, agriculture, food, conservation, cultural diversity and community well-being—the Global Alliance shares a belief in the urgency of advancing sustainable global agriculture and food systems, and in the power of working together and with others to effect positive change.

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KEY MESSAGES

1. **Diverse and robust local seed systems are central to sustainable food systems that are renewable, resilient, equitable, diverse, healthy, and interconnected.**

2. **Farmers have a crucial role in improving seed varieties and enhancing agricultural biodiversity, a role they have played throughout the history of agriculture.**

3. **The knowledge and practices of smallholder farmers, particularly those who are women and Indigenous Peoples, are central to the survival of local seed systems.**

4. **The value of resilient and diverse seed systems goes far beyond any economic measure. Community based seed systems are connected to diverse cultural and culinary traditions, health and wellness, resilient agroecological landscapes, and sustainable local economies.**

5. **Maintaining and enhancing agricultural biodiversity is critical in light of global challenges such as climate change, and food and nutrition security.**

6. **There is an urgent need to support community based and farmer managed seed systems in order to protect and enhance agricultural biodiversity.**

7. **Farmers should not be limited in their ability to access, exchange and improve the seeds they use—whether they are locally managed, government produced, or commercial seed varieties from other regions of the world.**

8. **Organizations led by Indigenous Peoples, women farmers and smallholder farmers need greater voice and influence in the development of local seed policy as well as the international governance systems that affect and regulate seeds.**

9. **There is great potential in farmers and the more formal seed establishment coming together to co-create solutions where they have a common agenda.**

10. **Strategic opportunities for positive change include: to continue to research and document the importance of community based seed systems, to support seed leaders to engage in policy advocacy, and to leverage additional funding from philanthropy, governments, and bilateral agencies for community based seed systems.**

FOREWORD

Increasing the availability of agrobiodiversity will become more and more important, not only in the pursuit of improved crop performance, but also in the context of adaptation to climate change, greater resilience, improved nutrition, maintaining the socio-economic balance of farming communities, and the rehabilitation of degraded ecosystems.

— EMILE FRISON AND TOBY HODGKIN

We couldn't agree more. The Global Alliance for the Future of Food is a strategic network of independent foundations with divergent views and perspectives; yet when it comes to the preservation, maintenance, and enhancement of agricultural biodiversity, the Global Alliance believes that diverse and robust seed systems are central to sustainable food systems that are renewable, resilient, equitable, diverse, healthy, and interconnected. We also believe that there is an urgency to supporting community based and farmer managed seed systems in order to protect and enhance seed diversity.

Because of the centrality of resilient seed systems to our collective future of food, and because of the urgency to attend to the threats currently placed upon them, the Global Alliance commissioned an opportunities report, written by Emile Frison and Toby Hodgkin, and a dozen associated commentaries written by diverse leaders in the field from across the globe. The opportunities report and commentaries constitute *The Future of Food: Seeds of Resilience,* which we are excited to release to a broad array of stakeholders, from private enterprise to policy makers to farmers and funders.

This compendium captures a rich diversity of perspectives related to seed systems and agricultural biodiversity, reflecting current research and firsthand experience in the field. This includes plant breeders, seed companies, farmers, academics, foundation staff, and many others with the associated disparities of opinion. Seed systems are a vast area of exploration and are dusted with strong beliefs and sometimes firmly held philosophies. We have encouraged—and look forward to further exploring—this diversity.

But while the contributors and authors of this report come with different world views, have diverse perspectives, and offer differing opinions, there is consensus that the value of resilient and diverse seed systems goes far beyond any economic measure: community based seed systems are connected to diverse cultural and culinary traditions, health and wellness, resilient agroecological landscapes, and sustainable local economies. What's more, maintaining and enhancing agricultural biodiversity is critical in light of global challenges such as climate change and food and nutrition security.

To do so, however, we must overcome a number of significant hurdles. Seed diversity is being eroded and community based seed systems, representing tremendous complexity, are under threat. Farmers do not have adequate

The Global Alliance believes that diverse and robust seed systems are central to sustainable food systems that are renewable, resilient, equitable, diverse, healthy, and interconnected.

representation within the international governance systems that regulate seeds. Communities are feeling the negative impacts of the increasing privatization of seeds. The current intellectual property regime restricts traditional and local seed saving practices. Moreover, the world of farmer seed systems and the world of the more formal seed establishment too often remain in their own orbits hampering the potential of co-creating solutions and coming together as positive participants where they have a common agenda. When seed systems are disconnected from farmers—and vice versa—farmers are unable to contribute to protecting and enhancing agricultural biodiversity—an important role they have historically played.

And thus we sit at a crossroads. This is a historic moment for seed systems. We have a number of seemingly overwhelming challenges, and yet from what we learn from our colleagues, whose voices you will hear in this compendium, there is reason for hope if we collectively embrace the recommendations and positive pathways forward that they map for us.

The contributors to the compendium offer both thoughtful and challenging recommendations for conserving and enhancing agricultural biodiversity, including:

- developing a coordinated advocacy strategy in support of community based seed systems;
- providing greater resources and support to community based seed systems; and
- strengthening the central role that women and Indigenous Peoples play in agricultural biodiversity.

In the coming months, the members of the Global Alliance will be exploring how to move these ideas forward, especially as they relate to the imperative to continue to research and document the importance of community based seed systems, to support seed leaders to strategically engage in advocacy, and to leverage additional funding for community based seed systems.

It will, however, require significant resources to adequately and effectively support this important work on agricultural biodiversity—going well beyond philanthropy. We invite all stakeholders to listen to the voices in *The Future of Food: Seeds of Resilience*, to appreciate the urgency of action, and to lend your needed contribution to this most essential issue at the foundation of sustainable food systems: seeds.

RUTH RICHARDSON
Executive Director, Global Alliance for the Future of Food

SYNTHESIS OF FINDINGS

The diversity of traditional seeds saved by peasant farmers is rooted in the knowledge that seeds are the foundation of life, and more than a source of food—they are a history and culture handed down by our ancestors…This holistic thinking about the value and sacredness of seed over the past generations has been the basis for sustaining diversity and hence stability, in the surrounding environment.

— NELSON MUDZINGWA,
ZIMBABWE SMALLHOLDER ORGANIC FARMERS FORUM

Agricultural biodiversity is essential to the future of food. A deep pool of biodiversity will ensure that we have plant species and varieties that can withstand changing weather patterns. Agricultural biodiversity is directly connected to global nutrition, dietary health, cultural and culinary diversity, and to the resilience of local economies and markets. Seeds are central to the everyday practices of small-scale farmers that feed 70 per cent of the world's population.

In order to understand the landscape of initiatives working to advance seed diversity globally, the Global Alliance commissioned a compendium containing an opportunities report and 12 commentaries. The diverse perspectives that emerged offer insight into how Global Alliance members and members of other organizations can bolster agricultural biodiversity in ways that prioritize and

"Community based approaches have been given more voice in this compendium in an effort to bolster their importance and shine a light on their fundamental contribution to sustainable food systems."

strengthen farmer centred and community based efforts around the world. Drawing on a literature review and key informant interviews, leading agricultural biodiversity experts Emile Frison and Toby Hodgkin wrote the opportunities report, entitled "Strategic Opportunities to Strengthen Community Based Approaches to Seed Agrobiodiversity." A broad range of experts—from organic farmers and community activists to researchers and scientists within the seed industry—read the report, and each wrote a brief commentary outlining what they see as threats to agricultural biodiversity, as well as their recommendations on how Global Alliance members and others can best promote farmer managed and community based efforts and strengthen the diversity and resilience of both seeds and seed systems.

The perspectives represented in the compendium illustrate a nuanced discussion on agricultural biodiversity, at times aligned and at times divergent. The majority of experts asked to contribute to this compendium support community based approaches to agricultural biodiversity conservation, a perspective often underappreciated in global discussions and policy circles where more formal, institutional, *ex situ* approaches have been the primary focus. Community based approaches have been given more voice in this compendium in an effort to bolster their importance and shine a light on their fundamental contribution to sustainable food systems. Many of the contributors to this compendium articulate that an important opportunity is being missed—an opportunity to foster better linkages and partnerships across diverse seed systems and across approaches to agricultural biodiversity. This opportunity aligns well with Global Alliance members' mandates to support organizations and networks that strengthen community based and farmer centred seed systems.

The synthesis that follows represents a summary of the contributors' key points and the shared themes woven throughout the compendium. To understand the nuanced, rich contributions of each of the authors, a full reading of the entire compendium is encouraged; however, this synthesis aims to provide an overview that draws upon the diversity of perspectives.

AGRICULTURAL BIODIVERSITY AT RISK: **MAKING THE CASE**

The urgency for agricultural biodiversity conservation is well documented. In its first global assessment of the world's flora, published in May 2016, the Kew Royal Botanic Gardens, documents that 21 per cent of global plants are at risk of extinction (Royal Botanic Gardens, Kew, State of the World's Plants. 2016).

Emigdio Ballon of the Pueblo of Tesuque provides startling detail: "In spite of its vital importance for human survival, agricultural biodiversity is being lost at an alarming rate. It is estimated that in the past, some ten thousand species have been used for human food and agriculture. Currently, no more than 120

"A mere four plant species (potatoes, rice, maize and wheat) and three animal species (cattle, swine and chickens) provide more than half of our food supply."

cultivated species provide 90 per cent of human food supplied by plants, and of those, only 12 plant species and five animal species alone provide more than 70 per cent of all human food. A mere four plant species (potatoes, rice, maize and wheat) and three animal species (cattle, swine and chickens) provide more than half of our food supply. Hundreds of thousands of farmers' heterogeneous plant varieties and landscapes that existed for generations in farmers' fields until the beginning of the twentieth century have been substituted by a small number of modern and highly uniform commercial varieties."

At the simplest level this reduces our ability to respond to plant diseases and changing environmental conditions using different, possibly more resilient, species. Climate change and accelerated environmental change are putting increased pressure on our food sources, placing even resilient species at risk. Agricultural biodiversity loss compounds the crisis of hunger and malnutrition, the loss of indigenous knowledge, the erosion of dietary diversity, and local food economies.

The authors of the opportunities report and the accompanying commentaries outline a number of threats to agricultural biodiversity which they feel must be addressed. The lack of formal recognition of farmer managed and community based seed systems is a key concern that has implications for local, national and international seed policies as well as investment flows. Government support of proprietary commercial seed research over farmer centred, participatory plant breeding approaches undermines the capacity of farmers to improve their own plant varieties, and therefore increase plant diversity to account for characteristics that they most value. Farmers are necessarily flexible, adaptive, and responsive to their local environmental contexts, which is crucial for resilient food systems. Not engaging farmers directly in seed research is a missed opportunity for creative partnerships between formal and informal, and private and public sector approaches to agricultural biodiversity conservation.

Other pressures are noted as well: rural-urban migration, population growth, the consolidation of the seed industry, and the global focus on increasing agricultural productivity. These combined pressures—local/global, environmental/social, and political/economic—are threatening the viability of thousands of seed varieties.

In light of these threats, compendium authors turn quickly to solutions. The next two sections of this synthesis of findings outline the principal themes and recommendations that emerge from the compendium.

SEEDS AND THE FUTURE OF FOOD: **COMMUNICATING THE RELEVANCE**

AGRICULTURAL BIODIVERSITY IS CRITICAL TO GLOBAL FOOD AND NUTRITION SECURITY, SMALLHOLDER PROSPERITY AND RESILIENT LOCAL ECONOMIES

"Seeds are the first link in the food chain and the repository of life's future evolution. As such, it is our inherent duty and responsibility to protect them and to pass them on to future generations."

Unanimously, the diverse contributors to the compendium emphasize the importance of seeds to the future of food. Nelson Mudzingwa from the Zimbabwe Smallholder Organic Farmers Forum speaks about the importance of maintaining and enhancing agricultural biodiversity. "Seeds are the first link in the food chain and the repository of life's future evolution. As such, it is our inherent duty and responsibility to protect them and to pass them on to future generations. The protection and strengthening of community seed systems is derived from the understanding that seed was given by the Creator and it is the farmer's basic right to keep seed. The growing of seed and the free exchange of seed among peasant farmers has been the basis of maintaining a stable biodiversity and a source of food security. Supporting and enhancing traditional practices on seed saving, especially as practiced by elderly women, who have bred seed freely in partnership with each other and with nature, will further increase the diversity of that which nature gave us, for biodiversity and cultural diversity mutually shape one another."

FROM OUR CONTRIBUTORS

BUILDING A STRONG FARMER MOVEMENT TO PROTECT SEEDS IN ZIMBABWE

Nelson Mudzingwa, Zimbabwe Smallholder Organic Farmers Forum

Members of the Zimbabwe Smallholder Organic Farmers Forum (ZIMSOFF) have created a strong movement to save their traditional seeds. ZIMSOFF's work addresses their challenges to recover food sovereignty and achieve agrarian reform. Nelson Mudzingwa articulates local concerns over the loss of consumer knowledge of food, as well as the corporate control of food and privatization of the food system. To confront these challenges, Mudzingwa emphasizes the importance of working with farmers and households to support seed exchanges and community seed banking. These local networks and relationships are central to resilient community based and farmer managed seed systems.

ZIMSOFF works at the grassroots and household level to influence change horizontally and vertically. Householders know each other and can easily connect, learn from each other, exchange seeds, protect seed banks, and monitor seed quality. ZIMSOFF members have continued to multiply their diverse traditional and open pollinated seed varieties, organizing farmer field days, seed and food fairs, campaign workshops and exchange visits to build capacity of the participating farmers.

A number of contributors also emphasized the importance of agricultural biodiversity in the context of changing climate conditions. Cary Fowler, former Executive Director of the Global Crop Diversity Trust, argues that farmers need to be engaged to experiment with different varieties to ensure optimal adaptation to changing climate conditions.

Jim Gaffney and Valasubramanian Ramaiah of DuPont Pioneer write that seed is the fundamental input for sustainable agriculture and the foundation of successful farming for smallholder farmers. This contribution differs significantly from the other perspectives in the compendium in that "the use of improved varieties and hybrids and greater use of agronomic inputs cannot be considered separate from, or in opposition to, the informal seed system or conservation of agrobiodiversity."

Additionally, Gaffney and Ramaiah argue that "hybrid crops and improved agronomics may also address environmental issues by intensifying agriculture on less land."

"How do we improve resilience and risk management strategies and maintain agrobiodiversity while increasing the productivity and prosperity of smallholder farmers? And how do we limit environmental pressures as we meet these challenges?"

They pose important questions for consideration: How do we improve resilience and risk management strategies and maintain agrobiodiversity while increasing the productivity and prosperity of smallholder farmers? And how do we limit environmental pressures as we meet these challenges?

WOMEN AND INDIGENOUS PEOPLES PLAY A CENTRAL ROLE IN AGRICULTURAL BIODIVERSITY

Emigdio Ballon and Winona LaDuke call attention to the importance of Indigenous Peoples and communities to agricultural biodiversity. Ballon writes: "There are thousands of Indigenous communities throughout our Mother Earth fighting to protect their inherent rights to practice their traditions and grow their foods and seeds. They seek to draw attention to overlooked food crops in the world so that these communities, their foods and seeds are not forgotten or destroyed by genetic modification. The crops are not yet truly lost; indeed, most are well known in many areas of the world, especially among Indigenous groups, but protecting these varieties is the main focus of international scientists and people trying to protect the food."

The role of women in agricultural biodiversity conservation was highlighted by many of the contributors. The African Centre for Biodiversity writes, "The role of rural women and smallholder farmers in African society has been profoundly undervalued, despite the fact that around 80 per cent of Africa's population is dependent on smallholder agriculture—the backbone of the rural economy—where women provide 70 per cent of the farm labour. When it comes to seed, women are the custodians at the centre of seed saving, with significant importance in ensuring food security and genetic diversity."

FROM OUR CONTRIBUTORS

PRESERVING THE GENETIC DIVERSITY OF FRUIT IN TAJIKISTAN

Muhabbat Mamadalieva and co-authors

Zan va Zamin (Women and Earth) works with local communities in the mountainous areas of Tajikistan, across Khovaling, Muminobod and Shuroabad. During the Soviet era, agriculture became centralized and many local crops were no longer grown. After this period of focus on hybrid seeds and varieties, the *Zan va Zamin* project was launched to support the restoration and rehabilitation of traditional forms of agriculture. The project supports local varieties of agricultural products to be reclaimed, as well as community based seed cultivation.

The project conserves the agricultural biodiversity of fruit crops by working with farmers who are growing rare varieties *in situ* and who have started a rare fruits nursery. Muhabbat Mamadalieva and co-authors stress the importance of formally recognizing local varieties, hybrids, and grafts cultivated by local farmers. They describe how farmer-to-farmer and farmer-to-scientist exchanges, partnerships and training are central to enhancing agricultural biodiversity, as is identifying and working with local seed champions. The preservation of agricultural biodiversity is also dependent on the culinary use of these crops by households and local institutions.

Bettina Haussmann, who works across Mali, Burkina Faso, and Niger with the Collaborative Crop Research Program, also emphasizes women's special role in agricultural biodiversity and the link to nutrition: "Working specifically with women farmers to cultivate and maintain local crop and varietal diversity could be an opportunity to (re-) link agriculture with nutrition, to enhance dietary diversity in rural families and to achieve desired nutritional outcomes and the reduction of malnutrition and hidden hunger."

SEEDS ARE SACRED AND HOLD VALUE AND MEANING BEYOND MARKETS

The value of seeds—far beyond yield per acre, and beyond the income generated by the sale of crops—was another central theme identified by compendium contributors. This value includes agricultural biodiversity's connection to local culinary traditions, taste, nutrition, the value of diverse products in local markets, and the value of ecological resilience.

Because of the significant value and meaning of seeds across jurisdictions and contexts, seeds are considered sacred by many of the contributors. Emigdio Ballon writes, "Life forms, plants, and seeds are all-invoking, self-organized, sovereign beings. They have intrinsic worth, value and standing.... Uniformity is being pushed as positive criteria, in order to legitimize corporate control over seeds.... Patents on seeds are legally wrong because seeds are not an invention. Patents on seeds are ethically wrong because seeds are life forms. They are our kin. They are members of our Earth family. Owning life by claiming it to be a corporate invention is both ethically and legally wrong."

FROM OUR CONTRIBUTORS

REALIZING THE POTENTIAL OF ACCESS TO SEEDS FOR SMALLHOLDERS IN INDIA

Jim Gaffney and Valasubramanian Ramaiah, DuPont Pioneer

In the agrobiodiversity-rich Koraput district of Odisha, India, smallholder farmers use traditional varieties and practices, contributing to *in situ* agricultural biodiversity conservation. The area is recognized for its rich diversity of Asian cultivated rice, and is known to be one of the centres of origin of these varieties. However, lack of support mechanisms and relevant training to enhance skills in the seed selection process are constraining the needed scale of quality seed production.

These constraints are being addressed through a variety of public-private partnerships. Several private seed companies and cooperatives are supplying an increasing proportion of rice seed, in addition to two public seed agencies. The open access to source seed, the active participation of smallholder famers, the availability of growers and processing facilities on a contract basis and a well-developed marketing network have reduced transaction costs, enabling the emergence of a wide range of seed enterprises, particularly in the private sector.

This system utilizes the best of what both the formal and informal seed systems have to offer, and, perhaps most importantly, has provided smallholder farmers with market access and more options for their farming enterprise.

"By valuing specific crops and varieties as healthy food and possibly creating a local value chain and local markets, farmers can be encouraged to add these crops and varieties to their existing portfolio, for improving family nutrition and also for income generation purposes. The use of this diversity will thus ensure that it is not lost."

The culinary uses of crops (flavour, texture, nutritional and medicinal values) are important when considering the value of seeds. Humberto Ríos Labrada of ICRA, speaking about his experience working with farmers and breeding landraces, states, "Culinary criteria of the varieties were extremely important in keeping more diversity on-farm. Women organized cooking tests as an important criteria for varietal selection. Mostly male farmers voted for varieties with high yield and associated characteristics. Female participants voted for varieties related to culinary properties. In the cooking tests, men noted that more than 80 per cent of the varieties tested were of good cooking quality, whereas women were more rigorous."

Bettina Haussmann stresses the link between the everyday value of agricultural biodiversity and its preservation: "By valuing specific crops and varieties as healthy food and possibly creating a local value chain and local markets, farmers can be encouraged to add these crops and varieties to their existing portfolio, for improving family nutrition and also for income generation purposes. The use of this diversity will thus hinder that it gets lost."

COMMUNITY BASED SEED SYSTEMS ARE A STRATEGY FOR RESTORING, MAINTAINING AND REHABILITATING AGRICULTURAL BIODIVERSITY

The authors overwhelmingly spoke of the need to restore, maintain and rehabilitate agricultural biodiversity through a focus on community based seed

systems. For example, Maryam Rahmanian explains: "Community based seed systems are obviously the result of a *collective* endeavour—no individual could undertake this work on their own, so it's the collective nature of the seed system that has to be at the heart of any effort to protect and strengthen it."

Jean-Louis Pham of Agropolis Fondation describes how community based seed systems are diverse and complex entities: "There is a diversity of seed systems because of the diversity of eco-geographical and economic conditions, of the crop reproductive biology, of cultural factors, etc. Between yam seed systems in Benin and the rice seed systems in the Philippines, differences are huge, even though one can reasonably attempt to describe them with a single theoretical framework. It results from this diversity and complexity over space and time that ways to sustain, protect, and strengthen community based seed systems will have to be diverse, tailored and adaptive. In a sense, there is no 'best way' to protect and strengthen community based seed systems—there are ways which are appropriate or not depending on the situation."

"Given the diversity and complexity of local contexts, methods to sustain, protect and strengthen community based seed systems will have to be diverse, tailored and adaptive."

Community based seed systems are a reflection of the various roles food plays in our lives, beyond sustenance. They are linked to culinary traditions and the markets that sell local food; they are contextual and rooted in local relationships. Yet one of the most significant points made in Frison and Hodgkin's report is that seed and agricultural biodiversity governance, local to international policies, and many international institutions, all work in the opposite direction, operating from the top down, dismissing and ignoring the people vital to community based seed systems.

"Effective local seed systems are the mechanisms for the access and exchange of materials needed by farmers," write Frison and Hodgkin. They are "key to the maintenance of seed diversity" and they are already in place. Frison and Hodgkin cite a survey of numerous farmers in six countries that found that more than 50 per cent of their seed came from local markets, neighbours, friends or relatives. They estimate that 90 per cent of farmers get their seeds informally, and emphasize that *in situ*, on-farm seed saving strategies are essential complements to *ex situ* seed banking efforts.

Intrinsic to community based seed systems is saving seeds *in situ*, but compendium contributors diverge in their perspectives on how best to support and enhance these systems. For example, Jim Gaffney and Valasubramanian Ramaiah make the argument that "local sites are often inadequate and seed degrades over time due to exposure to the elements, disease and insect damage." As a result, the saved seed from traditional varieties "may, over a few generations, no longer provide the same level of productivity or quality or are no longer genetically distinct."

Gaffney and Ramaiah, as well as Cary Fowler, express another concern about *in situ* storage—that it does not promote enough genetic diversity for climate adaptation. Fowler suggests addressing this by creating packages of diverse

FROM OUR CONTRIBUTORS

RESTORING INDIGENOUS SEED FARMING IN NORTH AMERICA

Winona LaDuke, Honor the Earth

Across the United States and Canada, many tribal communities and Indigenous organizations have taken leadership in seed restoration and farming restoration. Some of this work is to defray the introduction of more GMO seeds, as this would have a detrimental impact on indigenous seed stock and diversity. Winona LaDuke describes the challenges facing these communities, including the appropriation of land, loss of Native farmers, lack of access to United States Department of Agriculture loans and programs, and the concentration of seed ownership. These challenges have contributed, over time, to a decline of food wealth. LaDuke emphasizes the connection between community based tribal agriculture and seed restoration programs, and the need for Indigenous-led agriculture research stations that promote and improve indigenous seed stock.

seeds from different geographic regions "assembled and provided to farmers on a massive scale to promote adaptation" as a strategy for getting a greater number of varieties into the hands of farmers.

Bettina Haussmann suggests we move to a more systems-oriented approach to breeding, where the different functions of a crop or cultivar in the production system are considered and improved/optimized. She writes: "Such an approach actually includes a paradigm shift from promoting just a few 'best-bet' varieties to promotion of functional diversity via the development of a portfolio of "'best-fit'" varieties (varieties that are specifically adapted to different contexts, functions and needs). To enable this, a paradigm shift is needed from considering farmers just as 'beneficiaries' and passive 'adopters' to considering farmers as real partners who inform and advise the crop improvement process."

Haussmann proposes to strengthen the partnership between farmers and the public and private sector seed improvement establishment. This could include the participatory development and evaluation trials of varieties that are adapted to the local context, training of farmer seed producers, and public-private-farmer partnerships that include farmers as partners and co-creators of new research and business models to enhance agricultural biodiversity.

Pat Mooney with the ETC Group states that, "It is now abundantly clear that farmers play a vital role in both conserving traditional plant varieties and also in crossing traditional varieties with varieties bred by public and private institutions to improve and develop entirely new varieties. The important distinction is that farmers not only preserve, but they also develop. Indeed, preservation is far from a curator function—it is part of a practical strategy to maintain diversity for future needs."

"It is now abundantly clear that farmers play a vital role in both conserving traditional plant varieties and also in crossing traditional varieties with varieties bred by public and private institutions to improve and develop entirely new varieties. The important distinction is that farmers not only preserve, but they also develop. Indeed, preservation is far from a curator function—it is part of a practical strategy to maintain diversity for future needs."

The compendium contributors clearly communicate the relevance of agricultural biodiversity for sustainable food systems and the future of food on our planet. The contributors stressed the importance of agricultural biodiversity, the central role of women and Indigenous farmers in maintaining and enhancing agricultural biodiversity, and the extraordinary value of seeds for family nutrition, resilience to climatic changes, and local economic development. The importance of farmer managed and community based seed systems was emphasized repeatedly, as was the need for new partnership models that bridge traditional divides between diverse geographical contexts, and formal and informal, private and public sector approaches to agricultural biodiversity conservation. This provides a backdrop for the broad range of recommendations and solutions proposed in the compendium.

PROPOSALS FOR THE FUTURE OF SEEDS: **ADVOCATING FOR SOLUTIONS**

Within the context of both shared and divergent views on the relevance of seeds and principal themes, the contributors to the compendium offered recommendations and proposals to strengthen agricultural biodiversity. These have been distilled and only a few of the many specific and contextual recommendations are offered in this synthesis as there were too many to list individually. For the complete list please refer to the full compendium.

PROPOSAL 1: DEVELOP A COORDINATED ADVOCACY STRATEGY IN SUPPORT OF COMMUNITY BASED SEED SYSTEMS

Many contributors expressed concern that current seed laws and policies are undermining farmer managed and community based seed systems, and that effective and coordinated advocacy and investment in support of agricultural biodiversity and community based seed systems is required now more than ever. This advocacy ranges from defending local seed systems to ensuring that small-scale farmers have a stronger voice in international decision making fora. The legal implications of laws and policies eroding or protecting seed ownership for farmers are significant, and farmers and their organizations and allies need to be a part of these decision making processes. For example, Pat Mooney proposes to create an independent Civil Society Mechanism (CSM) for the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) using the model currently in place for the Committee on World Food Security (CFS). Full participation of farmer and civil society organizations at these meetings would ensure seed and agroecology issues are addressed, and could impact a wide range of seed policies at both the international and national levels.

Many contributors articulated that international laws, policies and conventions should strengthen, and not undermine, farmer managed and community

based seed systems. Organizations and social movements representing farmers, women, and Indigenous Peoples should have a seat at the tables where policies and laws on agricultural biodiversity and seed systems are negotiated and determined.

As well, developing a coordinated strategy could facilitate the participation of farmers, women, and Indigenous Peoples in policy negotiations, surface common challenges, priorities and creative solutions, as well as encourage the release of the funding and investment required to enhance community based seed systems. Donors can be central to the development of such a strategy and can lend their voice in support of community based seed systems at international and national meetings and gatherings.

PROPOSAL 2:
PROVIDE GREATER RESOURCES AND SUPPORT TO COMMUNITY BASED SEED SYSTEMS

"The legal implications of laws and policies eroding or protecting seed ownership for farmers are significant, and farmers and their organizations and allies need to be a part of these decision making processes."

Many contributors underlined the importance of directing resources and support to community based seed systems. This could include training for farmers' organizations, support for participatory plant breeding programs, gene pool maintenance, and engaging farmers in research, monitoring and decision making. The objective would be to (1) enhance resilience and adaptability across seed systems, (2) foster creative connections between informal and formal systems, and (3) benefit from public and private sector approaches to agricultural biodiversity. The diversity within community based seed systems is a strength from which to understand and share approaches.

Farmer led and community based research, and research that promotes a partnership between farmers and scientists was emphasized. The African Centre for Biodiversity, Jim Gaffney and Valasubramanian Ramaiah, Nelson Mudzingwa, Mamadalieva et al, and Bettina Haussmann all proposed increasing knowledge-sharing between local farming communities and the public and private sectors in order to build an integrated platform to conserve agricultural biodiversity. Central to this integrated knowledge-sharing and research platform could be a new partnership between farmers, and the public and private sectors, with the co-creation of new business and research models. Government agencies could support local research and monitor agricultural biodiversity, as well as develop policies for the protection of community based seed networks.

Additionally, some contributors suggested that further understanding and monitoring of both global and national policy contexts would be helpful. The African Centre for Biodiversity, Maryam Rahmanian, Nelson Mudzingwa, Emigdio Ballon, Emile Frison, and Toby Hodgkin all state that seed legislation and intellectual property laws are national and must be monitored for the limits they impose—intentional or not—on farmers' ability to freely produce and exchange seed.

Contributors emphasized that donor agencies can play an important role in convening and strengthening networks of advocates and researchers related to farmer managed, community based seed systems. Donors can also work together to leverage funding for and investment in community based seed systems. In addition, donor agencies can support further research on community based seed systems, especially in relation to how these systems can be supported by international laws, policies, and conventions instead of being undermined—as is currently happening.

PROPOSAL 3:
STRENGTHEN THE CENTRAL ROLE WOMEN AND INDIGENOUS PEOPLES PLAY IN AGRICULTURAL BIODIVERSITY

Many contributors stress the importance of the participation of women and Indigenous Peoples in decision making at local, regional, national and international levels, and underline that both groups are often absent from decision-making processes.

Central to this integrated knowledge-sharing and research platform could be a new partnership between farmers, and the public and private sectors, with the co-creation of new business and research models.

Mamadalieva and co-authors propose to support these seed keepers by creating certificates for new varieties of seeds thus officially recognizing their role as custodians of agricultural biodiversity when selling or exchanging seeds at farmer's markets and within farmer seed networks. Winona LaDuke emphasizes the need to establish indigenous agricultural research stations so that Indigenous researchers can work on the adaptation of varieties and restoration of seed stock as well as train tribal leadership in community based seed systems.

To build capacity and support on a local level requires on-the-ground networks and knowledge sharing, starting with the participation of farmers. Supporting Indigenous Peoples and enhancing the role of women requires deliberate engagement and support of these constituencies, as well as targeted funding and investment to facilitate participation.

CONCLUSION

As seen in this overview of the recommendations that emerge from the compendium, strengthening agricultural biodiversity requires action at the local, regional, national and international levels. The urgency is clear. Agricultural biodiversity is central to the future of food and our planet. The diverse contributors to this compendium stress the importance of bolstering community based seed systems, and propose that donors, governments, researchers, and civil society organizations align their priorities with this goal. With the publication of this compendium, the Global Alliance for the Future of Food is emphasizing the importance of agricultural biodiversity to sustainable food systems. We encourage you to read all of the contributions. This is just the beginning of a longer term exploration of these critical issues, and we hope to engage many more perspectives and opinions in a conversation about the complexity of community based seed systems, how they fit within the broader landscape of food systems, and how to better support them and their potential to shift towards a future of food that is more sustainable, equitable and secure.

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STRATEGIC OPPORTUNITIES TO STRENGTHEN COMMUNITY BASED APPROACHES TO SEED AGROBIODIVERSITY

Opportunities Report
by Emile Frison and
Toby Hodgkin

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INTRODUCTION

Although agrobiodiversity reflects the entire panoply of diversity that contributes directly and indirectly to food production, including livestock, pollinators, microbes etc., in this report we focus on the diversity of crops and the plant genetic diversity of farmer maintained local varieties or landraces of major crops (LR) and neglected and underutilized plant species (NUS) and their crop wild relatives (CWR), and the rangeland plant species so important to pastoralists and herders.

Improving conservation and increasing the availability of agrobiodiversity will become more and more important, not only in the pursuit of improved crop performance, but also in the context of adaptation to climate change, greater resilience, improved nutrition, maintaining the socio-economic balance of farming communities and the rehabilitation of degraded ecosystems (Frison et al., 2011). The management and sustainable use of agrobiodiversity is important to sustain the livelihoods of poor communities who practice traditional farming systems and who live in harsh, often marginal, environments (Jarvis et al., 2016).

The continued or increased use of agrobiodiversity is not only important to produce sufficient nutritious food but also plays a key role in providing regulating, supporting and cultural ecosystem services, by contributing to the resilience and sustainability of the agricultural ecosystems and enabling the maintenance of cultural traditions, particularly of Indigenous Peoples (Thrupp, 1998). The genetic resources of local species play a vital role in rehabilitating and restoring degraded ecosystems (Broadhurst et al., 2008). Additionally, and of direct relevance to rural farming communities, agrobiodiversity can make vital contributions to supporting and diversifying the livelihoods of its custodians. It is important to note that agrobiodiversity, while an essential component of agricultural ecosystems, is also a product of these same agroecosystems. It is shaped by multiple anthropogenic and environmental processes.

On-farm or *in situ* conservation and management of plant genetic diversity complements *ex situ* conservation (Maxted et al., 1997) in that it allows the continued evolution and selection of the diversity to adapt to changing environments (Vigouroux et al., 2011) and conserves a wider genetic base (Scarcelli et al., 2006). In the absence of continued evolution *in situ*, the so-called global system of conservation for use risks becoming static, without the built-in adaptability essential to respond to future challenges.

The presence of plant genetic diversity in production systems (in the form of seeds and the planting material of vegetatively propagated crops) is therefore essential to ensuring sustainable, adaptive and resilient food production systems that meet the needs of rural communities and Indigenous Peoples. It is an essential ingredient of agroecological approaches of production (see e.g., Altieri, 1999). Access to such diversity can provide direct benefit to the 500 million

family farms that, according to recent estimates by IFAD, produce over 70 per cent of the world's food, 475 million of which are farms of less than two hectares.

For the majority of smallholder farmers, traditional, informal seeds systems, based on farmer maintained seeds, exchanges between neighbouring or distant farmers, and local markets, still provide up to 90 per cent of the seed and planting material grown.

While many countries have developed formal seed systems selling commercial varieties (often protected by IPRs), they only represent a fraction of the seeds planted in developing countries. For the majority of smallholder farmers, traditional, informal seeds systems (Almekinders and de Boef, 2000), based on farmer maintained seeds, exchanges between neighbouring or distant farmers, and local markets, still provide up to 90 per cent of the seed and planting material grown (McGuire and Sperling, 2013; McGuire and Sperling, 2016). The support for, and improvement of, these farmer managed seed systems is an important objective.

This report evaluates the available knowledge and range of existing efforts to protect, restore and advance the maintenance of seed-based agrobiodiversity and the sources of support for such efforts. It explores strategic opportunities to strengthen the growing range of community based efforts and identifies options for future support. It is based on a review and assessment of available information supported by interviews with a selected range of key informants (see Appendices 3 and 4 for a description of methodology and informants).

OVERVIEW OF CURRENT EFFORTS

In this report, "seed diversity" includes the propagating materials of different varieties, clones and populations of agricultural crops. Thus, as well as seed, it includes roots and tubers, cuttings, rootstocks and all other materials that are used for propagation by rural communities (Jarvis et al., 2005). The crops may be annual or perennial, inbreeding, outbreeding or clonally propagated with many or few recognized traditional varieties depending on the practices, knowledge systems and cultures of the societies involved. The focus of this section is on work done largely with local communities.

While there has certainly been a substantial loss of diversity from many production systems, the general assumption of the 1980s and 1990s that traditional varieties (landraces) were destined inevitably to disappear from all production systems has not materialized. These varieties continue to form an essential part of many production systems throughout the world, especially in marginal production areas and those subject to significant stresses (e.g., drought). This is not always just a local phenomenon, as shown with pearl millet and sorghum in Niger and Mali where diversity was found to be stable or increased in both of these countries during the 25 years from the mid 1970s to early 2000s (Vigouroux et al., 2011).

Following the work of Altieri and Merrick (1987) and of Brush (1995), studies over the last 20 years on the maintenance of traditional varieties and locally important crops, and the work done to support their continued conservation *in situ*, have resulted in a much clearer understanding of their role in traditional production

systems, including the contribution they continue to make to rural livelihoods and cultures, the factors that contribute to their continued use, and the barriers to their continued maintenance. Some of the main findings are summarized in the next paragraphs (see Jarvis et al., 2016 for an extended treatment).

UNDERSTANDING THE FACTORS AFFECTING ON-FARM DIVERSITY MAINTENANCE

The reasons for maintaining crop genetic diversity in the form of traditional varieties include: stability and risk avoidance; resilience, adaptation and adaptability to variable, difficult or marginal environments and to environmental change; provision of key ecosystem services such as pest and disease control, pollinator diversity, below ground diversity and soil health; socio-economic contributions such as meeting changing market demands, coping with distance to market and adult labour availability; dietary or nutritional value; and meeting cultural and religious needs (see review by Jarvis et al., 2011 and references therein). Often, a number of these reasons operate together and result in cultivation of traditional varieties in a significant part of a production system in combination with modern varieties (e.g., Rana et al., 2007).

Traditional production systems are dynamic. The crops and varieties change over time reflecting the changing production conditions (e.g., climate change, movement of people to cities) and changing agronomic practices (e.g., Bezançon et al., 2009; Deu et al., 2010). Many farmers continually seek to adapt their materials and access new materials that will improve their production within frameworks of risk avoidance and securing stable production. Yet traditional varieties often continue to provide a culturally desirable, risk-avoiding basis for production.

It is not unknown for Andean farmers to plant over 60 varieties of potato. Similar numbers of rice varieties were maintained by farmers in mid altitude Nepal.

Traditional production systems often contain very large numbers of varieties of major crops. It is not unknown for Andean farmers to plant over 60 varieties of potato (Brush, 1995). Similar numbers of rice varieties were maintained by farmers in mid-altitude Nepal (Jarvis et al., 2008). However, diversity in many traditional production systems is often found to be lower than that desired by the communities who identify lack of range of desired varieties as a key problem in participatory rural appraisal processes (Jarvis et al., 2011). Thus farmers in Nepal in the high altitude area of Jumla still maintain and use more than 30 varieties of rice but none possess resistance to rice blast, a major disease of the area (Bajracharya et al., 2006). Similarly, farmers sometimes lack varieties with the temperature or drought tolerance traits required to cope with changing climatic conditions (Jarvis et al., 2011) or with changing patterns of labour availability. These limitations are discussed further below.

Seed availability can best be understood in terms of the operation of more or less complex seed systems—social institutions that mediate seed exchange and access (Almekinders and de Boef, 2000; Fig. 1). For most rural communities throughout the developing world, the informal parts of the system

are responsible for 90 per cent of seed supply. Farmers often seek to maintain their own seeds from season to season but, according to McGuire and Sperling (2016) who surveyed large numbers of farmers in six countries, over 50 per cent of seed is purchased mostly from local markets but also from neighbours, friends or relatives. The ways in which local seed systems operate are key to the maintenance of seed diversity within production systems (Patausso et al., 2013).

Traditional, informal seed systems are not perfect. They may need improvements in terms of the phytosanitary quality of the seeds, and seed storage from season to season, or for longer periods, may present challenges. This does not mean they should be abandoned, but rather improved from that perspective while maintaining the advantages mentioned above.

Effective seed systems provide the necessary mechanisms for access and exchange of materials needed by farmers. Seed systems support the maintenance of diversity of both rare and common varieties (Thomas et al., 2015) and support the genetic processes that allow evolution and adaptation and support resilience (e.g., migration, gene flow, selection, recombination) (Hodgkin et al., 2007). However, traditional, informal seed systems are not perfect. They may need improvements in terms of the phytosanitary quality of the seeds, and seed storage from season to season, or for longer periods, may present challenges. This does not mean they should be abandoned, but rather improved from that perspective while maintaining the advantages mentioned above.

The view that farmers and rural communities cannot manage the complexity of agrobiodiversity has now been disproved in many parts of the world. Indeed, more commonly, modern agricultural production approaches are unable to manage this complexity. They are driven to oversimplify farmer diversity based management of agroecosystems with its emphasis on monocultures based on a few uniform varieties. Many descriptions of the richness and complexity of traditional production systems and the seed systems that sustain them can be found (see Jarvis et al., 2008 for more than 20 crops in eight countries; see Jarvis et al., 2011 for references or Jackson et al., 2007; FAO/PAR, 2011). Coomes et al (2015) have recently challenged four beliefs about seed systems that they consider are unfounded:

1. Farmer seed networks are inefficient for seed dissemination.
2. Farmer seed networks are closed, conservative systems.
3. Farmer seed networks provide ready, egalitarian access to seed.
4. Farmer seed networks are destined to weaken and disappear.

Interviews with those directly involved in the maintenance of seed diversity for the preparation of this paper confirmed these findings and noted, in particular, issues of access, especially access to sources with a range of diverse materials. Fig. 1 illustrates the richness and complexity of seed systems.

The work of the last few decades has led to the development of a number of tested practices that support the maintenance of traditional varieties and minor crops and contribute to what is also called dynamic conservation. General frameworks that can guide interventions have been developed such as the Community Biodiversity Management (CBM) approach (Sthapit et al.,

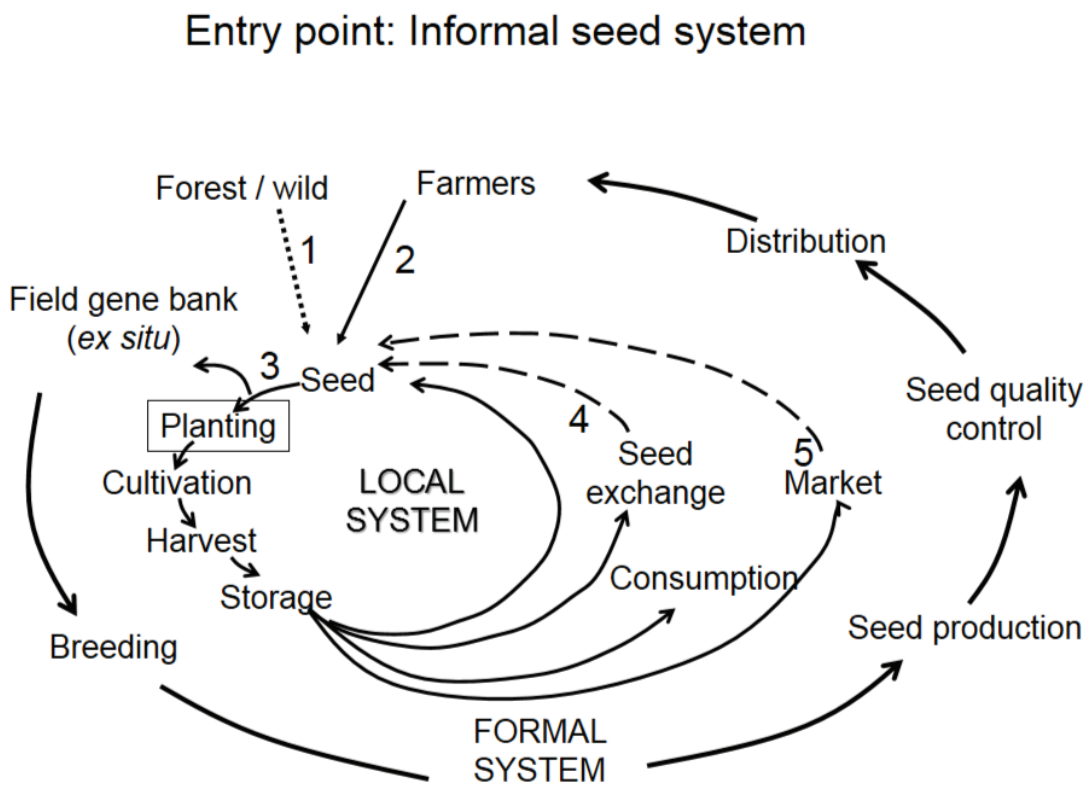

Fig. 1. A generic representation of seed systems to show the interconnections present in the system (modified from Almekinders and de Boef, 2000; see Jarvis et al., 2016)

2006, Appendix 2; de Boef et al., 2013) and Scaling Up Pathways, developed from the three-year global program "Putting lessons into practice: Scaling up People's Biodiversity Management for Food Security" (Oxfam Novib et al., 2015). The practices in both these programs are similar and include these actions to support biodiversity:

- Baseline assessment of diversity (or PGRFA toolkit)
- Building community management systems and awareness
- Strengthening capacity through farmer field schools or diversity field fora
- Improving access to seed diversity and securing availability through, e.g., community seed banks
- Developing links between community and national agricultural programs

Other activities regarded as necessary include support for adaptation to climate change, the explicit inclusion of gender dimensions, and the advocacy required to ensure appropriate supportive national policy frameworks.

Crop improvement, through participatory variety selection (PVS) or

participatory plant breeding (PPB), has been an important feature of many of the actions to support diversity maintenance (Sthapit et al., 1996; Ceccarelli and Grando, 2009). This may simply take the form of reselection from an existing range of seed lots of a single traditional variety, by the farmers themselves and based on their knowledge and appreciation of the materials. The development and distribution of the Nepalese rice variety Jethobudho is an example of this (Gyawali et al., 2006). However, it has also involved more substantial plant breeding efforts involving the cross-breeding and selection of improved materials, often using newly introduced materials to provide characteristics needed by farmers but not available in their existing materials. Improving seed quality has also been a common feature of many interventions.

Box 1

SUPPORTING SEED DIVERSITY: EXAMPLE OF SUCCESS FROM BEGNAS, NEPAL

One compelling example of community biodiversity management is the restoration of the Rupa lake watershed in Begnas, in the Lekhnath Municipality in Kaski district of Nepal. The Begnas landscape lies in a Himalayan valley, with the elevation ranging from 600 to around 1,400 metres above sea level. It comprises a mosaic of Rupa and Begnas lakes, wetlands, forests, rice terraces, agroforestry gardens and grazing areas. Affirming a common vision and their commitment to conservation, the local communities and the Lekhnath Municipality have declared the landscape a pilot project for an agrobiodiversity conservation area. The work began in the mid 1990s, supported by Local Initiatives for Biodiversity, Research and Development (LI-BIRD) in collaboration with national and international research organizations. It has included substantial investigation of—and support for—the crop seed diversity in the area.

CBM is embodied by a local farmers' umbrella organization called the *Jaibik Shrot Samarachyan Abhiyan* (Bio-Resources Conservation Movement), which brings together three cooperatives, seven community development committees and five women's groups. Each of the 15 groups affiliated with *Jaibik Shrot* is entrusted with specific conservation responsibilities, including documentation of local knowledge on genetic resources through community biodiversity registers (CBRs). The CBRs contain information about more than 440 species and crop varieties, including 111 wild medicinal or non-timber species and 92 wild food and timber species.

Jabik Shrot has also supported and expanded the existing seed networks, ensuring that critically endangered but valuable varieties (such as Anadi rice) were multiplied and made more widely available. Additionally, sponge gourd, cucumber and taro diversity has also been made available and the group has supported PPB activities aimed at improving local rice varieties.

The work has involved decades of collaboration involving CARE Nepal, LI-BIRD, Nepal Agriculture Research Council, Bioversity International and their various projects in the Begnas landscape.

Source: Sthapit S et al, 2014

National policies, programs and regulations play a key role in supporting or (more usually) limiting the ability of farmers to access or maintain their traditional varieties.

The diversity maintained by rural farming communities exists within a wider landscape, a regional or even national framework. National policies, programs and regulations play a key role in supporting or (more usually) limiting the ability of farmers to access or maintain their traditional varieties (Jarvis et al., 2016, Chapter 10). The period when national programs actively sought to destroy traditional varieties is largely passed but there are still substantially negative perceptions as to either the value or need to maintain this diversity. At the same time, many grassroots and national civil society organizations, such as Asociación ANDES in Peru, Gene Campaign in India, LI-BIRD in Nepal, SEARICE in Southeast Asia and Community Technology Development Organisation in Zimbabwe, have become actively involved in supporting seed diversity. The most successful interventions seem to have been those which bring together national agricultural programs with civil society groups, a model pioneered by Bioversity International (then IPGRI) in the 1990s (see Boxes below for examples).

Originally seen in largely biological terms, research soon made clear the importance of community-level social institutions and socio-economic factors in supporting the availability of seed diversity. Key factors that were identified included economic value, the relative roles of men and women, the importance of cultural dimensions and social institutions. As noted above, the social networks that mediated seed access were found to be particularly important and a number of key players were identified through network analysis, particularly nodal farmers (who played a major role in seed supply) and custodian farmers who were seen to play a major role in the maintenance of a wide range of diverse varieties of different crops (Subedi et al., 2003; Sthapit et al., 2013). Nodal farmers were later found to change to some extent over a number of seasons.

In many communities, while the capacity and knowledge involved in maintenance and cultivation of a wide diversity of crops and varieties still exists, in others it is retained only by older members of the community and is disappearing. The use of diversity in a production system is a knowledge-rich characteristic, often linked to cultural practices based on traditional knowledge. It has been shown that such traditional knowledge, linked with new skills, plays an important part in adaptation to climate change by rural communities and Indigenous Peoples (Mijatovic et al., 2013). As Mijatovic et al. (op. cit.) noted, supporting seed diversity in production systems has often involved validating and using traditional knowledge together with new information and technologies.

Early research largely focused on *in situ* conservation of traditional crop varieties and was concerned with describing the extent and distribution of this diversity and the different factors that influenced its maintenance (e.g. Brush, 2000). In recent years, more attention has been paid to the mechanisms and the features of rural communities that support maintenance and the functions that crop and seed diversity fulfill in production systems. This is reflected in the activities of some of the major players undertaking or supporting such

work; for example, Bioversity International undertakes large projects that focus on three aspects: (1) the role of varietal and crop diversity in pest and disease control (Mulumba et al., 2012; Jarvis et al., 2012); (2) the ways in which crop and varietal diversity can support adaptation to climate change and the mechanisms (e.g., crowdsourcing distribution, improved market chains to provide economic benefits) that can increase availability of diversity (see http://www.bioversityinternational.org/seeds-for-needs/ and below); and (3) the role of policy, economics and markets in supporting diversity maintenance (e.g., Lipper et al., 2010). The Global Environment Facility (GEF) has also provided significant support in the last two decades, and continues to fund a number of projects (especially The United Nations Environment Programme; see UNEP-GEF, 2010). These too increasingly focus on the function of diversity in production systems and what is needed to mainstream diversity maintenance into production systems. Oxfam Novib has also moved into a new phase of support for biodiversity management through its current program on scaling up pathways in peoples' biodiversity management, which is now expanding to additional countries the work previously undertaken in Peru, Vietnam and Zimbabwe (Oxfam Novib et al., 2015).

POLICIES AFFECTING ACCESS TO DIVERSITY OF SEEDS

The policy environment regarding agricultural biodiversity in general and PGRFA in particular is rather complex and we will cover only the most important aspects without going into details (see Halewood et al., 2013; Jarvis et al., 2016, Chapters 3, 10 for further information). This policy environment has changed drastically in the last 35 years or so.

In 1983 plant genetic resources for food and agriculture (PGRFA) were recognized in an international treaty as the common heritage of humankind and as such were to be freely available.

Until the early 1980s there were no specific policies at either international or national levels outside of plant variety protection legislation which affected only commercially bred varieties. Outside of these, seeds were considered a public good and were commonly exchanged among farmers and researchers alike. In 1983 plant genetic resources for food and agriculture (PGRFA) were recognized in an international treaty as the common heritage of humankind and as such were to be freely available. But with the increasing privatization of PGRFA through plant variety protection laws, the imbalance between the breeder's rights and the rights of the custodians of the PGRFA—i.e., the farmers—increased significantly, and many developing countries wanted to rectify this imbalance.

This led to the negotiation and adoption in 1992 of the Convention on Biological Diversity (CBD), which recognizes the sovereign rights of states over the genetic resources (GR) within their boundaries, the need obtain prior informed consent to access GR and the sharing of benefits on mutually agreed upon terms. The importance and special nature of plant genetic resources for food and agriculture were recognized, which led to the negotiation of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA or Plant Treaty) and its adoption in 2001, which attempts to recreate

Box 2

SUPPORTING SEED DIVERSITY: EXAMPLE OF SUCCESS FROM THE POTATO PARK, PERU

The Potato Park (*Parque de la papa*) is a locally managed Indigenous Biocultural Territory using the Indigenous Biocultural Heritage Area (IBCHA) model developed by Asociación ANDES, a local NGO. IBCHA incorporates the best of contemporary science, conservation models and rights-based governance approaches, including the IUCN's Category V Protected Areas, as well as positive and defensive protection mechanisms for safeguarding the collective biocultural heritage (CBCH) of Indigenous Peoples. The total population is about 3,900 from six different communities.

The main subsistence activity in the Potato Park is agriculture and animal husbandry. A bit more than 13 per cent of the park area (approximately 1,133 hectares) is used for the permanent agriculture of corn, *tarwi*, potatoes, beans, barley and other crops, while 34 per cent of the park area is made up of tundra or land which is resting. Crop rotation occurs every three to nine years. First, farmers cultivate potatoes, *masha* and *oca*, then the land is left fallow. During fallow periods, many medicinal plants can be found growing in these plots.

Much of the work on maintaining crop diversity has been led by Asociación ANDES and supported by numerous different donors including The Christensen Fund. The activities have included repatriation of over 400 local varieties of potato from the *Centro Internacional de la Papa* (CIP), adaptation to climate change, capacity-building, income generation and eco-tourism. While the core work is self-sustaining, ANDES is involved with work with many donors to extend the reach of these activities and expand into new areas.

Source: http://www.parquedelapapa.org/; http://www.andes.org.pe

At the international level, both the CBD and the Plant Treaty provide a supportive policy environment for the conservation and sustainable use of PGRFA and foresee the fair and equitable sharing of benefits arising from their use. Of particular relevance are the farmers' rights. Yet so far, very few countries have implemented national legislation to implement farmers' rights.

a "commons" for PGRFA of the most important crops through the multilateral system of access and benefit sharing, and recognizes both breeder's rights and farmers rights.

At the international level, both the CBD and the Plant Treaty provide a supportive policy environment for the conservation and sustainable use of PGRFA and foresee the fair and equitable sharing of benefits arising from their use. Of particular relevance are the farmers' rights, (Article 9 of the Plant Treaty. See: http://www.planttreaty.org/content/texts-treaty-official-versions) specifically: (1) the right to protect traditional knowledge relevant to plant genetic resources for food and agriculture; (2) the right to equitably participate in sharing benefits arising from the utilization of plant genetic resources for food and agriculture; (3) the right to participate in making decisions at the national level on matters related to the conservation and sustainable use of plant genetic resources for food and agriculture; and (4) the right to save, use, exchange and sell farm-saved seed/propagating material, subject to national law and as appropriate. Nevertheless, while the Plant Treaty is a legally binding agreement in international law, the responsibility for realizing farmers' rights,

Yet so far, very few countries have implemented national legislation to implement farmers' rights.

as they relate to plant genetic resources for food and agriculture, rests with national governments. So far, very few countries have implemented national legislation to implement farmers' rights.

At the national and regional levels, access to seeds is mainly affected by seed legislation, aiming at ensuring the agronomic value and the quality of seeds being sold, and by intellectual property protection legislation (plant breeder rights or patents) aimed at supporting crop improvement by granting breeders the exclusive right to exploit, for a number of years, the plant varieties they develop. Both types of legislation and related policies support a formal seed system for commercial varieties. These policies and legislation mostly have negative consequences for the informal seed systems which are the main source of seed for smallholder farmers in developing countries and for farmers globally who grow traditional or heirloom varieties. Indeed, the varieties grown by these farmers are genetically diverse and do not satisfy the "uniformity" and "stability" requirements of both types of legislation. The consequence is that farmers are either forbidden to sell their seed or are allowed only to sell small quantities.

Other policies that can represent obstacles to the continued use of diverse seed include subsidies for improved commercial seed, strict prescription by extension services and governmental regulations about which varieties a farmer should or can grow.

Box 3

SUPPORTING SEED DIVERSITY: EXAMPLE OF SUCCESS FROM GOROMONZI DISTRICT, ZIMBABWE

The work was funded by the International Fund for Agricultural Development (IFAD) and Oxfam Novib and led by the Community Technology Development Trust (now the Community Technology Development Organisation) (CTDO), Zimbabwe. The number of primary target households involved was 6,720. They chose farmers who grew—on average—five to six different crops and three to four varieties of each crop; a mix of traditional and modern varieties. The program's intervention led to an increase in the number of varieties per household from three to five. The intervention involved establishing 65 farmer field schools (FFS). There were 750 farmers trained in small grain production through the FFS. They produced 17 tonnes of pearl millet seed and seven tonnes of sorghum seed, which have been sold locally. Through the program, two sorghum varieties from the gene bank and four local varieties from Uzumba-Maramba-Pfungwe district, which had been lost from the farming systems, were reintroduced. On the policy side, a new Farmers' Rights Bill between CTDT staff and officers and Ministry of Agriculture officials was drafted. In addition, an alliance with the Zimbabwe Farmers Union ensured outreach to more than 10,000 farmers in neighbouring districts.

Source: Oxfam Novib et al., 2015

Nonetheless, it should be noted that appropriate policies can also promote access to diversity through support to farmer maintained varieties, community seed banks, participatory plant breeding and seed diversity fairs. Such support may be through national legislation, regulations, guidelines, national plans, financial support, or decisions that favour the use of greater diversity by local, regional or national authorities. At the national level, the full implementation of farmers' rights as enshrined in the Plant Treaty is perhaps the single most important step. Different countries have also taken steps to support community seed banks (e.g., Nepal, Brazil, and Mexico) embedding them into their conservation system. In the state of Paraiba in Brazil a special program allows the state government to buy seeds of local varieties and distribute them among farmers (see case studies cited in Vernooy et al., 2015; Jarvis et al., 2016 Chapter 10).

FUNDING STREAMS

Funding for informal seed systems and on-farm management of agrobiodiversity has so far been limited and very dispersed when compared with investments in *ex situ* conservation. Both the Commission on Genetic Resources for Food and Agriculture and the governing body of the International Treaty on Plant Genetic Resources for Food and Agriculture have asked for more investment to be made in this area; however, these recommendations have not yet been translated into significant investments.

Funding for informal seed systems and on-farm management of agrobiodiversity has so far been limited and very dispersed when compared with investments in *ex situ* conservation. It involves many isolated actors, including NGOs, foundations, international organizations and bilateral donors. In recent years, this area of work has been receiving more attention, and both the Commission on Genetic Resources for Food and Agriculture and the governing body of the International Treaty on Plant Genetic Resources for Food and Agriculture have asked for more investment to be made in this area; however, these recommendations have not yet been translated into significant investments. In general, the donors listed below have funded a mix of activities which includes action research, support for farmer managed systems and advocacy. Early development aid donors focused more on research and community based support, while NGOs included support for advocacy. The Oxfam Novib program emphasizes the importance of combining these areas of activity in the work it supports, exemplifying a trend towards a more integrated approach.

Among international NGOs (INGOs), three are implementing substantial work on traditional seed systems and on-farm agrobiodiversity management. These are the Norwegian Development Fund (a Norwegian NGO supported by the Norwegian Ministry of Foreign Affairs), Oxfam Novib and USC Canada. In addition, many other INGOs support local initiatives at a smaller scale.

Among the development aid donor countries only a few are supporting significant work in this area. Currently it seems that Canada, Norway and Switzerland are the major donors. The first two work mainly through NGOs based in their country (USC for Canada and the Norwegian Development Fund for Norway). Switzerland is supporting work by Bioversity International, Research Institute of Organic Agriculture (FiBL), the Berne Convention, the African Centre for Biodiversity and BioVision. The Belgian Development Cooperation has recently shifted the emphasis of its support in Central and West Africa away from formal, commercial seed systems to informal seed systems, farmer field

schools and agroecology. Germany, through GTZ (now GIZ) has invested significantly in seed systems and agrobiodiversity in the past, but this is no longer a priority in the German development cooperation agenda.

A number of members of the Global Alliance for the Future of Food have been supporting projects on relevant areas, either directly or through general support to community based organizations that carry out relevant work in this area. This topic has been gaining importance on the agenda of foundations such as The Christensen Fund, Agropolis Foundation, the Kalliopeia Foundation, the New Field Foundation, the Swift Foundation and The Tudor Trust. In addition, The McKnight Foundation, The Heinrich Böll Foundation, and Fondation Daniel & Nina Carasso, amongst others, have supported projects that include relevant components.

Among other private foundations, the topics of informal seed systems, on-farm management of agrobiodiversity and agroecology have also gained greater interest in recent years. For example, the Fondation Charles Léopold Mayer pour le Progrès de l'Homme is supporting significant informal seed system work in France, and the W. Garfield Weston Foundation is supporting work in Canada through USC Canada. A German foundation called Welthungerhilfe (WHH), is also supporting work in Cuba through USC.

A number of other foundations provide more modest support to this area of work, either directly or indirectly through support to NGOs that have some activities in this broad area. They include: Bread for All, Switzerland; Brot für die Welt, Germany; Lillian Goldman Charitable Trust, United States; CS Fund, U.S.; Misereor/KZE, Germany; Swissaid, Switzerland; La Fondation Léa Nature, France; Fondation de France, France; Fondation Un Monde par Tous, France; La Fondation Terra Symbiosis, France; Fondation Nature et Découvertes, France; Petzl Foundation, France; and The Salvia Foundation, Switzerland. [Note: This is by no means an exhaustive list. It is merely a compilation of information provided to us by interviewees or on the websites of a few organizations with relevant activities.]

The ITPGRFA Fund has called for proposals that include on-farm conservation of PGRFA; a number of projects have been funded. The UNEP-GEF program has made significant investments in agrobiodiversity conservation and the GEF-6 Strategy includes a new program called "Securing Agriculture's Future: Sustainable Use of Plant and Animal Genetic Resources," which aims to support *in situ* conservation by local communities. It will focus on farmer management, support for livelihoods and food, and nutrition security through community based management of crop and animal diversity (GEF-6 Programming Directions paras. 71-72). The UNDP-GEF small grants program has recently consulted with countries in Latin America which have expressed a strong interest in applying for small grants to support work about on-farm management of agrobiodiversity and implementation of farmers' rights. Similar consultations are taking place in Asia and Africa.

Several governments of countries in the Global South have started to invest in programs that support farmer managed seed systems and on-farm management of agrobiodiversity. These include India, Nepal, and Sri Lanka in Asia; Ethiopia, South Africa and Zimbabwe in Africa; and Brazil and Peru in Latin America.

Although there appears to be an overall steady increase in funding for work about the on-farm management of agrobiodiversity, the scattergun approach, characteristic of current efforts, has limitations. For this work to gain momentum and visibility, to attract more support globally, and to be more efficient in scaling up and scaling out successful initiatives, an effort to bring together a number of different funders would be most beneficial (see section below on strategic opportunities).

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BARRIERS AND CHALLENGES

There are significant barriers to the deployment of increased seed diversity in production systems and a number of powerful drivers have contributed to a reduction in the diversity in production systems.

Table 1 below lists drivers affecting biodiversity that were identified in country reports prepared for the forthcoming first Report on the State of the World's Biodiversity for Food and Agriculture (SoWBFA) currently being prepared for the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA). These drivers also affect the continuing availability of seed diversity, although some have a greater effect than others. Those of particular importance to seed diversity include changes in land use, pests and diseases, markets and trade, policies, movement from rural areas to cities, changes in economic, socio-political and cultural factors, and scientific and technical advances in the form of new varieties. This last driver has been supported by the increasing privatization of plant breeding and the large investments of multinational companies in

Table 1. Drivers of change of biodiversity for food and agriculture

Changes in land / water use/management
Pollution and external inputs
Over-exploitation and over-harvesting
Climate change
Natural disasters
Pests, diseases, and alien invasive species
Markets, trade, and the private sector
Policies
Population growth and urbanization
Changing economic, socio-political, and cultural factors
Advances and innovations in science and technology

the development of a global, vertically integrated seed industry.

How do these drivers influence seed diversity at landscape or community levels? Jarvis et al. (2011) reviewed over 500 papers on the maintenance of traditional varieties and developed a framework to identify the main constraints to the continuing use of such varieties. They identified four main limitations:

1. Local crop genetic diversity does not exist or is not in sufficient quantities within the production system.
2. Local crop genetic diversity exists but is not accessible to farmers.
3. Farmers do not value and use local crop genetic resources.
4. Farmers do not benefit from the use of local crop genetic diversity.

Jarvis et al (*op. cit.*) summarized the causes of these different situations and noted the importance of policy constraints, resource limitations, the effectiveness of seed networks, the strength of social institutions, the realization of market and non-market benefits, available knowledge, and the quality of the materials (both seed and agronomic).

Anyone using an intervention to strengthen seed diversity might find it useful to follow the approach developed by Jarvis and her collaborators as part of a diagnostic and baseline analysis and to review, specifically, the extent to which seed networks exist and have the potential to ensure that benefits from interventions are sustained (see Appendix 1).

Seed networks illustrate the importance of social institutions in improving seed diversity, and the weakness of these institutions was identified as a major barrier to the success of interventions by those interviewed during the preparation of this paper.

Seed networks illustrate the importance of social institutions in improving seed diversity, and the weakness of these institutions was identified as a major barrier to the success of interventions by those interviewed during the preparation of this paper. The importance of social institutions has also been described by van Oudenhoven et al. (2011) in their work on the development of social-ecological resilience indicators. Often more formal structures are needed to strengthen the functions of social institutions and the development of community based organizations (CBOs) has been identified as a key step in supporting diversity maintenance by Sthapit et al. (2006). Such organizations provide an operational framework at a community level from which to address specific challenges such as lack of shared knowledge or access to materials. They can also support the realization of both market and non-market benefits.

The nature and role of local organizations varies. The Oxfam Novib and Hivos joint program places emphasis on Farmer Field Schools as a continuing way to bring farmers together in a community to share knowledge and address challenges. Both CBOs and FFSs support the introduction of new knowledge and materials, and the absence of effective local organizations is clearly an important constraint. Community seed banks may need external funding for their establishment, but the different approaches that have been developed involve operating practices aimed at ensuring a rapid move towards self-sufficiency in their maintenance of operations. Even so, participating farmers often

remain linked to NGOs and national agricultural agencies which continue to provide advice and are a potential source of new materials of interest to them. (For a review of practices and experiences, see Vernooy et al., 2015).

A major challenge in many countries is the weakness of their national agricultural systems and their limited capacity to support community based interventions. This can be an advantage in that communities are left to find their own solutions and thereby gain a freedom of operation that might otherwise not exist. However, in the longer term, and with the objective of ensuring and mainstreaming diversity into production systems, national agricultural systems will need to be engaged and involved. This is emphasized by the Oxfam Novib program and by the different GEF supported projects. Their involvement also provides one entry point for addressing policy issues. Successful community initiatives still operate within a national, or even regional, policy framework, especially as these affect access and distribution of seeds and varieties, participatory crop improvement or marketing.

Efforts to remove policies that undermine, and to develop policies that support, have to be integral parts of all interventions.

Supportive national and regional policies are important prerequisites for successful scaling up and mainstreaming of on-farm management of diversity. Attention needs to be paid in any intervention to the negative or positive effects that policies will have. Efforts to remove policies that undermine, and to develop policies that support, have to be integral parts of all interventions. National or local civil society organizations are often important partners in this regard. While interventions need to be community based, questions remain concerning the scale at which interventions are most useful.

Earlier research-based projects concentrated on single communities or villages, but more recent work has involved larger areas and has adopted what has been described as a more landscape-based approach. Landscape approaches bring benefits involving larger numbers of farmers who share common features with respect to their production system (some examples include the work undertaken in Kaski, Nepal and by ANDES in Peru). They can reflect more closely the full extent of seed networks and support a greater access to, and exchange of, materials. On the other hand, from a research perspective, landscape approaches can require greater investment in terms of sampling and establishing the baseline. As the Oxfam Novib and Bioversity Seeds for Needs programs suggest, perhaps the real challenge is to scale out beyond a single landscape.

Interviews conducted for this report confirmed the analysis above. The barriers below were most frequently mentioned, in no particular order.

- Low awareness by policy makers about the key roles of agricultural diversity, in situ and on-farm conservation and community based diversity management
- Lack of funding for such activities
- Lack of information and capacity of farmer and community based organizations

- Legal/policy restrictions on local seed saving and exchange at national, regional and international levels
- National policies, laws and practices that promote industrial agriculture
- Limited examples of policies and laws that support this kind of work
- Strong private sector promotion and distribution of improved commercial varieties and associated technology packages based on synthetic inputs
- Lack of access by farmers to genetic resources in gene banks
- Socio-cultural prejudices and negation of traditional knowledge by academia and institutional settings and national agricultural programs
- Lack of support for participatory plant variety selection and breeding programs
- Lack of producers of diverse seed materials.

The analysis of barriers and challenges emphasizes the importance of a community-level, participatory, farmer driven approach, and the need for policy and institutional frameworks that can support these, providing partnerships, benefits of scale, access to new knowledge and varieties that complement traditional knowledge, experience and materials. The analysis also emphasizes the importance of combining agricultural and biological aspects with social and economic perspectives and recognizing the potentially constraining effects of national and regional policies.

STRATEGIC OPPORTUNITIES

While recent decades have revealed a continuing trend towards industrial agriculture based on simplified production systems and increasing monocultures, the value and benefits of diversity-rich production systems have also been increasingly recognized. There are good reasons to suggest that significant opportunities now exist to increase support for actions that strengthen the maintenance and use of diversity on farms. The most important are:

- the recognition of the value of agroecological approaches;
- the need to support adaptation to climate change and improve resilience in production systems;
- the increasing demand of many stakeholders (including consumers) for changes in currently dysfunctional food systems; and
- the importance of diversity in improving food security and nutrition.

Underpinning these is the recognition of the need to develop more sustainable approaches to agricultural production.

Crop and traditional variety diversity make important, though perhaps under-recognized, contributions to the ecological processes needed for agroecology to succeed.

Agroecology

The management and use of biodiversity underpins agroecology. Soil health, pest and disease management, improved nutrient cycling, better use of water and management of abiotic stresses all depend, to a greater or lesser extent, on ensuring that the biodiversity needed to support these processes is present in and around production systems. The agrobiodiversity community increasingly recognizes this with its focus on the function of diversity within production systems. Crop and traditional variety diversity make important, though perhaps under-recognized, contributions to the ecological processes needed for agroecology to succeed, especially with respect to pest and disease control and abiotic stress management (see e.g., Mulumba et al., 2012; Hajjar et al., 2008). There remains, however, a disconnect between the actors who are concerned with strengthening agrobiodiversity in production and those whose entry point is agroecology.

Climate change and resilience

Mijatovic et al (2013) have shown that Indigenous and rural communities have made significant use of agrobiodiversity in adaptation to climate change. The Commission on Genetic Resources for Food and Agriculture (CGRFA), at its last meeting, adopted a set of guidelines to support the use of genetic resources for adaptation to climate change that closely followed the approach of the United Nations Framework Convention on Climate Change (UNFCCC) in its own guidelines on the development of National Adaptation Plans of Action.

Production systems are not only experiencing changing climates, they are subject to climate regimes which have not previously existed in other parts of the world. Both widely adapted robust traditional varieties and new varieties from other parts of the world will be an essential part of national adaptation strategies. Increased diversity in production systems will be needed to provide the necessary portfolio effect, future option strategies, and resilience benefits needed.

Bioversity's Seeds for Needs program explores one approach that can support increased availability and access to variety diversity for smallholder farmers. The process involves identification of a set of crop materials—including both traditional and modern varieties—that are distributed to farmers (three varieties per farmer) using a crowdsourcing approach. Farmers provide feedback by mobile phone, and the information from all the different farmers in the region is integrated to provide variety recommendations and support wider dissemination of materials through community seed banks and farmer-to-farmer exchange. In Ethiopia there are now 2000 farmers involved, and over 400 varieties have been tested. In India some 15,000 farmers are now reported to be participating (http://www.bioversityinternational.org/seeds-for-needs/).

Over-nutrition or obesity, and its associated non-communicable diseases—including Type 2 diabetes, cardiovascular diseases, and different types of cancers—have now become the largest cause of mortality in both low and middle income countries. It is recognized that greater diversity, especially underutilized species, play a key role in providing the dietary mix necessary for a healthy life.

Malnutrition

In recent years, there has been an increased recognition of the societal impact of different forms of malnutrition; not just hunger or under-nutrition, traditionally the focus of food security concerns for many years, but also micronutrient malnutrition and over-nutrition/obesity. Micronutrient malnutrition is affecting more than two billion people, undermining their developmental potential with a direct impact on national productivity. Over-nutrition or obesity, and its associated non-communicable diseases—including Type 2 diabetes, cardiovascular diseases, and different types of cancers—have now become the largest cause of mortality in both low and middle income countries. It is recognized that greater diversity, especially underutilized species, play a key role in providing the dietary mix necessary for a healthy life (Frison et al., 2011; Carletto et al., 2015).

Demand-led change

It is frequently claimed that the global food system is dysfunctional and unsustainable, involving massive subsidies and substantial waste while still not meeting the challenges of dealing with hunger and malnutrition. A growing movement of consumers is seeking alternative solutions through support for local food sources, organically produced products and, in Europe, a continuing suspicion of technological approaches, particularly reflected in a negative attitude towards genetically modified foods.

At the same time, there has been significant growth in civil society activities that challenge many of the current industrial farming approaches to food production. This is exemplified by support for food sovereignty, the growth of the Slow Food movement, and the increasing activities of organizations such as La Via Campesina and seed savers groups. Other rural groups have shown increasing interest in food-based issues, particularly the Indigenous Peoples' movements around the world.

These different trends have led to an increased interest in diversity-based production and the roles of traditional varieties, minor or neglected crops. This quest towards diversified approaches is often hijacked by agribusiness, as in the case of quinoa where very few varieties have come to dominate production with negative impact for the producers in the Andes using traditional varieties. However, the increasing demand for alternative approaches to production, with a trend towards agroecology and diversified production using traditional varieties, is a reality that presents an important opportunity.

Building alliances

Together with these major opportunities to obtain significant societal benefits from the increased use of seed diversity, there are opportunities to work with a number of organizations that have developed increasingly clear strategies and actions that support this approach. The GEF Strategy now places emphasis on sustainable agriculture and directly supports actions to achieve the Aichi Biodiversity Targets (of which Targets 7 and 13 are particularly relevant). It also

includes a program (Programme 7) of direct relevance to the community maintenance of seed diversity. The UN Sustainable Development Goals (SDGs) have a clear target supporting the conservation of agrobiodiversity. Also, Oxfam Novib's new program reflects a growing commitment from outside traditional conservation or agrobiodiversity based organizations.

Other developments of this nature include the UNDP-GEF small grants program, which could provide a great opportunity for co-financing. The Small Grants program could fund grassroots activities in countries; while co-funding by other donors, including foundations, could support the necessary technical backstopping and capacity development that cannot be funded by the Small Grants program. FAR has been identifying funders who could provide this kind of co-financing.

A significant opportunity would be to establish a broad, collaborative initiative, based on a matching funding agreement between a number of foundations and bilateral donors. A number of bilateral donors supporting work in this area, and who have expressed an interest in doing more, could be approached with a proposal. In the past Norway has provided major funding for *ex situ* conservation of PGRFA through the Global Crop Diversity Trust, including US$23 million to the endowment fund and a 10-year grant of US$50 million. They have also provided support to the Benefit Sharing Fund of the ITPGRFA, which supports projects related to the on-farm conservation of PGRFA. The Norwegian Ministry of Agriculture is very supportive of on-farm management of diversity, and could support the idea of a joint effort in this area. Switzerland might be interested in joining forces through a collaborative initiative. It would therefore be very opportune for a group of foundations to approach Norway, Switzerland and potentially other donors with a concrete proposal to create a co-financing mechanism with a credible implementation mechanism. The possible focus of such alliances is discussed in the final section.

OPPORTUNITIES FOR FUNDERS

There are opportunities that could be seized to make a leap forward in scaling up and scaling out on-farm management of diversity and securing the access to the necessary seed diversity by farmers.

As described above, there are opportunities that could be seized to make a leap forward in scaling up and scaling out on-farm management of diversity and securing the access to the necessary seed diversity by farmers. These opportunities could be made to converge in a major international effort to incorporate diverse, thriving, agroecology-based systems into the mainstream by developing a broad strategy including the elements described below and supported by a group of funders' coordinating their efforts. Each funder could support activities in line with the broad strategy while focusing on those most in line with their mandates and priorities.

In each area, one important need is to create a stronger link between agroecology and agrobiodiversity-based approaches. This includes collaborative knowledge generation, the development of practices which build on experiences from both areas, policy links and collaboration on building capacity and advocacy.

From the consultations and analysis of the current situation, a broad consensus emerged about the areas that need support. These have been grouped into five categories:

1. WORK AT THE COMMUNITY LEVEL

One of the most important actions needing to be funded is the strengthening of farmer and community based organizations that work to support community based and farmer driven seed systems. This includes *in situ* / on-farm seed conservation and use, seed banking, and participatory applied research (PVS and PPB) aimed at the development of a broad and diverse base of adapted plant genetic resources. This requires support for the launch, spread or deepening of local initiatives and the piloting of new innovations, as well as support to achieve scale through interaction with various levels of government and other key seed and food security actors.

This should not involve any long-term dependency on external support beyond that which already exists in agriculture (e.g., from government sources). The focus should be on improving access to a wider range of diversity using the approaches described in previous sections and linking these to improved livelihoods and income (see also Boxes 1, 2 and 3 for examples).

There is a great need to strengthen knowledge exchange and networking. Support for farmer-to-farmer seed and related knowledge exchanges, and linking community seed banks to national and international gene banks would also be valuable.

There is a great need to strengthen knowledge exchange and networking. Support for farmer-to-farmer seed and related knowledge exchanges, and linking community seed banks to national and international gene banks would also be valuable.

Support is needed for local organizations of smallholder farmers implementing work on agroecology, the dynamic management of biodiversity for food and agriculture at the field/landscape level and adding value at the local level through processing and marketing local varieties in local/regional markets. This will include:

- opening up space at—or establishing—farmers' markets, organizing seed and food fairs and making connections to market outlets in cities;
- strengthening and supporting farmer organizations and social movements on policy matters central to their seed, food and livelihood systems; and
- supporting the creation and strengthening of existing national/regional networks of practitioners in the management of biodiversity for food and agriculture, such as farmers' seed producer networks, fruit grower networks, vegetable seed savers, farmer bakers, and rural women processors.

2. CAPACITY-BUILDING AND TECHNICAL BACKSTOPPING OF COMMUNITY-LEVEL ACTIVITIES

There is a strong demand for building capacity of farmer and community based organizations as well as national researchers and extension agents in a broad range of domains including:

- community organizational and technical skills (e.g., seed management, breeding techniques, and marketing skills);
- community participation and bottom-up planning and decision making;
- connecting local organizations/farmer communities with others doing similar work and having similar interests, in-country and across countries;
- participatory varietal selection (PVS) and plant breeding (PPB);
- community seed banking systems, seed storage techniques and appropriate technologies;
- strengthening farmer and community based organizations in advocacy on seed, land, farmers' rights; and
- extension capacity within farmer associations and amongst farmers.

In addition, many isolated community-based initiatives would benefit from technical and scientific backstopping to guide and share best practices for community seed banking, strengthening of informal seed systems and participatory plant breeding.

3. WORK TO PROMOTE SUPPORTIVE POLICIES

There is a need for more supportive and effective policies and laws, to remove obstacles and policies harming community based agrobiodiversity management, and to create a supportive framework for community based diversity management initiatives

There is a need for more supportive and effective policies and laws, to remove obstacles and policies harming community based agrobiodiversity management, and to create a supportive framework for community based diversity management initiatives. While in some regions (e.g., the European Union and the Southern African Development Community) seed related legislation has been developed, most policies and laws are developed and implemented at the national or state level. Bioversity International has done important work in this area, and could provide the necessary backing to countries to develop supportive policies and remove the harmful ones.

Support is needed to create space for the participation of farmer organizations and social movements at policy fora at various levels, and strengthening and supporting them on policy matters that are central to their seed, food and livelihood systems. Civil society and farmers' groups are already active in CBD, CGRFA, ITPGRFA and CFS (Committee on World Food Security) and their contribution to debates in these fora should be supported and strengthened. A stronger voice for farmer concerns about agrobiodiversity is needed in fora such as the International Union for the Protection of New Varieties of Plants (UPOV) and the UN Framework Convention on Climate Change (UNFCCC), which itself needs a much more focused consideration of climate change and agriculture.

There is a broad recognition for the important role of participatory, trans-disciplinary research in which farmers and researchers collaborate on equal footing and in which traditional knowledge and scientific knowledge are combined.

4. PRIORITY AREAS OF RESEARCH ON SEED AGROBIODIVERSITY AND SEED SYSTEMS

There is a broad recognition for the important role of participatory, trans-disciplinary research in which farmers and researchers collaborate on equal footing and in which traditional knowledge and scientific knowledge are combined. Participatory research practices have been widely adopted and involve free, prior and informed consent (see http://agrobiodiversityplatform.org/climatechange/the-project/abd_and_cc_project_fpic/), shared identification of research issues, (see, for example, the debates held on agricultural research agendas for West Africa http://www.newfieldfound.org/pdfs/AccraWorkshopEnglish.pdf) the development of trans-disciplinary research agendas (Lang et al., 2012), participatory working practices, (Gonsalves, 2005) and the sharing of all findings with participating communities.

This analysis, and those interviewed, identified the need for more research into:

- effective policy and legal mechanisms and incentives to support farmers and their organizations to make the best use of agricultural biodiversity and to have their voices and choices recognized and taken into consideration;
- novel ways to make markets work for the custodians of agricultural biodiversity;
- the direct nutritional benefits of diversified food production, diversified diets, and the enhanced nutritional value of farmer's varieties and wild and semi-cultivated foods;
- seed network building methodologies and strategies;
- the functional contribution of seed diversity to agroecosystem properties including the provision of regulating, supporting and provisioning ecosystem services;
- characterization of genetic resources adapted to local conditions; and
- low cost seed conservation technologies.

5. ADVOCACY WORK

The low awareness by policy and decision makers about the key roles of agricultural diversity, *in situ* and on-farm conservation and community based diversity management is a major obstacle to mainstreaming such approaches. Therefore, advocacy is needed about the importance of these roles and other aspects, such as the impact of seed laws that undermine local seed saving. Advocacy is also needed to reform trade, and land and investment policies that are eroding community control of the commons, the natural resources, ecosystems and biodiversity, which are crucial to the long-term survival of family farming systems. Assisting farmers and civil society organizations engaged in this kind of advocacy to create a supportive environment will be important for the success of community based activities.

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APPENDIX 1. A HEURISTIC FRAMEWORK TO IDENTIFY LIMITATIONS IN AVAILABILITY AND ACCESS TO CROP GENETIC DIVERSITY (FROM JARVIS ET AL., 2011)

1. Local crop genetic diversity does not exist or is not in sufficient quantities within the production system.

- 1a. Local crop genetic diversity does not exist within the production system ecosystems
- 1b. Local crop genetic diversity exists but at insufficient quantities
  - 1b.1 Insufficient materials available
  - 1b.2 Lack of capacity to multiply materials

2. Local crop genetic diversity is not accessible to farmers

- 2a. Farmers lack resources to acquire the materials
  - 2a.1 Lack of funds to access from within the community
  - 2a.2 Lack of funds to cover costs of access from outside community
- 2b. Crop genetic diversity is not accessible due to social constraints
  - 2b.1 Pressure from formal sector limits accessibility
  - 2b.2 Lack of social ties to access diversity
- 2c. Seed flow systems lack capacity to change or provide large enough samples to ensure adaptation and evolution
- 2d. Policies and institutions constrain seed flow

3. Farmers do not value and use local crop genetic resources

- 3a. Farmers do not perceive local crop genetic materials as competitive
  - 3a.1 Information on values and benefits exist but is not available or accessed
  - 3a.2 Information on values and benefits does not exist
- 3b. The materials have poor agronomic, ecological or quality performance or lack cultural acceptability
  - 3b.1 The material has low agronomic performance
  - 3b.2 The material is not adapted to abiotic conditions
  - 3b.3 The material is not adapted to biotic pressures
  - 3b.4 The quality of the material is poor
  - 3b.5 The material is not culturally acceptable
- 3c. Management of the materials can be improved
  - 3c.1 Seed cleaning and storage is a constraint
  - 3c.2 Materials are not managed as diverse sets of varieties
- 3d. Policies inhibit the use of farmer led materials and management methods

4. Farmers do not benefit from the use of local crop genetic diversity

- 4a. Insufficient market benefits from the materials
  - 4a.1 Low market value
  - 4a.2 Low market demand
  - 4a.3 Lack of technology to process diverse materials
  - 4a.4 Lack of trust among market chain actors
- 4b. Insufficient non-market benefits from the materials
  - 4b.1 Social-cultural benefits not valued
  - 4b.2 Substitution for inputs (fertilize, pesticide) not valued
  - 4b.3 Ecosystem service benefits of the materials not valued
  - 4b.4 Farmers' rights not valued
  - 4b.5 Lack of social responsibility

4c. Weak local institutions and farmer/community leadership

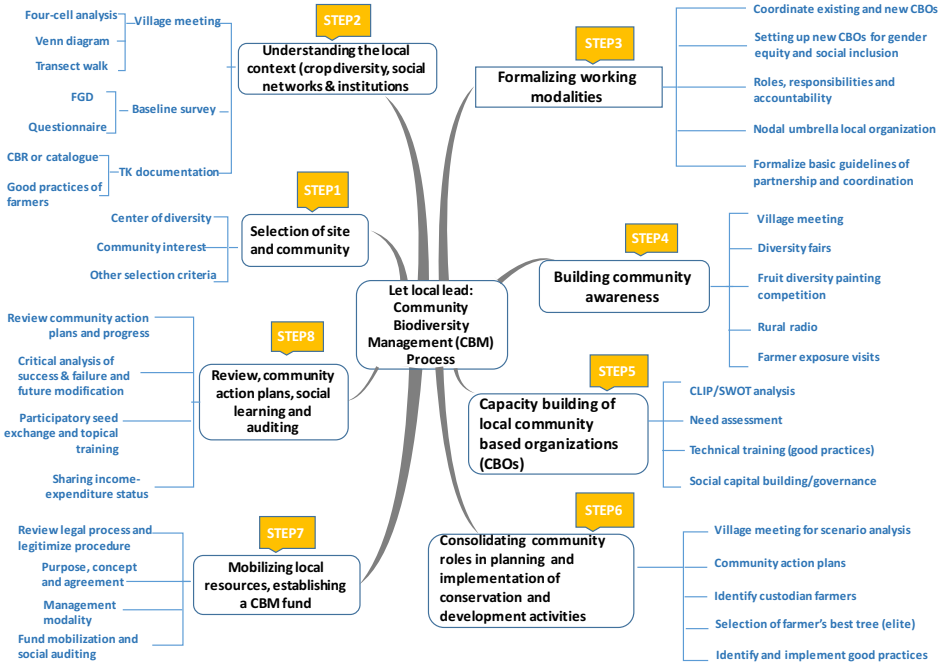
4c.1 Lack of collective action

4c.2 Lack of farmer/community leadership

4c.2 Lack of support to local institutions

From Jarvis et al., 2016. Note the limitations in any one community may be traced to a number of the causes identified above.

APPENDIX 2. THE COMMUNITY BIODIVERSITY MANAGEMENT APPROACH (ADAPTED FROM STHAPIT ET AL., 2006)



APPENDIX 3. REPORT METHODOLOGY

The authors evaluated the range of existing efforts to protect, restore and advance seed agrobiodiversity and the sources of support for such efforts. They explored strategic opportunities to strengthen the growing range of community based efforts with a view to identifying options for future support.

The work undertaken included the following elements:

- A review and assessment of available information on current efforts to protect, restore and advance seed agrobiodiversity, taking into account the nature and characteristics of seed systems and the wider framework which supports or limits seed agrobiodiversity maintenance and use (e.g., national and international policies which support or hinder such efforts)
- Phone and face-to-face interviews with some key players listed below. These included experts from FAO, GEF, Bioversity International, selected country donor agencies, private foundations, and civil society organizations (see Appendix 4).

The specific steps included:

1. Finalization of work plan, division of tasks between authors and agreement on precise use of terms such as "seed agrobiodiversity"
2. Analysis of information (using both published and grey literature) to identify, *inter alia*:
    - current status of work to protect, restore and advance seed agrobiodiversity at global, national and community levels;
    - current funding sources and possible trends in funding support for seed agrobiodiversity work;
    - typology of key players at community, national, international levels
    - contribution of seed agrobiodiversity to agroecology;
    - available information on indicators of impact of work on seed agrobiodiversity; and
    - current constraints to efforts to protect, restore and advance seed agrobiodiversity and their sources (e.g., policy, technical, resource, capacity).
3. Review of main findings and identification of gaps in information and possible ways of filling them
4. Preparation of the report and additional information provided as Appendices

APPENDIX 4. INTERVIEWEES WHO PROVIDED INPUT TO THIS REPORT

Civil society organizations

Alejandro Argumedo, ANDES, Peru
Sajil Sthapit, Director, LIBIRD, Nepal
Normita Ignacio, Director, SEARICE, Philippines
Guy Kastler, La Via Campesina
Henk Hobbelink, GRAIN, Spain
Susan Walsh, USC, Canada
Delmah Ndhlovu, ZIMSOFF, Zimbabwe
Robert Brac de la Perriere, BEDE; Semences paysannes, France
Gigi Manicad, Oxfam Novib

National program and project related experts with recent relevant experience

Athula Liyanage, Sri Lanka
Bert Visser, Netherlands

International agencies

Marieta Sakalian, UNEP-GEF
ITGRFA personnel, FAO
Mark Holderness, GFAR

National donor agencies

Christina Blank, SDC, Switzerland
Alberto Camacho, GIZ, Germany
Daniel van Gilst, NORAD, Norway
Teshoma Hunduma, Norwegian Development Fund, Norway
Philip Chiverton, SIDA, Sweden
Karin Höök, SSNC, Sweden
Van Vaerenbergh Reinout, MFA, Belgium
Jean Lebel, IDRC, Canada

Seed experts

Oliver Coomes, McGill University, Montreal, Canada
Jacob van Etten, Bioversity International
Michael Halewood, Bioversity International
Ronnie Vernooy, Bioversity International
Devra Jarvis, Bioversity International
Shawn McGuire, University of East Anglia, United Kingdom
Yves Vigouroux, CIRAD, Montpellier, France
Bhuwon Sthapit, Bioversity International

COMMENTARIES: INTRODUCTION

Since fall 2015, members of the Global Alliance for the Future of Food, which is made of up philanthropic foundations working in various regions of the world, have been exploring how we might collectively strengthen community based and farmer led efforts to protect and promote seed biodiversity. Given the complexity of the issues involved, we decided from the outset of the process to request input from diverse and divergent perspectives to help guide our decision-making. We started by commissioning an opportunities report from two well-known experts on the topic with broad experience at the international level. We then sent the report to experts in the field from diverse sectors and regions. The majority of experts asked to contribute to this compendium are farmers or scientists who support community based approaches to agricultural biodiversity conservation. We asked these experts to share with us, from their own experience, what they see as the best ways to strengthen community based and farmer managed seed systems, and how funders can contribute effectively to these efforts.

The commentaries are structured in response to three key questions:

1. What are the best ways that you know of to protect and strengthen community based seed systems?
2. Beyond lack of funding, what do you see as the blockages/barriers that get in the way of success?
3. Where do you think that funders can intervene for greatest impact in the area of seed systems?

We also encouraged commentators to choose from the following questions to address, based on whichever are within their realm of experience and expertise:

- What examples of success have you seen in community based seed systems that you feel could be examples for others to learn from, and why?
- How can researchers and farmers work together constructively to promote seed diversity?
- What role do you see public health institutions playing, if any, in promoting seed diversity as a component of community health and nutrition?
- How do you feel institutions might learn from Indigenous and traditional cultures in regard to the central role of seed to promoting cultural resilience and spiritual health?
- Do you see a role for policy advocacy in regards to promoting community based seed systems? If so, why? At what level should funders support advocacy in this regard?
- What do you think large development agencies and government institutions should be doing to promote community based seed systems?

Their responses are as rich and diverse as we could have hoped. They represent the beginning of what we hope is an ongoing conversation on the crucial issue of agricultural biodiversity. We share the commentaries here in their entirety. We have also summarized the key points in our synthesis of findings and in the summary of recommendations.

COMMENTARY: PUTTING FARMERS AT THE CENTRE OF THE STRATEGY

The African Centre for Biodiversity (ACB)

THE AFRICAN CENTRE FOR BIODIVERSITY (ACB) is a South Africa-based NGO that carries out research, analysis, advocacy and information-sharing which informs and amplifies the voices of social movements fighting for food justice and food sovereignty throughout Africa.

1. What are the best ways to protect and strengthen community based seed systems?

The best ways we know of to protect and strengthen community based seed systems are to build decentralized farmer seed networks to share seed and knowledge, with support from civil society organizations, government extension workers, researchers, technicians and others. Wherever possible, make links between seed work and membership-based farmer associations, at all levels, with the aim of learning and sharing and building organization. Reallocate a share of public and development funds towards participatory processes of experimentation, sharing, learning and strengthening all aspects of farmer seed systems. Some concrete ideas are suggested below.

2. Beyond lack of funding, what are some of the blockages/barriers that get in the way of success?

Poverty and desperation lead many farmers to respond to pressing needs with short-term solutions (such as using hybrids and synthetic fertilizers) but this comes at the cost of long-term viability of farmer seed systems.

Restricted information flows: There is a lot of evidence and many widespread practices regarding farmer seed systems, but this knowledge is often very local and inaccessible to most farmers. Many farmers are not organized locally, yet local farmer organizations are the basis for sharing and learning.

Urbanization and modernity pose a major threat to farmer seed systems.

"Green Revolution" solutions in government policy, programming and budgeting have become so politically entrenched that even though many are aware of problems, they find it difficult to shift out of this relationship with farmers/citizens.

The role of rural women and smallholder farmers in African society has been profoundly undervalued, despite the fact that around 80 per cent of Africa's population is dependent on smallholder agriculture—the backbone of the rural economy—where women provide 70 per cent of the farm labour. When it comes to seed, women are the custodians at the centre of seed saving, with significant importance in ensuring food security and genetic diversity.

In many rural areas, women tend to manage complex production systems with multiple functions, purposes, and species. While being responsible for the nutrition of their families, they produce, handle and prepare food, and provide most of the labour for farming, from soil preparation to harvest. After harvesting, they are almost entirely responsible for operations such as storage, handling, stocking, marketing and processing. These production systems are

not designed to maximize the productivity of any single crop but to ensure overall stability and resilience of the crops produced. Although these are crops of often minor commercial significance, they are key to household nutrition and food security.

This essential work carried out by women is often invisible and neglected by support agencies due to its diversity and lack of commercial value.

3. Where can funders intervene for greatest impact in the area of seed systems?

Funders can and should support the multi-disciplinary development of decentralized seed networks amongst farmers, CSOs, extension workers and technicians at various levels (local, national, and regional).

Ensure women remain at the centre of localized seed production systems and that farmers define needed improvements to seeds.

Provide technical support to link farmers with public sector research and development systems and in return they can draw and share lessons from the farmers' practice.

Support the development of multi-stakeholder advocacy coalitions around farmer seed system support, such as: policies, programs and budgets at local, national and regional levels, and promote engagement in national and regional policy spaces and the linkages between those policy spaces.

4. What are some examples of success in community based seed systems that could be examples for others to learn from, and why?

In all places we have visited, farmers are actively involved in selecting and saving seed for later use. Diverse traditional techniques are widespread and operational. At the same time, there are very few places where everything is a success.

There is dwindling interest in diverse seed and food, seed quality is not always ideal, yields may decline over time and local gene pools can stagnate. The need for cash means an orientation towards cash-making activities can predominate, leading to the use of higher yielding varieties (mostly hybrid for maize, which recycles very poorly) and no longer producing seed whose products cannot be sold for much cash.

There is evidence of participatory plant breeding (PPB) and participatory variety selection (PVS) in Africa. These practices are important because they connect farmers to the formal R&D system and the resources available there.

However, participatory processes of variety development and seed improvement do not have to be commercialized, information on this has yet to be gathered, synthesized, and analyzed. Lessons have yet to be drawn and shared. The same can be said for *in situ* conservation and seed enhancement and multiplication practices. Success varies and these practices need to be considered in their diverse contexts.

The success of collective/community seed banks depends critically on how farmers participate and take ownership of the process. If work could be done with the relevant households/custodian or nodal farmers to increase diversity in their seed banks and facilitate connections between them and other households interested in expanding seed diversity and with local distribution networks, this could be a far more decentralized and resilient model. Despite this, so far there seems to be little donor interest in household seed banks.

There are many traditional pest management practices for seed storage, such as smoking the seed, using mud and other methods. These practices can be learned and built on.

5. How can researchers and farmers work together constructively to promote seed diversity?

There are many traditional pest management practices for seed storage, such as smoking the seed, using mud and other methods. These practices can be learned and built on.

Technical work could include linking farmers with formal R&D and extension systems; germplasm access; on-farm participatory seed enhancement/improvement, selection and multiplication; seed storage; and systems of local and long distance exchange.

Participatory action research methodologies could be explored further. For instance, gathering and sharing information and knowledge in participatory ways in which farmers are directly involved, based on relationships of sharing and cooperation. Research which includes the direct involvement by farmers, their organizations and other relevant organizations, is based on shared learning. The action part refers to the research being a tool towards planning concrete actions with partners. At the outset the research must be shaped by all participants so that it serves a purpose for them.

Researchers can play a key role in facilitating and coordinating the action learning process, encouraging and ensuring farmer participation, making connections through face-to-face interactions with farmers who are part of the research team with CSOs and even extension workers where possible. This provides a framework for synthesis, facilitating processes of prioritization for further work, drawing in other participants where relevant and possible. It also facilitates learning and sharing, including farmer exchanges, documentation and analysis. Building research links across sites and countries can also build farmer organizations, especially when farmers are directly involved in the research as a participatory process, and the research feeds into practical action.

6. What role can public health institutions playing, if any, in promoting seed diversity as a component of community health and nutrition?

Seed diversity leads to nutritional diversity. The wider diversity of food crops people grow, the wider diversity of nutrients they can access. A decline in seed diversity results in homogenization of diets, a narrowing of nutrient diversity in varied combinations and a focus on calorie intake as a measure of food security rather than nutrient intake.

Public health institutions can support seed diversity by popularizing the link between nutrition and seed diversity. This need not take the form of direct relationships with farmers, which is not the core competency of public health institutions, but by working in cooperation with agriculture departments and other relevant government departments to mobilize support for expanding seed diversity, especially local production and local farmers' agroecologically adapted crops and varieties.

7. How can institutions learn from Indigenous and traditional cultures in regard to the central role of seed to promoting cultural resilience and spiritual health?

Traditional knowledge has been denigrated and is being lost. By and large, the youth have less interest in looking backwards—as they might consider it—and more interest in exploiting the possibilities presented by urbanization and modernity. Traditional or indigenous knowledge is seen as somehow less than science because it's less systematized. This knowledge mainly resides with the elders and is not being passed on.

In most of Africa, local farmer varieties are widespread, with a relatively small but highly significant encroachment of hybrid maize and related crops such as soya. This encroachment has sped up the homogenization of diets and the narrow focus on maize and calories consumed. This results in fewer local foods being consumed, creating a circular effect of reducing demand for diverse crops and varieties and hence their seeds.

Culture and spirituality are very dynamic concepts, and they are not locked down into some kind of atemporal stasis. We need greater understanding of the impacts of urbanization on lifestyles, livelihoods and the role of seed in the society at different scales.

8. Is there a role for policy advocacy in regards to promoting community based seed systems? If so, why? At what level should funders support advocacy in this regard?

A key issue is the allocation of public resources. Currently, in many African countries, there is a huge diversion of public resources into subsidizing corporate expansion through the farm input subsidy programs (FISPs). Information and analysis is needed on how public and development resources are being spent, and an argument must be made for the reorientation of seed-related resources put towards supporting and strengthening farmer seed systems.

Germplasm should be defined as a common good, since it is derived from centuries of crowdsourced human activity.

The extension of intellectual property (IP) through UPOV 1991 and the limits this imposes—whether intentional or not—on farmers' abilities to freely produce and exchange seed, is another policy threat that requires ongoing monitoring and advocacy. These laws threaten to reduce agricultural biodiversity through marginalizing and outlawing traditional/farmer varieties and practices. This may occur through the imposition of registration procedures, limitations on the exchange or sale of seed, and inappropriate certification requirements. Germplasm should be defined as a common good, since it is derived from centuries of crowdsourced human activity.

Identifying policy spaces and priorities, working with farmers, their associations and other CSOs is required at local, national and regional levels. Building at these three levels, civil society and other stakeholders, including the public sector, could work towards a long-term vision of decentralized seed networks. The aim of this advocacy would be to secure official support for farmer seed systems in laws, policies, programs, budgets and projects.

This is achievable by promoting strong farmer based seed production and exchange networks; building a widely shared knowledge base through farmer, CSO and extension exchanges and documentation; CSO seed networks cooperating with governments and identifying ways to work together; and creating links to global policy spheres (e.g., La Via Campesina, FAO and others).

This work is nascent and funders could support advocacy at many levels, including strengthening farmer voices through organization and networks; building CSO networks looking specifically at seed in relation to agroecology; linking farmers with technical support and recording the processes to strengthen and learn from farmer seed practices, and links to wider farming systems and agroecology; enabling participation in policy creation by identifying and opening spaces for meaningful civil society engagement which has a tangible impact on government decision-making processes; using these spaces to hear the voices of farmers, including through their network associations and organizations; identifying points of possible intersection between policy and program monitoring and analysis at national and regional levels; and supporting networked analysis of developments that identify and can create practical solutions.

9. What should large development agencies and government institutions be doing to promote community based seed systems?

They should dedicate resources to building the institutions, expertise, knowledge, etc., that support and promote farmer seed systems. This can be phased in, beginning with multi-stakeholder and multi-disciplinary involvement in areas of experimentation. They should start with farmers on areas identified through a participatory process as priorities. Networks can connect these activities and permit learning and sharing.

Some subjects to consider include: the role of farmers in plant breeding and seed selection, sources of public sector germplasm and farmer access, repatriation and technical support to expand seed diversity, enhancement and production in the field, local seed storage, local (household or community) seed banks, *in situ* conservation, the need and use of indigenous knowledge, ways of resuscitating and building seed diversity; intersections with formal seed systems and possible benefits and threats to farmer seed systems, the role of extension services and farmer organizations in seed systems, seed exchange and sale (e.g., seed and food fairs, exchange visits, meetings, and local markets).

Farm enhancement (breeding) and seed production/multiplication are also important areas to develop, but are excluded from the interconnections indicated between the informal and the formal system (see Figure 1 of the opportunities report).

Development agencies and government institutions can also support learning and sharing amongst farmers, advocates and practitioners from multiple institutions.

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COMMENTARY: REVITALIZING OUR INDIGENOUS HERITAGE

Emigdio Ballon,
Pueblo of Tesuque

EMIGDIO BALLON, a South American native, is a founder of the Four Bridges Traveling Permaculture Institute. He obtained his degree in Agricultural Engineering in his native country, Bolivia, and his Master's degree in Colombia. After working as a high altitude crops director in Bolivia, he moved to the United States to pursue a PhD in plant genetics. Currently he works as the Director of the Agricultural Department at the Pueblo of Tesuque in New Mexico. He continues to incorporate traditional agriculture, and the teachings of his ancestors, into all of his work.

1. What are the best ways to protect and strengthen community based seed systems?

As an indigenous Bolivian of Quechua decent, I grew up learning about my traditional seeds, foods, and medicines thanks to the knowledge of my mother and my grandparents. At a very young age, I learned to appreciate the importance of our traditional seeds which have been planted, cultivated, and saved for centuries. The Quechua people are descendants of the Incan people. They spent years developing ancient technology in growing and irrigation systems. Machu Picchu and Ollantaytambo in Peru are perfect examples of this technology. Using natural resources, the lay of the land, simple principals of physics, and sheer human strength, the Incans built an intricate irrigation system that, to this day still functions naturally, without need of a plumber. Our ancestors experimented to determine which crops grow best at various altitudes, weather conditions, and water availability, and created terrace gardens at altitudes of up to 4,200 metres. This history inspired me to pursue my degrees in plant genetics.

Thanks to the research and development of the Incan people, we now have more than 12,000 genotypes of potatoes, collected and stored in the International Potato Center, as well as several thousand genotypes of beans and corn collected and stored in their respective international centres. These crops are only a few examples of a society determined to hold on to traditions.

There are thousands of Indigenous communities throughout our Mother Earth fighting to protect their inherent rights to practice their traditions and grow their foods and seeds. They seek to draw attention to overlooked food crops in the world so that these communities, their foods and seeds are not forgotten or destroyed by genetic modification. The crops are not yet truly lost; indeed, most are well known in many areas of the world, especially among indigenous groups, but protecting these varieties is the main focus of international scientists and people trying to protect the food.

Education is central to protecting and strengthening community based seed systems. To help protect traditional seeds in Indigenous communities, we need to make their names known, we need to catalogue them and keep them under the watchful eye of the people. People need to protect the biodiversity of each community's ecosystem. Crops were developed by ancient Indigenous tribes. They established foods and seeds long before the invasion of their respective colonists. By the time of their conquest, the Indigenous tribes had brought these plants to their highest state of development and in many cases, such as maize, had spread them throughout other Indigenous communities.

Research is another way to protect seeds. Agronomists and ethnobotanists, many working in Indigenous communities, have begun preserving

what remains of traditional indigenous seeds. Indeed, a handful of dedicated Indigenous researchers have studied intensively and struggled for decades to promote them in the face of deeply ingrained prejudices in favour of European food. These efforts have sparked interest outside their regions. Some of these seeds are already showing promise in exploratory trials in other areas. For instance, the cultivation of quinoa has begun in the United States with some success. Other indigenous foods in other areas are also being tested.

Activism also helps to protect and strengthen community based seed systems. Winona LaDuke, an Anishinaabe activist, struggled for years to protect her community's sacred wild rice that "tastes like a lake." Her people won the fight against genetic modification. Hawaiians recently won their struggle to keep their traditional ***poy*** from being genetically modified. We are also struggling in New Mexico to protect chili and blue corn from genetic modification. Organizations such as the Four Bridges Traveling Permaculture Institute have helped to form the Northern New Mexico Coalition Against GMOs to protect the chili and blue corn.

This shows the importance of food crops and seeds that have been taken from Indigenous communities by corporations who seek to genetically modify and control them by patenting the resulting seed.

This indigenous heritage includes not only the food crops and seeds, but also the traditional planting and storing techniques. For example, the Hopi tribe is growing corn, beans and other crops in dry land, the same way that the Quechua people in the southern part of Bolivia grow quinoa in dry land.

2. Beyond lack of funding, what are the blockages/barriers that get in the way of success?

This indigenous heritage includes not only the food crops and seeds, but also the traditional planting and storing techniques

The major barrier to preserving indigenous foods and seeds is lack of funding, however, Indigenous people face many other barriers as well. I have witnessed the struggle in many Indigenous communities: the Quechuas, the Aymara, the Aztecs, the Mayans, the Hopi (descendants of the Anasazi), the Pueblo people of New Mexico, the people of the Iroquois Confederation (consisting of Mohawk, Oneida, Onondaga, Cayuga, Seneca, and Tuscarora nations), and many other Indigenous people.

Colonization has been a major factor in losing some of our cultural identity, which includes our traditional foods and seeds. Food is the basis for our existence, and without it, we cease to exist. This strategy of conquering Indigenous people by destroying their food supply is true for most Indigenous communities around the world.

As a military strategy, most so-called conquerors not only murdered the men, women, and children of a territory, but also laid siege to its food stores, which oftentimes held the seeds of the food supply for years to come. For the

Iroquois people, it was the newly formed American government that was the colonizer. To the American people, George Washington is known as the "father of his country," but to the Iroquois people he was known as "Ranataka'rias," or "town destroyer." In 1779, under the orders of Washington, John Sullivan's troops torched 40 Iroquoian villages, including 160,000 bushels of traditional corn. For the Aztec people, it is said that with the arrival of Cortez and the Spanish Conquistadors, nearly all of the amaranth—a grain that today is considered a super food—was burned, and its use forbidden.

Colonization has now morphed into modern political policies developed without Indigenous communities in mind. In colonial times, Indigenous people were forced into activities that were not traditionally their own. Slavery, mining, and other forms of hard labour threatened the very essence of each Indigenous community for hundreds of years. Use of traditional crops were forbidden, and nearly brought to extinction. Today, the same thing is happening with corporations such Monsanto, Bayer, Syngenta and others, who are poisoning our seeds with pesticides in the laboratory through genetic engineering and creating terminator seeds which cannot be saved and replanted. The poor farmer is dependent on purchasing seed each year from the rich corporations who attempt to own life, through patents.

Modern politics is also a barrier to the success of protecting and preserving traditional seeds and foods. Lobbying and protesting in support of protecting native seeds and foods needs to be organized in various political arenas.

Thus modern politics is also a barrier to the success of protecting and preserving traditional seeds and foods. Lobbying and protesting in support of protecting native seeds and foods needs to be organized in various political arenas. The fight against genetic modification and seed patenting must continue. Educating policy-makers on the importance of traditional seeds and the dangers of GMOs is essential. We must petition against governments in countries that work under the influence of corporations and with the World Trade Organization that supports genetic modification. We also need to fight against environmental contamination, caused by pesticides, fracking, and building pipelines, which threatens our foods and seeds.

We must reverse patents on life and patents on seeds. Living organisms make themselves. Life forms, plants, and seeds are self-organized, sovereign beings with intrinsic worth, value and standing. They are not invented by simply putting a gene into them. Adding a toxic gene should in fact be counted as pollution, not as a "creation," and furthermore, genetically engineered seeds with toxic genes in them need to be regulated with bio-safety in mind. Uniformity is being pushed as a positive criteria in order to legitimize corporate control over seeds.

Industrial breeding has used different technological tools to consolidate control over seeds; from so-called high-yielding varieties to hybrids, genetically engineered seeds, terminator seeds and now synthetic biology. The tools change but the quest to control life and society does not. The corporate law of the seed is undermining the very fabric of life. This is the ethical dimension of the issue. We are all members of the Earth family, stewards in the

web of life. Yet corporations are now claiming the role of creator. They have declared seeds to be their "invention", hence their patented property. A patent is an exclusive right granted for an invention, which allows the patent holder to exclude everyone else from making, selling, distributing and using the patented product. With patents on seeds, this implies that the farmers' right to save and share seed is now in effect defined as theft—an intellectual property crime.

Patents on seeds are legally wrong because seeds are not an invention. Patents on seeds are ethically wrong because seeds are life forms, our kin, members of our Earth family. "Owning life" by claiming it to be a corporate invention is both ethically and legally wrong.

3. Where can funders intervene for greatest impact in the area of seed systems?

Agricultural biological diversity, or more specifically, genetic resources for food and agriculture, provide humanity with food, clothes, and cultural identity and are essential to the development of sustainable agriculture and food security.

Evolution is the process by which nature practices its capacity of selection; for selection to exist, nature needs diversity. We need diversity to allow evolution, and thus capacity for adaptation. We need diversity in order to be able to select the best characteristics for crops. It is the basis for the farmer, the breeder, and the agricultural scientist in general. This diversity has been developed over thousands of generations and our duty is to safeguard it for future generations.

In spite of its vital importance for human survival, agricultural biodiversity is being lost at an alarming rate. It is estimated that in the past, some ten thousand species have been used for human food and agriculture. Currently, no more than 120 cultivated species provide 90 per cent of human food supplied by plants, and of those, only 12 plant species and five animal species alone provide more than 70 per cent of all human food. A mere four plant species (potatoes, rice, maize and wheat) and three animal species (cattle, swine and chickens) provide more than half of our food supply. Hundreds of thousands of farmers' heterogeneous plant varieties and landscapes that existed for generations in farmers' fields until the beginning of the twentieth century have been substituted by a small number of modern and highly uniform commercial varieties.

The loss of agricultural biodiversity has drastically reduced the capability of present and future generations to face unpredictable environmental changes and human needs. Also, meta-analyses published since 2005 have shown that as a general rule, reductions in the number of the genes, species and functional groups of organisms reduce the efficiency by which whole communities capture biologically essential resources into biomass. Thus, biodiversity

increases the stability of ecosystem functions through time.

On the basis of these facts, it is very important that foundations support retention and revitalization of traditional foods and seeds in Indigenous communities. I suggest the following plan of action in assisting these communities with their traditional foods, seeds, and agricultural practices.

- Identify and support areas where the natural collection of local seed exists.
- Create and support the exchange of seeds between Indigenous communities.
- Control the genetic erosion in plant resources for food and agriculture.
- Create and support local seed libraries.

COMMENTARY: PROMOTING CROP ADAPTATION: OLD STRATEGIES FOR NEW CONDITIONS?

Cary Fowler, Stanford University

CARY FOWLER is the former executive director of the Global Crop Diversity Trust, and the Chair of the International Advisory Council of the Svalbard Global Seed Vault. Originally from rural Tennessee, Fowler has been a professor at the Norwegian University of Life Sciences, a senior advisor to the Director-General of Bioversity International and a representative of the CGIAR Consortium in the negotiations of the International Treaty on Plant Genetic Resources for Food and Agriculture. He is currently a visiting scholar at Stanford University.

My views on the important question of whether and how agricultural crops will adapt and prosper in the future are based on two assumptions:

1. Climate change poses one of the greatest single challenges to agricultural productivity and food security in all of history. It is giving us higher average temperatures, higher extremes, longer periods of extreme heat, and high temperatures during vulnerable periods in the plant life cycle such as anthesis. Pests and diseases are extending their natural ranges resulting in new and novel assemblages of species existing together in fields and gardens. Water, land, energy, nutrient and other issues will pose additional and complicated challenges that will interact with climate to affect crop production.
2. Our crops do not come pre-adapted to constellations of conditions never before experienced.

Adaptation, as Darwin taught us, depends on diversity, inheritance, natural selection and time. In the case of our agricultural crops, we largely control diversity and, through plant breeding, natural selection. Without diversity—the "right" diversity providing the critically needed traits—there is no effective, sustainable adaptation. While individual farmers and gardeners in developing countries might, in a given year, have crop populations that are more diverse than the relatively uniform modern varieties of their counterparts in the U.S., for instance, there is no evidence that would suggest that this diversity will be appropriate or adequate to allow adaption to future developing country climates and conditions for which there are no analogues in the history of agriculture.

Modern seed systems have the virtue of being able to place new diversity—new combinations of genes—in the field from one year to the next. Furthermore, they draw on the immense genetic diversity found in gene banks. Consider that modern private or public sector plant breeders have access to perhaps 200,000 distinct samples or populations of wheat, yet even a so-called diversity-rich developing country farmer and his/her farming community will be growing only one or a handful at most. That will not change much from one year to the next.

We cannot depend on chance mutation to facilitate adaption. With the rapidity and scale of climate change, most farmers will go out of business before chance mutation and selection produces crops adapted to the scale of change forecast by climate models. Introduction of new and appropriate diversity is the only practical way of ensuring adaptation "in time."

To the extent that investments in plant breeding for climate change are being made or anticipated, these apply almost exclusively to the major cereal grains.

Even so, seed systems in many countries are incapable of supplying these materials to many subsistence farmers. Moreover, many of these improved varieties would not be appropriate or even adapted to the specific conditions of subsistence farmers anyway.

There is simply no plan, globally or nationally (in any nation) for promoting adaptation of food crops other than the main cereals. Individually, many of these crops are very important to food security locally, nationally or regionally. Collectively, they are essential globally. A Stanford University study noted that 27 of these orphan crops collectively occupy 250 million hectares of farmland, an area greater than that occupied by rice. Clearly their contribution to food security is more than trivial. Moreover, even crops that are extremely important to millions (e.g., yams, bananas) have fewer than 10 Mendelian-trained plant breeders working on them today. Perhaps half the domesticated crops that have entered world trade have never had a single such breeder, ever.

If farmers do not have access to broad diversity, including diversity from other countries and continents (that may be necessary for providing traits necessary for emerging novel conditions) and if there are few if any plant breeders, how can we expect crops to adapt? By magic? Adaptation and development without diversity? Unlikely.

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The U.S., in the 1800s, engaged in a massive seed diversity distribution program supplying millions of packages of seed to farmers for experimentation purposes. At its zenith, the program was distributing 10 million packages annually. It was this program that resulted, for example, in the eventual adaptation of wheat from Florida to Washington State. Farmers were empowered to experiment and adapt. The best farmer-selectors ended up supplying their neighbours and becoming seed companies. It is not possible to explain the spread and success of agriculture in the U.S. without reference to the distribution of genetic diversity and the use of it in countless adaptation experiments by farmers.

We have more institutional and informational capacity now than centuries ago. We have increasingly detailed climate models. We have better and better gene bank records with accession-level data. One could construct models that would allow for "best-bet" packages of diversity to be assembled and provided to farmers on a massive scale to promote adaptation. Packages would not contain enough seed to cause harm if the seed failed. It would simply provide enough for experimentation and selection. These packages could consist of mixtures of landraces and modern varieties—the point being to constitute them with diversity appropriate to the environmental and climatic conditions we anticipate. Packages could contain seed diversity of multiple crops, even "new" crops.

There are several challenges to repeating the dramatically successful American experiment elsewhere. First and foremost, we have forgotten our history.

Pursuing this approach may strike many as radical, strange, impractical, etc., even if it has been done before, successfully, in the 1800s, and even if they cannot conceive of or think about an alternative to promoting large-scale adaption of less-than-major crops.

Finding the appropriate institutional home is the second most important challenge. This institution—or institutions—would have to have credibility, scientific expertise, and would obviously need to have the ability to convene and enlist the participation of a wide range of partners. Without this, such a proposal could never succeed on any scale.

The third challenge could be resistance to allowing science to guide the content of the seed packages. Political pressures as well as restrictions on access to diversity in some national gene banks could decrease effectiveness by decreasing the range of traits provided.

Finally, of course, there would be the normal issues of securing country support and solving logistical issues with distribution. I believe these could be overcome with commitment and creativity.

Obviously, this approach is an ambitious one. A project or community-by-community approach is not likely to make a major impact quickly enough, nor is it likely to attract the attention and commitment of key scientific partners. Thinking big is the alternative I suggest, rooted in our own history and in the knowledge of how evolution works. Whether or not this approach is adopted or rejected, it is clear that global food security depends on having a very broad range of crops—not just a few—adapt successfully to the new conditions they are facing now and will face in the future.

COMMENTARY: THE PARADOX OF LOCALLY SAVED SEED, AGROBIODIVERSITY, AND SMALLHOLDER PROSPERITY

Jim Gaffney and
Valasubramanian Ramaiah,
DuPont Pioneer

JIM GAFFNEY started with DuPont Pioneer in 2010 and in his role works on advancing agronomic traits, including those that help crops better use water and improve yield and yield stability. Gaffney earned a Bachelor's degree from the University of Minnesota, a Master's from South Dakota State University and a PhD from the University of Florida. He is particularly passionate about improving African agriculture—an interest that dates back to his time as a Peace Corps volunteer in Cameroon, where he worked at an agricultural technical school.

VALASUBRAMANIAN RAMAIAH is an agriculture and biotechnology professional with 15 years of experience in the seed and agribiotechnology industry. Ramaiah earned his PhD from the University of Madras, India, and has been at DuPont Pioneer since November 2006 as a member of the company's Agbiotech Research and Development team. Committed to sustainable agriculture, his interests are to develop and commercialize technology-based solutions and agricultural products that improve agricultural productivity and science communication.

Seed is the fundamental input for sustainable agriculture and the foundation of successful farming for smallholder farmers. Smallholder farmers around the world are a resilient group of people and have survived for generations in the face of political unrest, unpredictable weather, and limited, or perhaps worse, uneven attention from politicians, policy-makers, donor organizations, and industry. They are self-reliant risk managers, operating without the safety nets of insurance for crops, health, or life, and in general have relied upon friends and family for labour and credit needs. Their cropping systems include multiple species, growing in close proximity, usually with no fertilizer, and most often utilizing locally saved seed or vegetative cuttings.

Regions where smallholder farmers dominate—Africa, India, and Southeast Asia—are changing rapidly. There is a continual rural exodus of young people seeking employment in large population centres. Labour shortages in farming communities are becoming common. Current smallholder farming practices can exert unsustainable pressure on soil and water resources, and expansion of cultivated land contributes to disproportionate (to the level of productivity) greenhouse gas emissions and degradation of natural biodiversity. Additional environmental pressure will come with population growth. Africa's population, for example, is expected to grow to two billion by 2050, and this rapid growth will be uneven, with some of the most poverty-stricken countries estimated to grow even faster than the rate of population growth of Africa as a whole. Africa will also be a very young population—by 2050, approximately 40 per cent of all births in the world will be African (UNICEF Generation 2030 Africa), adding to an intractable nutrition crisis in developing economies, according to The Cost of Hunger in Africa, a study that is part of a continent-wide initiative. Likewise, India's population is expected to reach 1.7 billion by 2050. Agriculture remains the largest sector of the Indian economy, with almost half of the workforce in India dependent on agriculture. Like Africa, output per hectare, a common measure of agricultural productivity, remains low in India when compared to many other countries, with large regional variations within the country.

Although saved and locally traded landrace seed may benefit agrobiodiversity, it also presents many challenges to smallholder success. Storage is often inadequate and seed degrades over time due to exposure to the elements, disease and insect damage. Saved seed and vegetative cuttings from traditional varieties suffer from genetic drift, in which once-differentiated varieties continually receive pollen from multiple sources and over a few generations no longer provide the same level of productivity or quality or are no longer genetically distinct. In addition, older genetics inherent to saved seed were developed for a climate and environment that no longer exist, and, with history as a guide, the climate will continue to challenge agricultural production (Stambaugh et al., 2011; Boyer et al., 2013). Finally, the resilience of these informal seed and smallholder production systems often leaves farmers to merely subsist, with

few opportunities to gain footing toward prosperity, and markets to purchase inputs or sell excess production remain out of reach.

The resilience of these informal seed and smallholder production systems often leaves farmers to merely subsist, with few opportunities to gain footing toward prosperity, and markets to purchase inputs or sell excess production remain out of reach.

Therein lies the paradox of the informal seed system and conservation of agrobiodiversity: How do we improve resilience and risk management strategies and maintain agrobiodiversity while increasing the productivity and prosperity of smallholder farmers? And how do we limit environmental pressures as we meet these challenges?

An anecdotal account about loss of agrobiodiversity comes from a personal communication from villages in southern Cameroon. As late as 30 to 40 years ago, a number of local, distinctly different roots and tubers were cultivated. In the local Bulu language, these crops were named *egnouma*, *adia*, *egom*, and *nbubi*, and each had specific agronomic and culinary attributes. Cassava (*Manihot esculenta*), which had been introduced to Africa more than 400 years earlier, is now the dominant root crop in these villages, and the local roots and tubers are rarely cultivated, if at all. The change to cassava was likely made for a number of reasons: cassava is more productive over a broader range of environmental conditions, it offers greater flexibility in food preparation and use, it is a more efficient crop to cultivate based on return-to-labour, and it likely has more value as a cash crop than traditional roots and tubers.

Smallholder farmers in India experienced a similar change on a much broader scale. During the Green Revolution, research and technology developed during the 1930-60s that increased agricultural production worldwide, numerous local rice cultivars were replaced on millions of hectares by "super varieties" developed to be more responsive to fertilizer and deliver a higher grain yield. In addition to reducing food prices, hunger and poverty, the Green Revolution has been credited with sparing millions of hectares of natural ecosystems from cultivation and lowering greenhouse gas emissions (Stevenson et al., 2012).

These relatively rapid changes to fewer crop species and varieties were made based on the same risk-management and survival strategies that smallholder farmers have been making for generations, and which have been repeated in many other crops and geographies. Farmers everywhere will make decisions based on what they need to do to support themselves and their families and until basic needs are met, agrobiodiversity will be a lower priority. How then, do we make local seed systems more productive and conservation of agrobiodiversity more meaningful and realistic for smallholder farmers?

First, formal seed systems, the use of improved varieties and hybrids, and greater use of agronomic inputs cannot be considered separate from, or in opposition to, the informal seed system or conservation of agrobiodiversity. Heterosis, or hybrid vigour, is simply the increased size or rate of growth of offspring over parents, when two unrelated parents are crossed (Duvick 1999) and should be considered as part of the solution. Long-term, successful breeding programs are based on heterosis and continual heterotic pool

development (Troyer and Wellin, 2009), and when combined with multi-location trials in the target environment with agronomic improvements, provide a powerful combination to account for environmental change, farmer needs, and productivity improvements in the most challenging of conditions.

For example, improved pearl millet varieties helped the households of western Rajasthan manage the risk of rain shortfalls and stabilized long-term yields. These improvements enabled farmers to shift a portion of their farmed area from millets to cash and other more productive and profitable crops (Bantilan et al., 2003). Improved cropping income has also led to concrete houses replacing mud housing and increased rates of schooling, especially for girls (Parthasarathy and Chopde, 2000). A doubling of sorghum yields over a period of thirty years in India (Kenga et al., 2004), and greater prosperity for smallholder maize farmers in Kenya (Mathenge et al., 2014) and Zambia (Mason and Smale, 2013), are just a few examples of value creation and ripple effects of increased prosperity through greater productivity and efficiency.

Hybrid crops and improved agronomics may also address environmental issues by intensifying agriculture on less land. Recent research shows that modern maize hybrids are more efficient users of nitrogen and phosphorous than hybrids from only 25 years ago, and maize yield under drought stress has improved significantly during the past 50 years, with no additional water extraction from the soil profile.

Hybrid crops and improved agronomics may also address environmental issues by intensifying agriculture on less land. Recent research shows that modern maize hybrids are more efficient users of nitrogen and phosphorous than hybrids from only 25 years ago (Ciampitti and Vyn, 2014), and maize yield under drought stress has improved significantly during the past 50 years, with no additional water extraction from the soil profile (Reyes et al., 2015). North American agriculture is among the least wasteful globally, with more efficient use of fertilizer and irrigation water and less greenhouse gas emissions than any major grain producing region (West et al., 2014). Combined with much greater productivity levels, these systems are among the most sustainable globally (Grassini and Cassman, 2012). Identifying other areas of high productivity using tools such as the Yield Gap Atlas (van Bussel et al., 2015) and applying the best available technology to farming will save millions of hectares from cultivation (Tilman et al., 2011) and overall, allow for greater biodiversity. Uncultivated ecosystems may not directly address agrobiodiversity, but they do offer similar benefits by preserving native flora and fauna on areas that might have otherwise been converted to cropland (Phalen et al. 2016).

To more directly address conservation, the seed sector in India offers an excellent case study for coupling higher productivity cropping systems with agrobiodiversity. Rice diversity in India consists of landraces, improved cultivars, hybrids, and closely related wild relatives adapted to varied agroecological conditions. Informal, formal and participatory seed systems coexist in India to maintain the biodiversity, conservation and sustained rice production in India. Traditional knowledge and the informal seed system play an important role in maintaining and cultivating landraces in smallholder farming communities. Public sector systems and state agricultural universities also play a major role in developing the improved cultivars for the specific regions, while the private sector mainly focuses on hybrid seeds through a formal seed system process.

The Koraput district of Odisha, India, is recognized for its rich diversity in Asian cultivated rice, and is known to be one of the centres of origin of these varieties. Smallholder farm families in the region cultivate landraces to fulfill their economic, social and cultural needs using traditional practices, which contribute significantly to maintaining *in situ* on-farm diversity and sustainability. Yet lack of support mechanisms and relevant training to enhance their skills in the seed selection process, common in the formal seed sector, are constraining the needed scale of quality seed production (Mishra et al., 2012).

The open access to source seed, active participation of smallholder famers, the availability of growers and processing facilities on a contract basis and a well-developed marketing network have reduced transaction costs, enabling the emergence of a wide range of seed enterprises, particularly in the private sector.

An answer to how these constraints might be addressed is observed in the rice seed system in the Andhra Pradesh and Telangana states of India, which offer a number of outstanding examples of the private delivery of public varieties. Several private seed companies and cooperatives are supplying an increasing proportion of rice seed, in addition to two public seed agencies, namely State Seeds Development Corporation and the National Seeds Corporation (NSC). The open access to source seed, active participation of smallholder famers, the availability of growers and processing facilities on a contract basis and a well-developed marketing network have reduced transaction costs, enabling the emergence of a wide range of seed enterprises, particularly in the private sector. Also, a greater degree of public-private interface is facilitated by transparent mechanisms for acquiring source seed, commercial incentives and an enabling regulatory framework. This system utilizes the best of what both the formal and informal seed systems have to offer and, perhaps most importantly, has provided smallholder farmers with market access and more options for their farming enterprise.

Zhu et al. (2003) offer an interesting experience in China, where more than 50 per cent of rice production is sown to hybrids. Intercropping of traditional varieties with hybrid rice has maintained or increased yield and reduced disease pressure and fertilizer needs while also increasing use and preservation of 20 traditional varieties and meeting China's productivity needs. This would seem to be a relatively simple solution that meets multiple needs: more efficient use of inputs, greater productivity, and conservation of valued landraces.

Benzançon et al. (2009) reported on the ability of farmers in Niger to preserve diversity of sorghum and millet varieties. Even with social and climate change, a high level of diversity was maintained in traditional varieties, thus highlighting the potential for on-farm conservation of agrobiodiversity. Barnaud et al. (2007) reported on the structure and dynamics of sorghum landraces in northern Cameroon and found that while high potential for gene flow existed among the dozen or more sorghum landraces found in a single farm plot, biological barriers likely contributed to maintenance of differentiation among landraces. At least part of the significance of these studies is that with some prior thought and planning, improved varieties and hybrids could likely be introduced while still maintaining genetic diversity of landraces. As with the example from Zhu et al. (2003), multiple objectives, including more options for farmers, would be achieved.

Conclusions

The drive toward conservation of agrobiodiversity must first address farmer well-being if any level of success is to be expected. Informal seed systems, while often resilient, are often inadequate to meet the complete seed needs of the smallholder farmers due to challenges of productivity, lack of enhanced breeding skills, seed conditioning, storage, marketing and distribution.

The following points should be considered in order to maintain a balance between productivity and agrobiodiversity.

An integrated and participatory approach that includes the formal, informal and traditional seed systems is needed for knowledge sharing, maintenance and use of germplasm and conservation of agrobiodiversity.

- An integrated and participatory approach that includes the formal, informal and traditional seed systems is needed for knowledge sharing, maintenance and use of germplasm and conservation of agrobiodiversity.
- The formal seed sector, which includes hybrids, improved agronomics, and the intensification of agricultural systems for smallholder farmers, has a strong history of gains in productivity, efficiency, health, nutrition, and overall prosperity, which in turn is likely to create more options for maintaining agrobiodiversity.
- Smallholder farmers must have greater connectivity to the markets—both to access new technology, credit, and insurance, and to be able to market excess production.
- Regional agrobiodiversity exchanges—where local farming communities and the public and private sectors work on an integrated platform to conserve and use biodiversity though knowledge sharing (from traditional to modern science), while focusing on meeting the productivity needs of the country—will create a more sustainable effort.
- Government policy is critical and should support awareness of newer technologies and traits, ease of movement of germplasm and technology across borders, and land reform that is beneficial to smallholder farmers.

With changes in the population, climate and plant pest and disease spectrums, we cannot ethically ignore newer technologies and the necessary knowledge transfer required for those smallholder farmers to improve their lives along with maintaining and utilizing agrobiodiversity. A collaborative effort that supports more options for farmers is needed to meet the challenges of agrobiodiversity and greater prosperity.

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COMMENTARY: STRENGTHENING COMMUNITY BASED SEED SYSTEMS IN WEST AFRICA—EXAMPLE AND LEARNINGS FROM A MCKNIGHT-FOUNDATION-FUNDED INITIATIVE IN MALI, BURKINA FASO AND NIGER

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Example of success

Pearl millet (*Pennisetum glaucum*) and sorghum (*Sorghum bicolor*) are major crops cultivated under rain-fed conditions in the dryland areas of West Africa. Since 2006, the McKnight Foundation Collaborative Crop Research Program (CCRP) has been funding a project entitled "Sustaining Farmer-Managed Seed Initiatives for Sorghum and Pearl Millet in Mali, Niger, and Burkina Faso." This project is presently in its third phase. It has been led (until December 2015) by Eva Weltzien from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Mali and implemented in cooperation with scientists from ICRISAT-Niger, the national programs in Mali (IER), Burkina Faso (INERA) and Niger (INRAN), and seven farmer organizations (two each in Mali and Burkina Faso, and three in Niger). The project aims to contribute to sustainable seed supply to small-scale farmers in the three mentioned West African countries, through farmer managed production of sorghum and pearl millet seed. In 2014, the McKnight Foundation commissioned a case study to describe the project background, context and outcomes, to assess specific CCRP contributions, to summarize lessons learned and to provide recommendations. Major findings of the case study are summarized below; many more details can be found in the full case study document.[1]

The case study revealed that the project has been very strategic by tying participatory variety development and evaluation to farmer managed seed production, and by involving farmer organizations as equal partners in research. The core of the success was the participatory development of varieties that are adapted to the local context and produce considerably higher yields under farmers' production conditions, while also maintaining a number of other preferred traits. Through very decentralized, participatory variety evaluation trials, farmers have gained contextualized knowledge of diverse varieties and can make informed decisions on the options available to them.

The availability of seed of these varieties has much improved during the course of the project due to strengthening of farmer led production of quality seed. The number of seed producers increased from year to year, as did the area used for seed production and the number of varieties being multiplied. By taking a "mini-packet" approach for seed marketing to individual farmers, access to seed has also improved. In addition, there were several other pathways for seed distribution, including through government agencies, NGOs or private seed enterprises acting as partners of the farmer organizations. Impacts were reported by farmers in the following domains: (1) variety adoption and seed systems; (2) productivity, income and nutrition; and (3) knowledge, innovation and development capacities.

In summary, the project has convincingly demonstrated that farmer managed seed production is feasible, and can improve variety adoption and achieves

1 Christinck A., M. Diarra & G. Horneber, 2014. Innovations in seed systems: lessons from the CCRP-funded project "Sustaining Farmer-Managed Seed Initiatives for Sorghum and Pearl Millet in Mali, Niger, and Burkina Faso"; https://www.mcknight.org/system/asset/document/850/original/CCRP_SeedSystems_Nov2014.pdf

development impacts. However, there are still challenges ahead with regard to the sustainability of the project. Besides some necessary improvements in the seed chain itself, concerns exist regarding risk management at the farmer organizations, and improving the material resource basis for the farmer organizations and the national research institutes. Moreover, the sustainability of this project depends also on external factors, including decisions that are taken at the policy level. These external factors should be addressed, which may imply research and capacity-building measures that go beyond the original focus of the project.

The case study suggests conducting a policy and a stakeholder analysis in order to identify entry points for a science-policy dialogue, and to establish multi-stakeholder platforms in order to facilitate the development of shared visions and coordinated action towards the integrated development of more sustainable, equitable and resilient seed systems

In the seed chain, linkages where farmer organizations directly depend on other actors should be improved. Three critical junctions were identified: (1) provisioning of source seed; (2) seed certification; and (3) coordination of complementary dissemination pathways. It further needs to be emphasized that not only knowledge and capacity-building, but also a better material resource base and risk-reducing measures, may be necessary to make the farmer managed seed production more sustainable. In order to address the seed sector as a whole, the case study suggests conducting a policy and a stakeholder analysis in order to identify entry points for a science-policy dialog, and to establish multi-stakeholder platforms in order to facilitate the development of shared visions and coordinated action towards the integrated development of more sustainable, equitable and resilient seed systems in the three countries (Christick et al. 2014).

From my involvement as a pearl millet breeder in the seed systems project in Mali, Burkina Faso and Niger, followed by my function as CCRP liaison scientist, the following additional thoughts come to my mind:

How to promote seed diversity

Smallholder farmers' production objectives, preferences and needs in West Africa are heterogeneous, therefore, these farmers need to be offered a range of variety options. Plant breeders should not strive to search for or promote just a single one-size-fits-all "best" variety—because such varieties actually do not exist in smallholder farming systems. Plant breeders aiming to serve smallholder farmers should rather strive to understand the heterogeneity of the production objectives, preferences and needs, and then strive to develop a basket of varietal options from which farmers can chose those varieties that fit best into the individual context. This would also include a move to a more systems-oriented breeding, where the different functions of a crop or cultivar in the production system are considered and improved/optimized.

Such an approach actually includes a paradigm shift from promoting just a few "best-bet" varieties to promotion of functional diversity via the development of a portfolio of "best-fit" varieties (varieties that are specifically adapted to different contexts, functions and needs). To enable this, a paradigm shift is needed from considering farmers simply as beneficiaries and passive adopters

to considering farmers as real partners who inform and advise the crop improvement process. This is necessary, because farmers know much better than researchers what they really need and what a good variety represents in a particular context. Working with the farmers (women and men) as partners also helps to develop and improve ownership, and can enhance speed of adoption of new varietal diversity. Developing a diverse set of specifically adapted varieties also means to get away from considering yield (potential) under high-input conditions as the main trait to be improved; there are many more diverse traits that are important for farmers and that need to be integrated into different varieties by breeders in order to serve the diversity of smallholder farmers well.

"Offering diversity to the diversity of farmers and enabling them to choose what fits best into their respective situation" has also been the approach that was followed in the above-mentioned, CCRP-funded project. Annual participatory variety evaluation trials with about 20 cultivars (which changed in each year as new varieties came out of the breeding pipeline) exposed farmers to newly available variety options for the target region on a regular basis. These were followed by validation trials involving between three to six farmer selected varieties. These again were complemented by the seed mini-packet approach where small quantities of seed, together with information of the respective varieties, were offered to farmers for testing at very affordable prices.

Farmer exchange visits were organized to support farmer-to-farmer learning about varietal diversity and seed production. Seed and input shops in target villages, seed fairs and mobile seed shops contributed to enhancing access of farmers to seed and information of various cultivars, even in remote villages. This was then combined with massive training of the partner farmer organizations in certified, quality seed production for their communities. Different farmer seed producers would produce quality seed of different cultivars, so that a diverse variety portfolio became available to the communities.

By offering such a diverse variety of options and associated information and by conducting large-scale farmer managed on-farm validation trials, farmers can be enabled to choose varieties that fit best into their system. In doing so, varietal diversity at local levels can be maintained or even promoted.

On the breeding site, initial participatory diagnostics helped to identify and understand farmers' needs and preferences. Then, varieties revealing the priority traits were developed together with farmers, both women and men, to serve their respective needs best and, at the same time, develop ownership. Examples are varieties with resistance to ***Striga*** for areas infested by this parasitic weed; early varieties to provide food in the hungry period; late varieties that better serve marketing quality; varieties with specific adaptation to low plant available phosphorus in the soil or to flooding/water stagnation; varieties with high micro-nutrient (iron, zinc) content to serve infant nutrition; varieties suitable for beer brewing; dual-purpose varieties that serve both food and fodder (and thereby crop-livestock integration in agroecological production systems), etc. By offering such a diverse variety of options and associated information and by conducting large-scale farmer managed on-farm validation trials, farmers can be enabled to choose varieties that fit best into their system. In doing so, varietal diversity at local levels can be maintained or even promoted.

Role of public health institutions in promoting seed diversity

Public health institutions did not play an important role in the project, but I imagine that they could play a role in promoting specific, nutrient-rich cultivars and recipes that combine different crops (for example cereals, legumes and nutritious minor crops such as hibiscus, mango or Moringa) and/or specific varieties into nutritious end products, targeting specific use groups, for example small children or specific patients. By valuing specific crops and varieties as healthy food and possibly creating a local value chain and local markets, farmers can be encouraged to add these crops and varieties to their existing portfolio, for improving family nutrition and also for income generation purposes. The use of this diversity will thus prevent it from being lost. (A similar "use it or lose it" approach has been applied by the International Potato Center (CIP) to conserve Andean root and tuber crops.)

The central role of seed for resilience

Understanding the number and type of crops, the varieties farmers maintain and how seed of these is managed can help breeders to integrate new varieties in existing systems. Participatory diagnostics conducted in the project revealed, among other things, that farmers in one village maintain several cultivars (up to 15 or more) explicitly for different purposes, including for risk management, food and nutritional security, and income generation.

Learning from nature can help us understand naturally existing mechanisms to cope with unpredictably variable environmental conditions and to achieve some resilience. Haussmann et al. (2007)[2] studied intra-varietal heterogeneity of flowering time in six pearl millet landraces from Niger. Genetic differences between the earliest and the latest full-sib family derived from the same landrace were 16 days at minimum and 39 days at maximum. The enormous intra-varietal heterogeneity in these Sahelian pearl millet landraces for flowering time likely reflects adaptive benefits of intra-population diversity, whereby only a portion of plants is at their most sensitive stage at any point in time. This diversity arose through natural and farmer selection over many generations, and is likely an important mechanism for adaptation to high inter-annual climate variability in the Sahel. Sahelian pearl millet breeders are thus faced with the question of how much intra-varietal heterogeneity is desirable—or necessary—to obtain improved and stable varieties that consistently out-yield local cultivars under extremely variable growing conditions. This may be in conflict with the common understanding that "improved" cultivars should be distinct, *uniform* and stable.

Furthermore, Haussmann et al. (2012)[3] reviewed breeding strategies and required variety characteristics to enhance farmers' resilience in variable and changing climates. According to these authors, developing variety types with high degrees of heterozygosity and genetic heterogeneity for adaptation traits can help in achieving better individual and population buffering capacity. Traits that potentially enhance adaptive phenotypic plasticity or yield stability

2 Haussmann B.I.G., S.S. Boureima, I.A. Kassari, K.H. Moumouni, and A. Boubacar. 2007. Two mechanisms of adaptation to climate variability in West African pearl millet landraces – a preliminary assessment. E-Journal of Semi-Arid Tropical (SAT) Research. Vol. 3(1). Sorghum, millets and other cereals. http://ejournal.icrisat.org/.

3 Haussmann B.I.G., P.S.C. Traoré, H.F. Rattunde, E. Weltzien-Rattunde, K.vom Brocke and H.K. Parzies. 2012. Breeding strategies for Adaptation of Pearl Millet and Sorghum to Climate Variability in West Africa. (Review article). Journal of Agronomy and Crop Science, 198:327–339. doi:10.1111/j.1439-037X.2012.00526.x

Farmer-participatory dynamic gene pool management using broad-based populations and diverse selection environments can be useful in developing new diverse germplasm adapted to specific production constraints, including climate variability.

in variable climates include photoperiod-sensitive flowering, plastic tillering, flooding tolerance, seedling heat tolerance, and phosphorus efficiency. Some of these traits (for example, photoperiod sensitivity) had been removed from elite germplasm during the Green Revolution, thereby reducing the germplasm's ability to cope with unpredictably variable, marginal stress environments. But these traits are essential for stable performance, as in regions with a highly variable beginning of the rainy season and consequently variable planting dates, such as in West Africa. Farmer-participatory dynamic gene pool management using broad-based populations and diverse selection environments can be useful in developing new diverse germplasm adapted to specific production constraints, including climate variability. It also contributes to *in situ* management of genetic diversity. Larger-scale, on-farm participatory testing is required to enable assessments of varietal performance under evolving climatic variability, to provide perspective on needs and opportunities, and to enhance adoption. Strengthening seed systems will be required to achieve sustainable impacts regarding resilience.

The role of policy advocacy

There is a need for policy advocacy.

As mentioned above, resilient varieties that have a capacity for population buffering and stable yield in variable environments such as the Sahel require at least some genetic variation for adaptation traits, for example for flowering time. They thus cannot fulfill the common "distinct-uniform-stable" (DUS) criteria required for release of improved varieties in developed countries. But these DUS criteria are often also being promoted in regions where they are just not appropriate, in regions where uniformity also means vulnerability. Advocacy is therefore required to inform responsible authorities about the potential benefits of genetically heterogeneous, non-uniform cultivars, so that such types of varieties can also be released. Of course there will be an optimum heterogeneity, depending on the variability of the target environment, and heterogeneity for adaptation traits must not mean that the cultivar does not have an identity. Rather, a variety can be variable for flowering time but uniform for other plant traits such as panicle and grain characteristics.

Another area where policy advocacy would be helpful is related to the right of farmers to produce and share seeds. There is a need to recognize farmer-produced quality-declared seed and the so-called informal seed sector (which usually is not informal at all, but relies heavily on social rules established in a community) as important components of the overall system. A protection of farmers' most popular, locally selected and maintained varieties should also be considered, for example in the form of a protected designation of origin (PDO).

Christinck and Tvedt (2015)[4] explore the relationship between the International Convention for the Protection of New Varieties of Plants (the UPOV Convention), farmers' rights as enshrined in the International Treaty on Plant Genetic

4 A. Christinck and Tvedt. 2015. The UPOV convention, farmers' rights and human rights: An integrated assessment of potentially conflicting frameworks. https://www.giz.de/fachexpertise/downloads/giz2015-en-upov-convention.pdf

Resources for Food and Agriculture (ITPGRFA), and human rights, particularly the right to adequate food. These three legal frameworks have in common that they are all related to the issue of seed and to rules that concern access to seed. According to the authors, farmers' rights as mentioned explicitly in the legally binding ITPGRFA, include the right to the protection of traditional knowledge; the right to participate in decision-making; the right to benefit-sharing; and the right to save, use, exchange and sell seed and propagating materials. However, the wording in the ITPGRFA is complex and does not provide a firm legal basis to farmers' rights in international law. Also, the ITPGRFA does not establish a hierarchy between itself and other legal obligations of states. The UPOV variety protection convention renders illegal farmers' customary practices of storing, processing, sharing, exchanging, selling and using seed, as far as protected varieties are concerned. This creates a conflict. It is the responsibility of governments to implement obligations of different treaties in a harmonious manner in their national legislation. Therefore, state parties need to be supported to take concrete steps for the protection and promotion of farmers' rights, and balancing them against the breeders' variety protection rights as defined by the UPOV convention. The authors recommend that developing countries that have not yet joined UPOV should consider opting for alternative *sui generis* systems of plant variety protection that allow for more flexibility in meeting the obligations of different treaties, for balancing the interests of diverse actors, and for protecting and promoting farmers' rights, compared with the UPOV system. UPOV members may consider the diversity of agricultural conditions of their present and potential new members in the further development of rules and their interpretation, and consider allowing for more flexibility in designing national plant variety protection laws, with regard to exceptions for small-scale farmers and Indigenous people (from Christinck and Tvedt, 2015).

What large development agencies could do to promote community based seed systems

Development agencies, together with farmer organizations, form a collective infrastructure that could cooperate with plant breeders to support variety testing, understanding patterns of variety adaptation, and matching of varieties to specific farmer's contexts. They can also facilitate decentralized farmer based seed production, storage in community seed banks and commercialization/dissemination schemes. Monitoring and evaluation of these development activities would also thereby provide answers to researchers ("Development for Research", D4R approach), regarding adaptation and adoption constraints and opportunities observed for different variety options. This leads to the concept of farmer research networks (Nelson et al., under review)[5]. Farmer research networks are an approach under development within the McKnight Foundation CCRP and represent a strategy for matching diverse options (for example crops and varieties) and contexts in smallholder agriculture. In the context of the CCRP, farmer research networks would also aim at linking problem-solving research with action that could provide a context-specific evidence base for agroecological intensification, facilitate positive changes for farmers at

5 R. Nelson, R. Coe and B.I.G. Haussmann. Farmer Research Networks as a strategy for matching diverse options and contexts in smallholder agriculture. Experimental Agriculture, revised version is under review.

scale as well as meet requirements of mutuality, reciprocity, co-creation, beneficiary ownership and local agency. The vision of farmer research networks is to transform the way that much of agricultural research and development is done to engage more (rural, but also peri-urban and urban) people in prioritization, observation, experimentation and utilization of agricultural research. This concept could also be applied in the strengthening of community based efforts to advance seed agrobiodiversity.

Conclusions

Ways to protect and strengthen community based seed systems and varietal diversity could include: promotion of farmer participatory development of varieties that are adapted to the local context and produce considerably higher yields under farmers' production conditions, while also maintaining a number of other preferred traits; conducting large-scale, decentralized, participatory variety evaluation trials in order to appropriately sample the heterogeneity of smallholder farmers and enable identification of cultivars that are adapted to specific farmers' contexts; citizen science approaches in evaluating existing variety diversity on a large scale (as in the Seeds for Needs initiative); large-scale training of farmer seed producers; development of public-private-producer/farmer partnerships in concert with the development of business models that include farmers as partners in order to create win-win situations for all; and farmer research networks that would help match a basket of varietal options to smallholder farmers' diverse contexts.

Barriers to success of community based seed systems include, among others, the challenges of risk management in seed production and marketing; problems of cash flow (especially in regions where there is a short rainy season and a long dry season such as in the Sahel); lack of farmers' credit access; and lack of appropriate seed storage facilities based on locally available materials.

Policy issues that should be tackled include the introduction of DUS criteria for variety release in areas where farmers actually need or want heterogeneous, highly plastic, adaptable cultivars to cope with unpredictable inter-annual climate variation, or where farmers want to maintain intra-varietal heterogeneity for food security purposes, e.g., during the hungry period; and lack of recognition of local seed systems and strategies to build on these and the associated social values instead of imposing models developed elsewhere.

Greatest potential for impact is always relative, but my preferred areas of investment would always be the regions with the most vulnerable and poor smallholder farmers, and regions in the centre of diversity for a particular crop. Working specifically with women farmers to cultivate and maintain local crop and varietal diversity could be an opportunity to (re-) link agriculture with nutrition, to enhance dietary diversity in rural families and to achieve desired nutritional outcomes and the reduction of malnutrition and hidden hunger.

COMMENTARY: RESTORING AND RECOVERING INDIGENOUS SEEDS IN NORTH AMERICA

Winona LaDuke, Honor the Earth

Indigenous people work with 7,000 crops and one million varieties, while the majority of industrial agriculture has whittled this down to 135 major crops and 103,000 varieties.

—PAT MOONEY, ETC GROUP

My generation is the first generation in the world that has lost more knowledge than it has gained.

—TOBY HODGES, FAO

WINONA LADUKE is the Executive Director of Honor the Earth, an indigenous environmental advocacy organization, and a founder of both the White Earth Land Recovery Project and Native Harvest. LaDuke is a member of the Mississippi Band Anishinaabeg and lives on the White Earth Indigenous Reservation in Minnesota, United States. She is a graduate of Harvard University and Antioch University, is the recipient of multiple awards for her human rights work, and has authored six books on indigenous issues and the environment.

Background

Indigenous Peoples are landed, yet are marginalized. As such there are estimated to be around 40,000 Indigenous farmers in the United States, and fewer in Canada. However, many Indigenous communities retain some access to broad biodiversity and retain access to land. Many of the seed varieties came from our communities, and need to be restored there. There has been significant work and support for the restoration of seeds in the American southwest. Native Seed Search is the most well known, but tribal communities, particularly groups such as Tohono O'odham Community Action (TOCA), Traditional Native American Farmers Association, Tesuque Pueblo, and the Hopi Permaculture Project, to name a few, have major traction and leadership in seed and farming restoration. Some of their work now is to defray the introduction of more GMO seeds into the Navajo Nation, as those would have a detrimental impact on indigenous seed stock and diversity.

Another stronghold of indigenous farming is the Six Nations area, where a multitude of bean, corn, squash and tobacco varieties are intact. There is a growing movement of seed and farming restoration in the southeastern United States, particularly with groups such as the Muskoke Food Sovereignty Initiative.

In the Great Lakes region there are three major sources of seed diversity and a strong growing movement for indigenous seeds and farming. One of the leading organizations and tribal entities in the region includes Dream of Wild Health, a Minneapolis based organization that inherited a collection containing hundreds of varieties from Cora Baker, a renowned Indigenous gardener. At its small farm in Hugo, Minnesota, Dream of Wild Health staff work on keeping those seeds viable and promoting community based gardening in the Minneapolis area. In northern Minnesota, at the White Earth reservation, the White Earth Land Recovery Project has a long history of restoration of seeds. The Oneida Nation in southwestern Ontario has farming projects that include both traditional and non-traditional production (cattle), but also has a stronghold on the white corn varieties in the Great Lakes region. As well, just northwest of the Great Lakes region, the

Métis Horticultural Society in Winnipeg is a stronghold of the restoration of indigenous seeds.

Finally, international/cross-border work is important, as the Anishinaabeg are the most northern corn growers in the world, having pushed corn 160 kilometres north of Winnipeg by seed adaptation. The varieties are many, largely from the Ojibwe communities.

What we are looking at in the Great Lakes region

In Canada, three-quarters of all the crop varieties that existed before the 20th century are extinct. Of the remaining quarter, only 10 per cent are available commercially from Canadian seed companies (the remainder is held by gardeners and families).

In the 1800s, 120 distinct Anishinaabe agricultural varieties grew in our territory. Many of these varieties have disappeared, and many are difficult to find. Some are located in the Germplasm Resources Information Network (GRIN)-USDA seed bank, and some with individual Native people, organizations and families. In Canada, three-quarters of all the crop varieties that existed before the 20th century are extinct. Of the remaining quarter, only 10 per cent are available commercially from Canadian seed companies (the remainder is held by gardeners and families). As well, the Anishinaabeg and other Indigenous Peoples in the north have utilized over 660 different harvested plants for food sources. This includes over 50 varieties of nuts, 20 varieties of fungi, 145 varieties of berries, drupes, pomes, 60 teas, and 125 roots or bulbs. While not all of them are a part of the traditional landscape of northern Minnesota, or Anishinaabe Akiing, many are. Our agrobiodiversity and harvested biodiversity mirrors international statistics: Indigenous Peoples have traditional agriculture and harvesting knowledge that was the foundation for excellent nutrition and health.

Those varieties have continually formed the basis for not only our own foods, but also a premium market to non-Native people. As Mary Wingerd wrote in her book, North Country, "Dakota and Ojibwe women were deep into commercial enterprise....They...peddled sugar, wild rice, pumpkins, corn, squash and other agricultural products to the traders and the military. With virtually no food produced for the market by whites in Minnesota country in the 1840s, and fresh produce in high demand, Native women entrepreneurs could set premium price on their small surplus harvests."

Decline of Anishinaabe food wealth

Like many Indigenous Peoples, our wealth was the source of our poverty; our lands stolen through the allotment era; the prairies, cut and plowed into farm land. There are many traditional foods that are no longer available.

Factors which have contributed to the decline of our food wealth, whether agrobiodiversity or ecological diversity, include: (l) loss of Native farmers due to appropriation of lands; (2) lack of access to USDA loans and programs, as documented in the Keepseagle V. Vilsack case, and American Indian Farmers against the USDA; and (3) systemic loss of agrobiodiversity, with the concentration of seed ownership.

There is a need for more hands-on support for our work in the tribal communities. People have become fearful of farming and concerned that they are unable to grow. We need to address that with more technical support for community based agriculture and farming.

Recommendations

1. Funding for tribal, community based seed and food restoration programs in our communities.
2. Support for access to collaborative partnerships with organic farming, transitional farming and farm coaching work for our tribal communities. There is a need for more hands-on support for our work in the tribal communities. People have become fearful of farming and concerned that they are unable to grow. We need to address that with more technical support for community based agriculture and farming. There are a number of sustainable farming associations in each region, but those are usually non-Native. We would like to see stronger relationships and also control our seeds.
3. Support for regional/tribal agricultural research stations. Presently, county extension agents and the USDA support a model of agriculture and have access and knowledge about varieties and techniques that are not indigenous. We are interested in starting indigenous agricultural research stations. We have one idea for the Minnesota territory but similarly, there should be agricultural research stations in the northern plains region as well, to talk about adaptation of varieties, restoration of seed stock and training of tribal leadership for food systems.
4. Support of tribal agricultural infrastructure. The Red Lake Nation has more than 400,000 pounds of fish by-catch annually available. They are interested, and we're working with them (with Will Allen from Growing Power) to develop a fish hydrolysate fertilizer project. Other examples are easily found in Will Allen's Growing Power strategy, which has caught the eye of many tribes in our region.

Case study: Anishinaabe agricultural research station (currently in development)

The Anishinaabe Agricultural Research Station (AARS) would be created to make it possible to develop and restore food production by tribal people. This would take place through a series of goals and actions. The initial phase would see the organization of historical information on traditional Ojibwe agricultural practices and give tribal people with access to these practices, as well as access to the use of newer practices, such as fish based fertilizer, managed burns and in some cases, closely mirrored herd practices. The intention of this research is to both document and adapt the practices of our ancestors, and restore the topsoil and ecosystems of the tribal community.

The second phase would be a collaboration with the Fond du Lac Tribal and Community College, the Mille Lacs band of Ojibwe, individual farmers, and Honor the Earth, to implement beginner agriculture classes through the college; to conduct test plots of traditional foods (berries and hazelnut bushes

or traditional intercropping); provide a seed bank or library of seeds, tubers and plant starts (particularly berries and trees); and support tribal people interested in developing these practices.

Harriet Kuehnein of McGill University conducted studies of Indigenous food systems in India. She found that where there are significant reserves of agricultural biodiversity, there are lower levels of anemia. Similarly, Kuehnein found that levels of malnutrition, micronutrient deficiencies, dietary inadequacies, and hypertension were much lower where people cultivated their indigenous foods. In one area of northeast India, she found that tribal people used more than 327 foods, of which 138 were cultivated and 185 were wild, including 83 types of vegetables and fruits, and 24 types of mushrooms. It seems that recuperating our culture may be a better alternative for our personal and planetary health than industrial foods and vitamin drinks.

COMMENTARY: STRENGTHENING COMMUNITY BASED SEED SYSTEMS IN TAJIKISTAN

Muhabbat Mamadalieva, *Zan va Zamin*; Kubonali Partoev, Academy of Sciences of the Republic of Tajikistan; Makhmadzamon Sulangov, National Centre for Genetic Resources, Republic of Tajikistan, and Shoista Mubalieva, National Centre for Genetic Resources, Republic of Tajikistan

The mountainous region of Tajikistan has its own peculiarities, both geographic and climatic. For centuries, Tajik people were engaged in gardening; growing vegetables, legumes and wheat. During the Soviet period, however, cotton became a monoculture and intensive mechanization in agriculture was used. The system of seed for all crops was centralized, and there were large collective and state farms that specialized in seed production and mainly relied on government policy support. As such, the traditional and farming system of agricultural seed crops didn't exist and only a few farmers engaged in the preparation and storage of vegetable seeds for future planting. With no need to grow grain, the experience was forgotten, and some local varieties of wheat, fruits, disappeared. In addition, traditional knowledge on biodiversity, accumulated for centuries, began to disappear, and along with it went community based seed systems.

After the collapse of the Soviet Union, a period of reorganization of collective and state farms began, and farmers got their land returned to them. However, there was intense use of hybrid seed and varieties imported from other countries, instead of the local varieties that had been adapted to grow in local conditions. This led to a reduction in the nutritional value of our crops. Many valuable local varieties, as well as their wild relatives, are now on the endangered species lists in our country. In order for restoration and rehabilitation of traditional forms of agriculture to happen, and for local varieties of agricultural products to return, it is crucial to form and develop a new system of community based seed cultivation.

The Tajik community has just barely begun to establish a network of seed-growing farmers, who use seed mainly for vegetables, wheat and melons. The cultivation of fruit varieties by budding and the preparation of saplings or transplants has a longer history of success; however, establishing this has still been difficult because it requires that people learn to value and recover information that they may have heard from their grandparents. Through this process, rural inhabitants, farmers, and women have started to preserve some species, such as different varieties of tomato, onion, carrot, and beet, etc. Some varieties of fruits have been saved with the help and support of government and donors. It is very important to indicate that the budding of fruits at the community level has been considered one of the best means of cultivation.

Ways to protect and strengthen community based seed systems

It is important to raise the community's awareness of the importance of seed systems based in the local community for the conservation of agrobiodiversity. It is also important to enhance the role of farmers—and particularly, savers of seeds—among the members of the community through promotion, encouragement and support. In order to strengthen community seed systems, it is critical to identify the farmers who are involved in local seed preparation. It is very

MUHABBAT MAMADALIEVA is one of the first women in Tajikistan to have earned a PhD in Plant Genetics. In 1999, together with other professional women, she founded *Zan Va Zamin* (Women and Earth), an NGO dedicated to tackling issues facing rural women, including land rights, livelihoods, and environmental degradation. Under Mamadalieva's leadership, the organization won the Equator Prize in 2012 for showing leadership in promoting innovative ways to build resilient communities.

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important that their knowledge is shared with other farmers so as to improve the seed-growing process in the wider community. The first step in this very important action is to identify those farmers who produce high quality seeds of different species, and then to prepare them to teach others these skills.

In order to bring real change in society, it is important to change people's thinking. We must convince specialists and the public that it is critical to save the agrodiversity in our country. At the same time, we need to use some of the forgotten and traditional methods of farming to establish local kinds of crops more adapted to Tajikistan's unique climate.

Barriers to success

The major barriers to expanding community based seed growing systems can be considered as follows:

Farmers who grow local varieties argue that their products are unable to compete in the market. Since consumers pay more attention to the appearance of products, preference is given to the imported and industrial varieties.

- Local farmers and the general population have an insufficient level of knowledge about the genetic and breeding quality values of local varieties of crops.
- At the same time, even government officials and authorities at the relevant ministries do not have the required level of information and understanding of the importance of community based seed breeding to be clear on the necessity of its further development and strengthening.
- There is a lack of a clearly defined policy to establish and develop agrobiodiversity and conservation in a community based seed production system. There are no special state programs on the development of community based seed systems.
- Local varieties can't compete with the hybrid and industrial varieties. Farmers who grow local varieties argue that their products are unable to compete in the market. Since consumers pay more attention to the appearance of products, preference is given to the imported and industrial varieties. Although the local varieties possess valuable nutrition and have better tasting qualities, people still do not value these factors and their importance for human health. Subsequently, they do not value the importance of local agricultural products and their preservation.

As a result, farmers continue to grow local varieties, but only for their own use. As for the market sale, they mainly grow varieties that are more attractive in their appearance and are better in terms of yield. Farmers usually pay attention to the productivity of species rather than their biological diversity. Hybrid seeds usage for obtaining the greatest profit from the land is also an important barrier for development of community based seed production.

Many international organizations that have been working in Tajikistan provide support for agriculture by providing farmers with seeds for wheat, potatoes,

and other staple foods, in big amounts mainly purchased abroad. These organizations are mostly focused on poverty reduction, and introduce mostly imported hybrid seeds.

The wide availability of these hybrid seeds creates a kind of dependence which has gradually led to farmers no longer preparing and storing seeds for future planting. Instead many just hope for humanitarian assistance that provides seed from international organizations.

The wide availability of these hybrid seeds creates a kind of dependence which has gradually led to farmers no longer preparing and storing seeds for future planting. Instead many just hope for humanitarian assistance that provides seed from international organizations. Now that this has become a kind of habit for them, they have lost their desire, skills and knowledge of seed preparation for future planting.

The government and large enterprises and corporations use the same approach, purchasing seeds and transplants from abroad, which reduces the motivation of local farmers to produce local seeds.

Where funders can intervene

This is what is required to develop favourable conditions for strengthening the conservation of agrobiodiversity of community based seed systems in Tajikistan:

- Carry out a study to assess the current situation. Assess what is required to preserve agricultural biodiversity of seed produced by local farmers in the country, assess those seeds' potential, and work out recommendations and proposals for strengthening community based seed production.
- Develop and adopt a special program in the country for agrobiodiversity conservation of seed produced at the community level with the involvement of specialists, experts, experienced farmers, and agricultural scientists.
- Provide information to the public and private sectors—including community members such as women, leaders, and schoolchildren—about the conservation of agrobiodiversity in the local seed production system, its value and importance, and the need for distribution of seeds.
- Promote the creation of various forms of organization of local farmers engaged in the production of seeds, such as seed keepers' networks, associations, cooperatives, women's groups and men's groups at the community and district levels.
- Organize study groups and the exchange of experiences between seed keeping farmers of different regions through mobile seminars and meetings.
- Introduce local farmers to the best, most successful practices used in other countries in terms of community based seed systems, including ways to store seeds, how to create a network of seed keepers, how to create a gene bank, and how to generate funding for seeds. India, China and other countries have preserved a large variety of crops through seed production systems based in

local communities.

- Increase the interest of seed-keeping farmers by supporting and stimulating them to obtain certificates and patents for their invention of new varieties, seeds, seedlings, etc. We need to create forms of public recognition for seed savers for invention, so that they can benefit financially. Then these gains associated with local innovation will spread. This is, in fact, the action of strengthening of natural resources in agriculture.
- Hold trade exhibitions and innovative festivals, where the variety of seeds of local farmers can be displayed at the village, district and regional levels to encourage farmers and raise awareness about local seeds.
- Enhance the role of women and their involvement in the conservation of agricultural biodiversity. The lifestyle of rural Tajik women is designed so that they are always an active participant in the process of family agricultural activity.

Women have traditionally saved seeds during meal preparation using various plants and vegetables. They kept the seeds for the next planting season and because of their efforts, families never went without seeds and produce. This made it possible for women to know these varieties and increase their knowledge about seed growing.

Now many men are migrating to Russia to find jobs and almost all the work in the field is done by women. Many women are engaged with budding seedlings and are able to do budding.

Farmers who are producing seeds need to be trained in the relevant skills and knowledge needed to prepare various contracts and other documentation for the distribution of seeds, and to create seed banks in local communities.

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Examples of success

With the support of the Christensen Fund, our organization, *Zan va Zamin* (Women and Earth) works with the local communities of the mountainous areas of Tajikistan—Khovaling, Muminobod and Shuroabad—to conserve agricultural biodiversity of fruit crops (mainly local varieties of apples). We have arranged expeditions to the most remote mountain villages in the country just to identify the farmers who grow rare, valuable, local varieties of apples.

Through this process, we have identified more than 60 fruit farmers who are growing valuable and rare local varieties of fruits, such as apple, pear, and peach. These farmers have served as holders of gene banks *in situ*, and subsequently, they have been selected as a source of materials for budding local varieties.

In order to conserve, reproduce and distribute these local rare varieties, we created a nursery where we now have about 10,000 seedlings. In order to produce the seedlings, we traveled to the places where we had previously

detected rare varieties, and gathered the required material for budding. In this way, we were able to collect scions from various local varieties and produced seedlings in the nursery. We also acquired the materials to produce peach, apricot, pear and cherry seedlings.

Through this process, over 20 different local varieties of apple were cultivated and distributed, including *pashmak*, *kosimsarkori*, *Nosirboy*, *Lattase*, *Surkhseb*, *Safedse*, *Bekmatkhur (kandilsnab)*, *Shohiseb* and many others. We also produced local varieties of apricot, peach and almond.

The next year, we took the seedlings from the nursery and created a collection garden in the mountain regions of Khovaling and Muminobod. This grew in popularity, so that the seedlings were growing in the community and in schoolyards. Now we have a total area of seven hectares under cultivation.

We have found people in the communities—after many years of providing themselves and their close friends with seeds—to be very interested in supporting this process. As an example, Nazriev Ubaidullo, from Vakhsh district, has been engaged for many years in seed production. He provides people from neighbouring farms with seed material, mostly free of charge. He is engaged in growing, on two hectares of land, multiple varieties of potatoes, tomatoes, cucumbers, pumpkins and sweet potato. We can find other such people in different areas who grow seeds of various crops and connect them to a small range of producers.

In Romania, an organization called Eco Ruralis is working effectively with farmers' unions in producing local vegetable seeds. Eco Ruralis was founded in April 2009 by farmers from all regions of Romania. It is a grassroots association made up of over 500 small farmers who practice organic and traditional farming based on environmentally conscious principles. It stands for farmers' rights to practice sustainable agriculture. This includes the right to use, multiply and distribute traditional seeds, the pursuit of food sovereignty and respect for consumer health.

How to promote researcher-farmer collaboration

Researchers, with the help of farmers, can organize a science-based seed production system that will efficiently distribute high-quality seeds among the local population and farmers so that the diversity of types and forms of different cultures can continue to be preserved. It is important to strengthen cooperation and communication between scientists and seed growing farmers by organizing meetings, field days, field schools, trainings, round tables, and the publication of recommendations, brochures, manuals, etc.

This can be done through the development of curriculum, training courses and seed production guidelines, based on the community. It can also be done through supporting the creation of demonstration and pilot fields for the

cultivation of local varieties, and the creation of local seed banks. It would be important to create a special course on the preservation of local seeds to be taught in the country's agricultural universities.

Researchers can describe the local varieties, hybrids, and grafts that are cultivated by local farmers and keepers of seeds. They can facilitate the obtaining of a patent and a certificate by local farmers for the invention of varieties. All the new invented varieties need to be recognized by the ministries, agencies and the scientific community. This is, in fact, societal recognition.

It is important to conduct research to find and identify a variety of local crops and to create seed banks for their further reproduction, dissemination and preservation. Agricultural research institutions need to study the possibility and potential of community based seed production in the country in order to develop proposals and recommendations for the development of community based seed production.

Agricultural research institutions need to study the possibility and potential of community based seed production in the country in order to develop proposals and recommendations for the development of community based seed production.

Young professionals, graduate students, and graduates of higher education institutions should be involved in the study of the preservation of agricultural biodiversity of seed systems based in the community. Agricultural universities need to offer specific subjects or courses on the importance and necessity of community based seed systems, and their development and strengthening. Likewise, special classes devoted to the issues of preservation of a variety of seeds should be introduced into the curricula of secondary schools.

It is important to create a database of local farmers and gene banks to both conserve local crop varieties and document the biodiversity of community based seeds.

The role of public health institutions

Institutes of public health and nutrition can contribute to the conservation of biodiversity and the distribution of fruits, melons, potatoes, cereals and legumes, etc., through the dissemination of booklets and posters about a healthy lifestyle based on proper diet. This includes providing information on the nutritional value and high vitamin content of local varieties of produce, and their use in traditional culture to promote robust human health.

It is necessary to impact the public consciousness and bring awareness to people about food from local agrobiodiversity and its for human health benefits. One way to do this is through offering traditional meals made from diverse local ingredients for meals in schools and preschools.

Learning from traditional cultures

Every scientifically based discovery has its roots in local knowledge. Therefore,

institutions must learn the knowledge and culture of the Indigenous Peoples and the local community for the purpose of study, creation, promotion, preservation and enrichment of biological diversity.

The role of policy advocacy

It is important to promote regular coverage of local farmers and seed growers' activities in the mass media. This can include the preparation and presentation of a series of broadcasts on the importance of community based seed systems, and how this can greatly improve both human health and food security in the region.

The role of development agencies and government institutions

Tajikistan's Ministry of Agriculture, National Center for Genetic Resources, the Conservation Center for Biological Diversity, the Academy of Sciences, the Academy of Agricultural Sciences, Tajik Agrarian University, and the Committee for Environmental Protection should all develop a policy for the creation of community based seed systems.

It is necessary to develop and adopt special programs for the formation and development of agrobiodiversity conservation seed production at the community level with the involvement of specialists, experts, experienced farmers and scientist–agrarians. The government needs to develop and implement support programs to create favorable conditions for strengthening the conservation of agricultural biodiversity of community based seed systems in the country. At the same time, it is necessary to make some legislative changes and amendments to establish knowledge-based seed systems based on community experience.

COMMENTARY: RECOMMENDATIONS: A WAY FORWARD FOR AGRICULTURAL BIODIVERSITY

Pat Mooney, ETC Group

PAT MOONEY is the Founder of RAFI (Rural Advancement Fund International)—later renamed ETC Group—and has decades of experience supporting civil society advocacy around development and trade issues. Much of Mooney's work has centred on promoting agricultural biodiversity, with a more recent focus on the regulation of biotechnology. He is the author of several books on these issues, and is a recipient of the Right Livelihood Award (also known as the "Alternative Nobel Prize").

After more than 40 years of documented, practical experience with farmers' organizations and civil society groups in seed saving and plant breeding around the world, it is time to move beyond general statements of support to action. The following initiatives could be considered.

1. INITIATIVES THAT FACILITATE SEED ACCESS

Despite the rhetoric paid to farmers rights within the FAO ITPGRFA, the CGIAR gene banks system and national governments, farmers' organizations generally feel disenfranchised when it comes to access to national or international gene banks. Part of the problem is language and cultural barriers, but part of it is also a lack of interest by gene banks in supporting farmer access. Farmers' organizations not only need access to seeds, but also to practical information on seed pests and diseases, growing conditions, and future climate implications. These concerns have been raised with the ITPGRFA Secretariat as well as with the Global Crop Diversity Trust and some national governments. There is significant goodwill to work toward a solution.

1.1 The ITPGRFA should establish an Office for Farmer Seed Exchanges within the Secretariat in Rome.

This office should be capable of receiving requests from farmers' organizations (including individual farmers) and forwarding these to appropriate national or international gene banks. The office should have the capacity to have requests translated into working languages of the United Nations and should be able to follow through on requests to ensure that they have been met as far as is practicably possible. The office should maintain an electronic list of all requests received and information about how they have been disposed. The existence of the office should be widely publicized through national governments, international and national farmers' organizations and civil society organizations active in food and agriculture. Initially, the office may only require one skilled staff member but may eventually expand to two or three staff persons processing requests. The office should provide a website and basic information in multiple languages on the services provided. Print materials to this effect should be made available to farmers' organizations, CSOs and governments. Funding should be available for an experimental three-year time period. The office may cost from US$100,000 to $150,000 per year, and the money will have to be found from sources external to FAO. All costs related to gene bank seed multiplication, shipment, phytosanitary regulation expenses, etc., should be borne by the gene banks involved.

The ITPGRFA Secretariat in Rome has established an officer responsible for farmers' rights who is contracted to work with Indonesia and Norway who are the co-hosts for the farmers' rights global conference that will take place in Bali, Indonesia September 27–30, 2016. This is an encouraging step.

1.2 The ITPGRFA, perhaps in collaboration with GCDT, should establish a farmer-friendly electronic information system characterizing gene bank accessions, including information related to pests, diseases and climatic conditions.

The database should also provide mapping information that would help farmers and their organizations evaluate the most appropriate germplasm sources given changing climatic conditions. This information should be available in all of the languages of the UN system and the ITPGRFA/GCDT office should, as far as possible, be prepared to assist in providing additional translations. France has expressed interest in facilitating such an initiative. The cost of this initiative could be relatively high, but should be supported by the same funders that have expressed interest in supporting other new germplasm database endeavours. In fact, the ITPGRFA should commit to spending resources at least equal to those provided directly or indirectly for other information systems of use to larger institutions.

One concern to address is that there is considerable alarm among both Global South governments and civil society organizations that the DivSeek (super database for gene banks and researchers) initiative being led by GCDT and the ITPGRFA Secretariat has not only got off to the wrong start, but is developing a high-tech system that will not be practically accessible to gene banks or farmers in the South. There is general recognition that DivSeek would be a good idea and an important contribution in responding to climate change if there were more trust in the germplasm community. From the outset, however, the initiative has been clumsy: (1) describing itself as a contribution to "climate-ready" agriculture, mimicking Monsanto's Roundup Ready slogan and clearly worse than "climate-smart" agriculture; (2) in its goals, the initiative proposes to organize the policy for the many complicated intellectual property issues around germplasm information—an activity that requires national policy changes and even legislation well beyond the capacities of the initiative; (3) draft text for the initiative also proposes to encourage funders not to support any gene bank initiatives that don't comply with the initiative, which is asking for trouble; and (4) most importantly, the initiative doesn't begin with the obvious question: "What do our end users —farmers' organizations—need and want?"

The GCDT technical staff agreed with this critique and wants to reframe the initiative to ensure that the access needs of farmers' organizations are included in what might possibly be a wide-tech as opposed to a high-tech structure. They also recognized the polemics of the language that has been employed which had not occurred to them. We talked about convening a workshop or side event in Indonesia during the farmers' rights conference, to discuss the initiative and seek advice. We discussed the options of either the GCDT itself convening such a meeting; the meeting being co-hosted with ETC Group or others such as IFOAM; or civil society organizations inviting the GCDT staff to present at a meeting to discuss information systems in Indonesia. We agreed that we don't want to lose the initiative, we want to get the issues on

the table and make sure that the end product has value for the South and farmers. Some financial support for a workshop in Indonesia, including travel for some panelists, might be helpful. Side events with food in Bali—from past experience—are excruciatingly expensive.

1.3 Either the Global Alliance for the Future of Food, the ITPGRFA or the GCDT should undertake a formal survey of major national and international gene banks to ascertain their current practices with regard to facilitating farmer access to their collections.

This survey should seek specific data on facilitated access to farmers since 2007 and should draw conclusions on the various financial or technical barriers that reduce farmer access. Importantly, this survey should include a study of barriers to farmer-to-farmer seed exchanges both within and across national borders. This information should be published and made available to the Governing Body of the ITPGRFA.

There is general acknowledgement from Global Crop Diversity Trust that the scope and quality of information from national and international gene banks has declined in recent years, and less is known about who is accessing gene banks and for what purposes.

There is general acknowledgement from GCDT technical staff that the scope and quality of information from national and international gene banks has declined in recent years, and less is known about who is accessing gene banks and for what purposes. Additionally, many gene banks treat access requests from the private sector as confidential business information which might be understandable at the level of accessions but should not be necessary at the level of species. There is general agreement amongst the staff that more information should be available, and that the barriers to farmer access are not clear and should be identified. Ideally, it would be good to have such a study underway or completed in time for the farmers' rights conference or at least in time for the next meeting of the Governing Body in 2017.

2. INITIATIVES SUPPORTING ON-FARM PLANT CONSERVATION

Farmers have been conserving crop genetic diversity for more than 12,000 years. Contrary to some assumptions, conservation strategies have assumed that seeds must be saved for several growing seasons, not just the upcoming season. However, given the impact of climate change on agriculture, farmers need to have secure access to their own seed supply for as long as possible. They also may need to conserve a wider diversity of genetic resources than customary. The following initiatives will strengthen their resilience:

2.1 Although there has been research into farmer strategies regarding seed storage by community, climate and crop, this research has been fragmented and generally ignores gender considerations. Further, the research has not been situated within the framework of climate change resiliency.

It could be useful to farmers' organizations to work with researchers to undertake a study of the systems and practices employed by different communities

to determine not only how seed should be stored, but why and for what purposes. It would be important to understand how existing storage strategies might be augmented so that seeds can be kept for a longer time. The study might also disclose the need (if any) for enhanced strategies for new techniques. The study should also seek the views of farmers and their organizations on the need for longer or larger seed storage systems held by their communities or organizations. Is there, for example, a need to have access to a greater diversity over time? Does this diversity need to be stored locally? Because of the sensitivities involved, such a study should be conducted in conjunction with farmers' organizations but could otherwise include the Global Alliance, ITPGRFA or the GCDT.

2.2 In tandem with the above survey, research is needed to evaluate new techniques for long-term seed storage under ambient or near-ambient conditions.

This research should include the extreme drying experiments pioneered by César Gómez in Spain as well as the innovative work using ceramic beads that can be used to both dry seeds and keep food. Some investigations are underway through the Dutch gene bank, Kew Gardens and the Brazilian gene bank, CENARGEN. It seems possible to store orthodox seed for 40 years or longer extremely inexpensively under ambient conditions (no electricity or cooling).

2.3 In cooperation with GCDT (and possibly other parties), it would be helpful to conduct a careful study providing data on the current and historic levels of funding available for *in situ* seed storage around the world.

This data should be contrasted with the available information on *ex situ* storage funding. Based upon this information, the GCDT and other potential sources of funding should be encouraged to respond to the survey and provide concrete proposals for support.

There is an enormous potential for enhanced collaboration and effectiveness among the many seed organizations and agroecology networks that operate regionally and globally. These could include the AgroEcology Fund, La Via Campesina, Oxfam International's Sowing Diversity=Harvesting Security initiative, USC Canada, the Norwegian Development Fund, IUF (a federation of food and agricultural trade unions), International Foundation for Organic Agriculture (IFOAM), Slow Food International, The GAIA Foundation, URGENCY, and others that operate overlapping networks that espouse roughly similar goals. It is not unusual for two or more of these networks to function in the same country even in neighbouring communities. One network could host a capacity-building workshop in a country which would be very useful for partners in other networks within the same country. Several of the major networks have specialists in seeds, soils, or climate who could support the concerns

of other networks. When these experts are engaged in the same countries or regions where other networks are also working, the need for cooperation is obvious. Further, networks working with different partners in the same country may have the same policy needs and could perhaps more easily work together to achieve policy changes at the national level. The Global Alliance could encourage more dialogue between these networks and possibly provide modest additional funding to make sure that the workshops and expertise available from one network are shared with partners in other networks in the same country or region.

3. INITIATIVES TO SUPPORT APPROPRIATE SEED POLICIES

3.1 Create a Civil Society Mechanism for the Seed Treaty.

With additional financial support that would ensure both the attendance and the preparation of farmers' organizations and civil society, the Plant Treaty could have its own version of the Civil Society Mechanism and achieve a higher level of inclusiveness and participation in the negotiations.

The 2009 reformation of the CFS (Committee on World Food Security) has proven to be one of the great governance accomplishments of the 21st century in food and agricultural policy. In particular, the formation of the CSM (Civil Society Mechanism) and PSM (Private Sector Mechanism) has been found to be uniquely effective. Since 2011, the ITPGRFA has contemplated similar restructuring; however, this is more difficult for a legally binding treaty than for a consultative process such as the CFS. Moreover, in 2015, the seed industry took a large and very active role in the governing body of the Plant Treaty. Their resources and influence on this issue has put farmers' organizations at a disadvantage. With additional financial support that would ensure both the attendance and the preparation of farmers' organizations and civil society, the Plant Treaty could have its own version of the Civil Society Mechanism and achieve a higher level of inclusiveness and participation in the negotiations. There is a high probability that such an initiative would be well received by governments and the secretariat. We estimate that an additional US$60,000 to $70,000 every second year (around the biennial meetings of the governing body) would allow for capacity-building as well as participation, and could yield increased support for farmers' rights and *in situ* conservation.

3.2 Regional Ministerial Seed Dialogues could be organized during the biennial FAO Regional Conferences held in seven regions of the world including, incidentally, North America.

Currently, the biennial ministerial-level conferences serve little practical purpose, but the intent for some time has been to use these meetings to feed into processes such as the CFS. There is a move underway to restructure the regional conferences to emulate the CFS model, allowing the full participation of farmers' organizations and civil society. With preparation, farmers' organizations and their civil society partners could introduce seed and agroecology issues into these regional gatherings. This would not only influence the Governing Body of the ITPGRFA and the CFS but could have more useful impacts in ministries of agriculture in the region. As a rough estimate, this would amount to a biennial cost of US$20,000 per region. The Global Alliance

for the Future of Food could provide capacity-building and participation for key organizations to attend the regional conferences in Latin America and the Caribbean, Africa, and Asia and the Pacific. This work could impact a wide range of national-level seed policies.

3.3 Farmer-Ready Agriculture: Farmers' organizations could be supported to undertake their own independent evaluation of the preparedness of the Rome-based UN agencies and CGIAR to collaborate with farmers' organizations on issues related to seed saving, plant breeding and (more widely) farmers' rights.

A small team of farmers could undertake the evaluation on a regional basis in order to keep costs low and then representatives of each of the teams could meet in advance of the CFS in Rome to produce a global report. The report would explore the preparedness of gene banks to cooperate with farmers and the agencies and organizations to work on a range of issues. The report could be presented to the governing bodies of the organizations as well as to the CFS. This would be the first time in history that such agencies were evaluated by those they are supposed to support. Managed carefully and in harmony with other activities, the cost of this initiative could be approximately US$50,000.

SUPPLEMENTARY NOTES

1. History of civil society organizations and farmers' organizations

The history of CSO/farmer engagement is in the eyes of the beholder, but the first formal and recorded initiative is the Seed Savers Exchange (SSE) that was incorporated in Iowa, United States in 1975. The first global civil society discussions on seed policy were held by the International Coalition for Development Action (ICDA) in Saskatchewan, Canada in 1977. The first proposal that small farmers could be "seed curators" and collaborate with national and international gene banks came in 1983 with the publication of "The Law of the Seed" as a special report of the Dag Hammarskjold Foundation's journal, Development Dialogue. This initiative was generally opposed by CGIAR, including IBPGR (the original name of Bioversity International), but received some support from Canada's CIDA and IDRC. Based on the experience of the Ethiopian gene bank during the mid-1980s famine, RAFI published the Community Seed Bank Kit in three languages in 1985 and then convened a sequence of three regional conferences on community seed saving in Africa, Latin America and Asia in 1987. SEARICE in the Philippines began its community seed bank work at about the same time and USC Canada began working with the Ethiopian gene bank and partners in Zimbabwe and Mali in 1988. Throughout the 1980s, community level seed work was either ignored or opposed by the CG system.

At the conclusion of the Keystone International Dialogue on Plant Genetic

Resources (1988–91) the Dutch gene bank and Noragric, Norway proposed the establishment of the Community Biodiversity Development and Conservation Program (CBDC) to SEARICE (Southeast Asia), CTDC in Zimbabwe, CET in Chile, GRAIN and RAFI (later ETC). Individuals in the CGIAR system—notably in CIAT, CIP, ICARDA and ICRISAT expressed support for the initiative but did not get formally involved. At that time, IBPGR became IPGRI and expressed some interest in the initiative, hosting one meeting of the consortium, but was not invited to participate. By and large, the development of civil society and farmer activities around seed saving and plant breeding arose in spite of—rather than because of—international organizations.

2. Seed saving and plant breeding

In general, the international scientific community continues to regard farmers as strictly "seed savers," or as advisors in plant breeding programs. "Participatory Plant Breeding", for many scientific institutions, means that farmers are invited to observe nursery trials; to multiply institutional seeds; or comment on breeding priorities—not to initiate, direct, or even collaborate as equals in plant breeding programs.

In the 1970s and 1980s, civil society organizations, including ETC Group, emphasized the important role of community seed banks, but tended to downplay the role of farmers as plant breeders. However, by the 1990s, farmers organizations themselves made it very clear that farmers have been breeding new varieties and domesticating new species for 12,000 years, and that this work continues. Most recently, the international literature shows that farmers also nurture—and often cross so-called crop-wild relatives as an important source of breeding material. In general, the international scientific community continues to regard farmers as strictly "seed savers," or as advisors in plant breeding programs. "Participatory Plant Breeding", for many scientific institutions, means that farmers are invited to observe nursery trials; to multiply institutional seeds; or comment on breeding priorities—not to initiate, direct, or even collaborate as equals in plant breeding programs. It is now abundantly clear that farmers play a vital role in both conserving traditional plant varieties and also in crossing traditional varieties with varieties bred by public and private institutions to improve and develop entirely new varieties. The important distinction is that farmers not only preserve, but they also develop. Indeed, preservation is far from a curator function—it is part of a practical strategy to maintain diversity for future needs.

3. Relations between research institutes and CSO/farmer initiatives

There continues to be a cultural disconnect between farmers' organizations / civil society organizations (CSOs) and formal public sector research institutes. While farmers and CSOs are sometimes unnecessarily distrustful and fail to take advantage of collaborative opportunities with institutions, their experience has historically been painful and problematic and even well-intentioned institutions still fail to see both how they are perceived and how they perform. As in any endeavour, those who have resources and power tend to be so convinced of their knowledge and goodwill that they can't imagine that others could presume otherwise or that they could perform otherwise. With rare exceptions, international institutions continue to see farmers and CSOs as tools toward an end. CSOs are welcomed mostly because they reduce the transaction costs of relating to farmers and local governments. Farmers and

CSOs are not seen as initiators or experts in their field. This is dismaying since many farmers' organizations have long-standing formal and informal access to conventional scientific advice, and increasingly, actually employ conventionally trained plant breeders, soil specialists, foresters and geneticists with Master's degrees or PhDs from highly regarded universities. Farmers' organizations and CSOs often employ lawyers and anthropologists. Several CSOs have employed scientists who previously worked in the CGIAR, for example.

It is also important to note that, partly because of the exigencies of funding, many civil society organizations such as Oxfam International and Action Aid are not merely administrators or funders but also co-participants in seed and plant breeding initiatives around the world. Many of these organizations have substantial in-house expertise that should not be overlooked. Organizations such as USC Canada and the Norwegian Development Fund, for example, are also able to share experiences between regions and cultures and promote farmer-to-farmer collaborations based upon their expertise.

4. Genes and gender

One of the most important strengths of farmers' organizations / CSOs is that the role of women in seed saving and plant breeding is an immediate practical reality. Women play a central role in seed saving, seed selection and plant breeding. Women's goals in this work are different from men's. Women tend to breed for such factors as nutritional quality and energy efficiency. Any studies that omit or discount gender realities should be treated with caution.

COMMENTARY: BUILDING A STRONG FARMER MOVEMENT TO PROTECT SEEDS IN ZIMBABWE

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The value and sacredness of seed

Seeds are the first link in the food chain and the repository of life's future evolution. As such, it is our inherent duty and responsibility to protect them and to pass them on to future generations. The protection and strengthening of community seed systems is derived from the understanding that seed was given by the Creator and it is the farmer's basic right to keep seed. The growing of seed and the free exchange of seed among peasant farmers has been the basis of maintaining the stability of biodiversity and the source of food security. Supporting and enhancing traditional practices on seed saving, especially as practiced by elderly women, who have bred seed freely in partnership with each other and with nature, will further increase the diversity of that which nature gave us, for biodiversity and cultural diversity mutually shape one another.

The diversity of traditional seeds saved by peasant farmers is rooted in the knowledge that seeds are the foundation of life, and more than a source of food—they are a history and culture handed down by our ancestors. They hold a special place in the struggle for food sovereignty. These small grains are the basis for the future hence their diversity is a solution to the climate crisis. They shape, at each life cycle, the type of food people eat, how it is grown, and who grows it. This holistic thinking about the value and sacredness of seed over the past generations has been the basis for sustaining diversity and hence stability, in the surrounding environment.

Agroecology and seeds

Agroecology has emerged as an alternative to the industrial food regime. It is a social and political process that struggles for the integral recovery of food sovereignty and genuine agrarian reform. It is valued for its integration of scientific advances with the traditional knowledge of our people. This is the integration of humanity, in harmony and in equilibrium with nature and is the defence of local and traditional seeds. Agroecology gives us a deeper scientific understanding of how ecological processes work at the level of soils, living seeds and living food.

Through ecology and the new biology of our local and traditional seed systems, farmers know that life is self-organized complexity, life makes itself, and it cannot be manufactured. This also applies to food production through the new science of agroecology. Peasant farmers are deeply knowledgeable about their relationship to nature, the living world, the living soil and the living seeds.

The sacredness of food and consumer habits

Food is a sacred gift from the universe. That means it is not a commodity, and it is not there for profit or for commerce. This fundamental understanding has been lost, and now food is being produced, packaged and marketed, losing its spiritual value. There is another growing trend. The majority of consumers know very little about their food system, including its nutritional value. The only thing they hear is that food is a fuel that you put in the body like you put fuel in the car, so to drive the body you need food. When we lose contact with the food system, we lose contact with the soil. Losing contact with the food and the soil means losing contact with the seed as well. It is the seed which is the source of life and all the food we eat. Very large trees are grown from very small seeds. These seeds are so small we can break them with a finger, but that illustrates the value of small seeds. That is symbolic of the peasant farmers' respect for the sacredness of seed, and that experience is not mechanical. It is how the ancestors have lived with seeds for hundreds of thousands of years.

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We farmers are very aware that the control by a few has strangled the space between those who eat and those who produce that food; like a balloon being squeezed in the middle. The control of the food system is coming with the control of the seed and the privatization of our food systems. This is the time to put aside the panic of immediate threats, extend the limit of the horizon far beyond the sight, and forget about forced balances and stocks. Instead, open and reconsider the immediate surroundings, try the diverse native seeds, ecological contours and the local foods systems. It is an opportunity to try new ingredients and different recipes and bring back ecologies and economies into a more promising shape by carefully redrawing the way.

Living examples of protecting community seed systems

We farmers are conscious that life on Earth has diversity, not monocultures. Modern technology seems to have forgotten that, and it has designed monocultures for the profit of large multinational corporations while peasant farmers have continued to save, reuse and exchange this beautiful creation of God.

ZIMSOFF advocacy work at local level

Members of the Zimbabwe Smallholder Organic Farmers Forum (ZIMSOFF) have created a movement that can connect them to the very origin of their being through saving, reusing and exchanging their traditional and sacred seeds to protect their future well-being. The members are advocating for a world that allows the future of saving our own traditional seeds in alignment with the earth and life in abundance. Recognizing diversity in a deeper sense protects the earth because diversity is unique and self-sustaining. The foundation of social justice is ecological justice so whatever peasant farmers are doing, they are thinking of how their actions will create social and ecological benefits for future generations.

The experience of ZIMSOFF members has been that it is only from grassroots households that change should be influenced, horizontally and vertically. Households know each other and can easily connect; they can learn from each other, they can easily exchange seed and protect household seed banks of quality seed which they constantly monitor. They have noted that change will not happen via one person at a time so there is a need to work together as organized groups, try new ways of doing and commit to making a difference in the environment. Through networking and relationship-building they develop a common understanding. Members have continued to multiply their diverse traditional and open pollinated seed varieties, organizing best farmer field days, seed and food fairs, campaign workshops and exchange visits to build capacity of the practicing farmers.

The Zimbabwe Seed Sovereignty Program (ZSSP)

Seven organizations with vast experience in agroecology and seed diversity conservation have designed a collaborative and strategic multi-year program on strengthening community based seed systems in Zimbabwe towards seed sovereignty. The organizations include ZIMSOFF, the Participatory Ecological Land Use Management (PELUM) Zimbabwe, Towards Sustainable Use of Resources Organisation (TSURO) Trust, Chikukwa Ecological Land

ZIMBABWE SEED SOVEREIGNTY PROGRAM PRINCIPLES

1.0 Farmer-led

1.1 Opening, creating and promoting spaces for farmers to express their views, concerns, achievements and issues;
1.2 Ensuring farmers' rights and capacity to produce, exchange and trade seed;
1.3 Shifting research towards farmer-driven research.
1.4 Ensuring a farmer-led approach to planning, implementation, monitoring and evaluation of the program.

2.0 Strengthening Sustainable practices

2.1 Recognition and enhancement of local and indigenous knowledge and innovations;
2.2 Promoting and upholding ecological practices;
2.3 An emphasis on conserving and evolving traditional and OPV seed varieties of high quality (that are not genetically engineered)

3.0 Collaboration

3.1 Having a trusting and learning partnership of equals based on clarity of roles and transparency;
3.2 Reaching out to collaborate with other initiatives and stakeholders, wherever relevant, in Zimbabwe and beyond.
3.3 The partners recognize the importance of commitment to the program by the whole organization (not just certain individuals).

4.0 Inclusivity

4.1 Ensuring access to OPV and traditional seed of high quality by marginalized and vulnerable people.

5.0 Contextual understanding

5.1 Working towards a deeper awareness and understanding of socio-cultural, political and economic issues around seed at all levels.

Use Community Trust (CELUCT), Fambidzanai Permaculture Centre (FPC), Farmers Association of Community Self Help Investment Groups (FACHIG) Trust, and Practical Action. The program constantly refers to the principles below to evaluate its performance. The principles also assist in planning and decision-making.

Barriers to Success

The threat to community seed systems impacts the very fabric of human life and the life of the planet. The promises made by the biotechnology industry—increased yields, reduction of chemical use and control of weeds and pests through their monocultures—have not been kept. Meanwhile, we see greater environmental degradation, while indicators of climate change and poverty are growing.

The impact of the Green Revolution

Despite efforts by peasant farmers to save, reuse and exchange their traditional seed varieties, the Green Revolution continues to hold sway in terms of how African governments approach agriculture. The Green Revolution strongly favors the interests of large multinational corporations and the more powerful nation-states in the global system. The impact is visible from the African Union (AU) down to the individual government extension officer who interfaces directly with farmers through providing training on conventional methods that emphasize the use of hybrid seed, fertilizers and toxic chemicals. As a result, extension officers continue to advise farmers to buy certified hybrid seed maize in particular and to do away with farmer saved seed, regarding this practice as primitive. The myth is that to achieve high yields, farmers must buy only certified seed at a profitable rate for the corporation.

Currently there are hundreds of crop types and untold varieties in the farmer seed system. These are not recognized in policy or law, and are not given public support despite their critical social and ecological functions.

Public resources have been pulled into supporting this, from subsidies to hybrid seed maize, to seed research and development favouring corporate agendas. Across the region, there is hardly any recognition of farmers' ongoing seed reproduction practices that are absolutely critical to the maintenance of agricultural biodiversity across Africa. Currently there are hundreds of crop types and untold varieties in the farmer seed system. These are not recognized in policy or law, and are not given public support despite their critical social and ecological functions.

Harmonization of seed laws

Harmonization processes currently underway in the Southern Africa Development Community (SADC), the Common Market for Eastern and Southern Africa (COMESA) and the African Regional Intellectual Property Organisation (ARIPO) attempt to impose a blanket set of regulations for all seed producers, regardless of whether they are multinational corporations in large markets or individual farmers reproducing seed on their own land.

The harmonization process relates to commercial seed production. But it encroaches on farmer's rights as defined in the International Treaty on Plant Genetic Resources (ITPGRA), to which most countries in the region are signatory. Historically, farmers had the right to recycle any seed in their possession as long as it was used on their own land, and there were no restrictions on farmers selling seed informally.

The secretariat and 19 member states of the African Regional Intellectual Property Organisation (ARIPO) have been developing a harmonized law called the Protocol on Plant Variety Protection (PVP). This protocol is based on UPOV 1991 and was adopted in Arusha, Tanzania, in July 2015. The ARIPO PVP Protocol puts in place a regional PVP system that favours only commercial plant breeders and undermines the rights of farmers to freely use, exchange and sell farm-saved seed of a protected variety. It gives powers to the ARIPO office to grant very strong plant breeders' rights (PBRs) to commercial breeders. It makes PBRs granted by the ARIPO office valid in all ARIPO member states. All this makes it very easy for foreign seed companies to take over Africa's seed systems and illegally use local varieties and replaces national PBR laws and systems.

Harmonized laws make the recycling of varieties protected by PVP illegal. They threaten to criminalize any sale of seed by peasant farmers that has not gone through the formal certification process and does not meet formal regulations for seed production and storage. These include farmers' own seed, thus imposing a standardized legal model inappropriate to the context of long histories of local exchange and trade.

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POTENTIAL FUNDER INTERVENTIONS

Focus area 1: Advocacy for farmer seed rights

Increase the understanding of socio-cultural political issues by peasant farmers so they may advocate effectively against this process being pushed by the Green Revolution, which has the greatest impact on the security of community seed systems. The Green Revolution process is top-down, and promotes breeders' rights over peasant farmers' rights. It is a one-size-fits-all system in our region and based on UPOV 91 (a centralized system meant for the EU Trade Systems). The information on the processes is regarded as confidential, and there is very limited, if any, non-market access to smallholder farmer seeds, as the process is based on the distinctiveness, uniformity and stability (DUS). It is difficult for peasant farmers to access the technology required for breeding. The farmers' role under this regime is just to be growers, not innovators or stewards of their heritage. And, most importantly, policies based on the Green Revolution are not ecologically and economically viable.

Focus area 2: Infrastructure of seed systems

There is a need to strengthen seed production and conservation infrastructure at the household and community level, and to re-establish these where they have been lost. Formal dialogues, using exercises such as the Community Technology Development Organization's (CTDO) Diversity Wheel, to assess the seed situation in the participating countries, are envisaged. This process will also lead to the identification of lead seed farmers who will be strengthened as seed producers. This strengthening will cover seed production, selection, harvesting and storage. The strengthening will also combine local knowledge and some technical input from outside where necessary.

Support from funders should influence a movement towards agroecology and seed sovereignty, including Participatory Guarantee System (PGS) setups for community seed systems and adequate documentation of good practices.

Focus area 3: Trade and exchange

It is important to stimulate greater trade and exchange of a variety of seed amongst farmers within communities and between communities. Support from funders should influence a movement towards agroecology and seed sovereignty, including Participatory Guarantee System (PGS) setups for community seed systems and adequate documentation of good practices.

Focus area 4: Capacity-building

One of the key areas that requires support is capacity-building within farming communities and support services to increase knowledge and skills in relation to diverse community based seed systems. This includes carefully designed exchange visits, the development of farmer-friendly seed handbooks, and the circulation of learning materials.

Focus area 5: Research

Strengthening links between farmer led research and national and regional institutions under the auspices of Participatory Plant Breeding (PPB) is of paramount importance. The support will guarantee quality and quantity of seed produced and recycled among peasant farmers.

Focus area 6: Consumer education on health food styles

There is need for awareness. Many people across the world are beginning to ask questions about diet, nutrition and food generally. This is a very good base to work from, to change consumer perceptions to think favourably about traditional and organic foods, and to increase the knowledge among consumers about the benefits of eating traditional and organic foods. There is also a need to increase farmer knowledge on the benefits of producing traditional and organic foods, as well as to influence governments to incorporate the promotion of traditional and organic foods in relevant policies and strategies.

COMMENTARY: ADAPTING TO THE COMPLEXITY OF SEED SYSTEMS

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Community based seed systems are diverse and complex entities. There is a diversity of seed systems because of the diversity of eco-geographical and economical conditions, of the crop reproductive biology, of cultural factors, etc. Between yam seed systems in Benin[1] and the rice seed systems in the Philippines[2], the differences are huge, even though one can reasonably attempt to describe them with a single theoretical framework.

Factors of complexity within seed systems are numerous, but a few can be mentioned:

- Diversity of stakeholder categories (farmers, seed sellers, breeding companies, research institutes, etc.)
- Diversity of functions, expectations and behaviours of these usually heterogeneous categories of actors (innovators/followers, network nodes/network branches, experimented/newcomers, Indigenous/non-Indigenous, local/multinational, etc.)
- Changes over time in these roles, expectations and behaviours

The results from this diversity and complexity mean that the ways to sustain, protect and strengthen CBSS will have to be diverse, tailored and adaptive.

In a sense, there are no "best" ways to protect and strengthen CBSS; there are ways which are appropriate—or not—depending on situations.

A research study we conducted on rice diversity in the Cagayan Valley proposed solutions to sustain rice agrobiodiversity. Local seed systems were identified from a thorough diagnosis conducted on the reasons why farmers were discarding local, long-duration varieties or were not growing local varieties after climatic catastrophes. Only this diagnosis was able to suggest interventions.

We then took the possible interventions and placed them in two categories.

1. Make diversity a viable option for farmers.
   - Develop market niches for long-duration landraces (particularly, those threatened by short duration "modern" varieties).
   - Develop cropping methods to allow two cultivation cycles, including one with long duration landraces.
   - Improve local landraces.

2. Strengthen farmers' access to diversity.
   - Develop seed storage facilities at the household level.
   - Set up links between farmers and gene banks.

The lack of knowledge of seed systems is a bottleneck for actions aimed at supporting CBSS. In order to address this, it is helpful to carry out an assessment of the strengths and weaknesses of targeted seed systems as well as threats to seed diversity. However, baseline data on crop diversity are often not available, which makes difficult to assess the effect of interventions.

More generally, we have little knowledge on how to monitor the efficiency of seed systems. To do so, we would need to define what services are expected from each specific CBSS. Do we seek to measure food safety, diversity preservation, evolutionary services, community empowerment? That would lead to the identification of realistically measurable indicators and the timescale that should be used to measure these indicators.

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New information technologies make it possible to gather data on crop distribution and seed exchanges through crowdsourcing. This should be explored.

We have even less knowledge about what makes seed systems resilient or makes them collapse without possible restoration. Where are the tipping points? For example, what level of erosion of local knowledge or social exchanges can be tolerated without endangering a seed exchange network? This kind of research should be supported, and should involve the active participation of farmers.

Another important intervention is to promote the coexistence and interactions between seed systems. CBSS cannot be closed systems. For centuries farmers have had the practice of discarding some crop varieties and introducing new varieties from other communities, however seeds from breeding companies or national research systems are now the main sources of new varieties.

The challenge now is to promote the coexistence of CBSS with commercial seed systems. What are the benefits for CBSS and what can be expected from this coexistence? What seed policies are needed to facilitate the conditions for coexistence?

The role of international seed policy

The role of international bodies such as the International Treaty on Plant Genetic Resources for Food and Agriculture should not be underestimated in order to address local issues at the global level. There is a need to support the activities of the treaty, particularly through the support of research that could strengthen the scientific basis of initiatives led by it. The development of appropriate seed policies could also be encouraged at rather high levels in regional fora and organizations (i.e., CORAAF and CEDEAO in West and Central Africa).

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COMMENTARY: SUPPORTING AUTHENTIC FARMER MANAGED SEED SYSTEMS

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1. What are the best ways to protect and strengthen community based seed systems?

In my experience, establishing autonomous networks related to seeds which are controlled by peasant farmers is key.

Community based seed systems are obviously the result of a *collective* endeavour—no individual could undertake this work on their own, so it's the collective nature of the seed system that has to be at the heart of any effort to protect and strengthen them.

This collective work is best undertaken in networks that could, for instance, be national networks of local seed-saving organizations. I clearly distinguish the autonomous farmer networks from networks controlled by NGOs or technical experts (including well-known or "celebrity" defenders of seeds).

The networks need to be led by people whose livelihoods depend on the continued use of local seeds. Their dependence on these seeds gives them knowledge of both technical aspects of seed saving and knowledge of the kinds of policies they need. This knowledge can be supported, but not replaced, by the knowledge of technical, research and NGO experts.

These networks need to have the scope to work on several fronts: save and exchange seeds, research (whether participatory research with breeders or their own research), analysis of regulations, laws and policies and engagement with policy makers and legislators to develop more favourable policies as needed.

2. Beyond lack of funding, what are the blockages/barriers that get in the way of success?

a) As suggested above, experts —including researchers and NGOs—tend to become the *de facto* leaders of efforts to strengthen community based seed systems because local farmers often lack the resources to do all the work that they would like to do. Also, sometimes farmers are challenged to speak the language of donors and policy makers, and so NGOs often become their interlocutors. This can be a very important source of support for local farmers, but all too often the experts (sometimes subtly) lead the process. This is particularly risky when policy and legislative issues are at stake, because in many cases experts/NGOs take more toned-down positions. I think it is easier for them to make compromises precisely because their livelihoods do not depend on the outcomes.

b) Another barrier is that powerful economic players are involved in the seed sector. Intellectual Property Rights (IPRs), Genetically Modified Organisms (GMOs) and other emerging technologies are the most controversial and politicized issues in agriculture, although land is also an important and politicized

asset. It is challenging to get institutional support, which may include funds but is certainly not limited to that, to organize any activities that challenge powerful economic interests, such as the major seed companies.

c) These powerful economic interests (the major seed companies and the organizations that defend their interests such as UPOV) are very influential in shaping the thinking of national policy makers and research institutions. They have the resources to develop powerful communications tools and organize a large number of meetings through which they promote policies that benefit them. For example, they often advocate for a larger role for the private seed sector and a lesser role for public breeding. They also promote plant variety protection and seed laws that can impact farmers' rights to save and exchange their seed. National public research institutes and seed policies and laws should, in theory, support community based seed systems (since most farmers rely on them) but most do not.

Despite substantial evidence on the negative environmental and social impacts of Green Revolution technologies (including high-yielding varieties), the emphasis is still very much on increasing production at all costs. Hence for many researchers and policy makers, local and traditional varieties are relics of low-yielding production systems.

d) Productivist narratives have a massive influence on science and policy. Despite substantial evidence on the negative environmental and social impacts of Green Revolution technologies (including high-yielding varieties), the emphasis is still very much on increasing production at all costs. Hence for many researchers and policy makers, local and traditional varieties are relics of low-yielding production systems.

3. Where can funders can intervene for greatest impact in the area of seed systems?

a) Supporting collective action of ***organized*** peasant farmers (rather than working with individual farmers or groups of farmers through NGOs)

b) Supporting both field-based activities, and policy analysis and advocacy in an integrated way (i.e., each farmer seed network should be doing both)

c) Supporting national, regional and global level seed networks/platforms controlled by peasant farmers

d) Supporting exchanges between policy makers and national focal points to relevant international conventions (ITPGRFA, CGRFA) and peasant seed network leaders and other advocates for community based seed systems

e) Supporting trainings of farmer leaders on policy and regulatory issues

COMMENTARY: STRENGTHENING COMMUNITY BASED SEED SYSTEMS IN LATIN AMERICA

Humberto Ríos Labrada, ICRA[1]

HUMBERTO RÍOS LABRADA is the Latin America Program Director for ICRA, an agricultural research institute based in Spain. After earning a PhD in Agronomy in his native Cuba, he worked for over a decade at the National Institute for Agricultural Sciences, where he developed an innovative methodology for farmers to teach scientists how to increase crop diversity. He has applied these methods in various regions of Mexico and Bolivia. In 2010 he won the prestigious Goldman Environmental Prize for his successful efforts to improve agrobiodiversity.

I will briefly describe different approaches that I have been involved in with some success.

Participatory breeding of landraces

In my experience of working on-farm with farmers and breeding landraces I learned some important lessons:

- Differences in appearance, or phenotypic variability, exist among traditional varieties of a domesticated species of plant (landrace) grown in low-input conditions. This allows for options to breed new varieties by selection.
- Farmers are able to improve complex characteristics i.e., yield in low-input conditions. It was proven that through direct selection farmers can make genetic advances to yield and its components.
- Farmers have the capacity to choose varieties that are locally adapted. They understand—often better than professional plant breeders—which types of varieties are needed for local conditions.
- In order to stimulate seed diversity and farmer participation, it is more efficient to increase the learning process through a participatory landrace breeding approach than to externally determine the best variety for a specific zone.

In the various programs I have been involved with, farmers, civil society representatives and plant breeders have promoted community-organized seed collections to link their own seed bank to landrace breeding programs; and farmer sown collected materials: every cob or head was considered as a family and separately sown. Farmers chose and mixed the best families and made improved gene pools and multiplied seed for self-consumption, barter and/or sale.

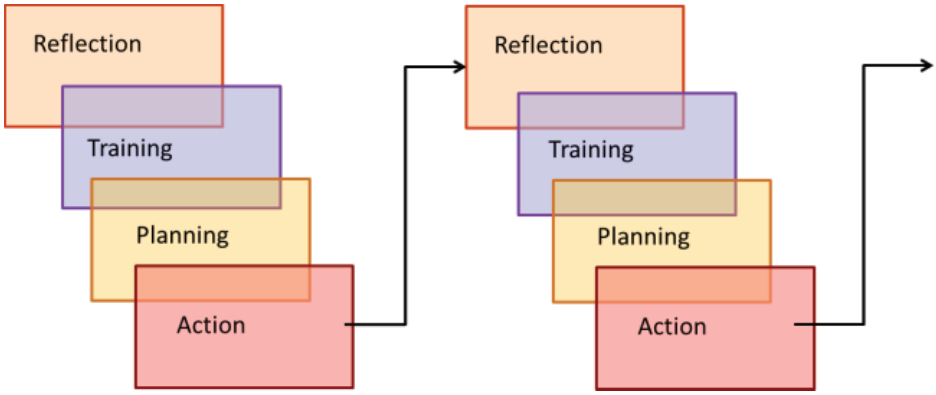
Participatory seed diffusion (PSD)

Varieties from formal and informal seed systems are sown under the usual cultural practices of the target environment. Farmers have the possibility to choose three-six varieties per crop in the field, then changes are introduced.

For example, at diversity seed fairs in Cuba, participants were not told the seed sources in the plot during the selection exercise; only afterwards were the identities of the varieties revealed. Afterwards, on their own farms, the farmers organized trials with selected seeds. Discussions on varietal performance took place within the communities; between farmers, researchers, and civil society representatives. In practice, each farmer who participated in the varietal selection exercise ran a small experimental station.

1 ICRA, formerly the International Centre for development-oriented Research in Agriculture, (based in the Netherlands) aims to support leadership and to develop critical mass in facilitating learning and action for agricultural and rural innovation.

Fig. 1. **Interactive learning cycles (Source: ICRA)**



Culinary qualities of the varieties were extremely important in keeping more diversity on-farm. Women organized cooking tests as important criteria for varietal selection. Mostly male farmers voted for varieties with high yield and associated characteristics. Female participants voted for varieties related to culinary properties. In the cooking tests, men noted that more than 80 per cent of the varieties tested were of good cooking quality, whereas women were more rigorous.

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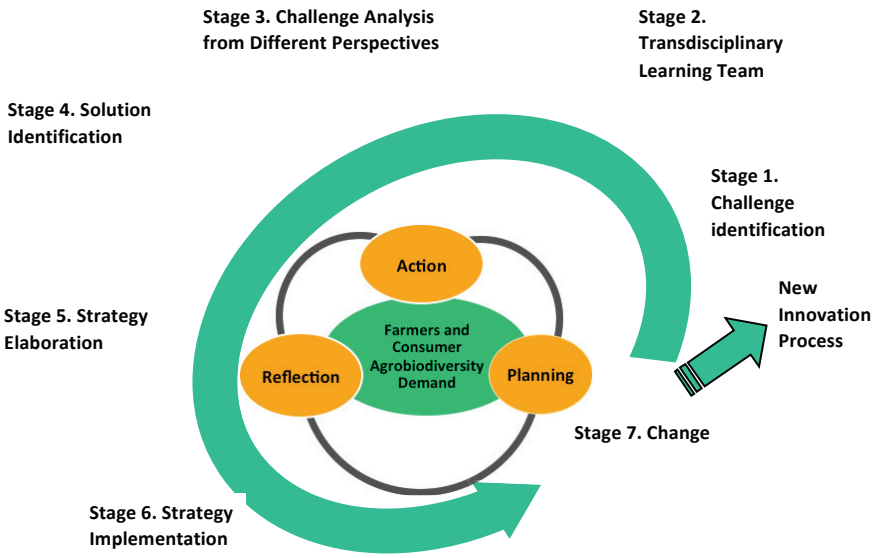
Innovation through collective learning and adaptation to opportunities and challenges

This approach, involving collective processes, enables stakeholders to seize opportunities, build trust and take joint action. ICRA has developed such an approach that leads multi-actor groups through progressive phases of joint action. We have applied this approach to scale up best participatory plant breeding practices in Cuba, Mexico and Bolivia.

An ICRA "interactive learning cycle" (Fig. 1) engages all those actors and stakeholders that face a common innovation challenge and stand to profit from joint learning and action. They reflect on the challenges they face, learn how to deal with them and plan how to apply the lessons learned in their own working environment.

However, for an action learning cycle to be successful, someone must keep the actors pointed in a jointly agreed direction. It is important to identify those who have excelled in the implementation of a new idea—champions—so they can be trained on the job as innovation brokers or facilitators. For instance, in four years, three learning cycles were conducted in Cuba (through the Local Innovation Program in Agriculture, PIAL) and Bolivia (through the National Innovation Systems for Agriculture and Forestry Innovation, SNIAF), applying

Fig. 2. **Interactive learning applied by Innovation brokers in Cuba and Bolivia. (Source: ICRA)**



Box 1

EXAMPLE OF A LEARNING CYCLE IN CUBA IN FAVOUR OF SEED DIVERSITY AND FARMER PARTICIPATION

Diversity seed fairs in Cuba have successfully promoted seed diversity use and farmer participation. Through facilitated collective learning, ways to sustain diversity seed fairs without international donors were identified.

In the picture, Joel and Idalmis, "champion" farmers from San José de Las Lajas, Province of Mayabeque, are presenting and discussing their business model of tuber and yam seed production and marketing. They organized diversity seed fairs to identify local farmers' demand and also explored how other champions can be part of seed diversity businesses in their cooperative.

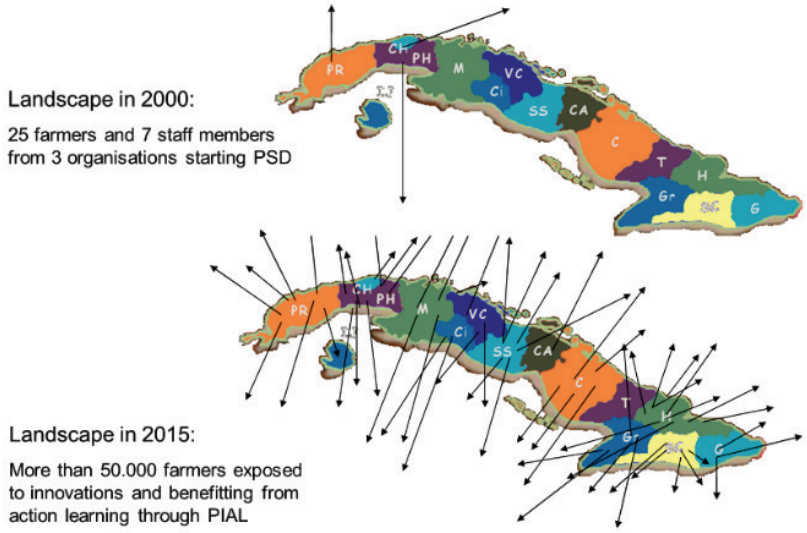
a two-track interactive and experiential learning approach in each cycle. They identified champions from different organizations (university lecturers, researchers, technicians, and farmers) who were then trained on the job as innovation facilitators/brokers. They facilitated a learning cycle with actors and stakeholders coming together to address a specific challenge (Box 1 and Fig. 2). Most important was the bottom-up approach, starting at the district level and gradually extending the learning groups to include other actors at the provincial and national level. A major success factor was the fact that the learning groups focused on real challenges that farmers were facing, and that the facilitators got the groups into action, collectively sourcing for solutions. This action learning helped to achieve a common understanding among a group of people as diverse as local governments, other public organizations and emerging business-minded farmers interested in agrobiodiversity. This method of action learning has been utilized to organize a critical mass of farmers and other stakeholders to promote seed diversity and farmers participation in Cuba (Fig. 3), Mexico and Bolivia.

Barriers to success

Sometime public policies are paternalistic and consider farmers as a burden rather than a development opportunity. Frequently, local governments and local NGOs subside local seed production by buying improved seed and distributing it freely to communities.

Researchers, extension services and universities have limited capacity to involve small farmers and others key actors in search for seed supply solutions. For instance, local adapted landraces are well received by local farmers; however, it is not clear how farmers, breeders, lecturers, professors, extension workers and consumers can work together to maximize use of landraces.

Fig. 3. **Effects of interactive learning cycles in enhancing seed diversity and farmer's participation in Cuba**



Box 2

EXAMPLE OF A BOLIVIAN LEARNING CYCLE IN FAVOUR OF SEED DIVERSITY AND FARMER PARTICIPATION

Bolivia has a great diversity of crops, however landraces are not considered by the formal seed sector as an alternative to increase yield and nutritional quality under low input conditions.

Members of a learning cycle from RASP (Network of Support to the Productive Sector) and INIAF (National Institute for Agriculture and Forestry Innovation) organized a participatory landrace breeding initiative to choose and multiply seeds for the local seed sector.

The public plant breeding sector is often top-down in practice, with plant breeders putting researchers at the top, extension workers and NGOs next and farmers and rural consumers at the very bottom, as if they lack the intelligence that a researcher has to provide adequate seed solutions.

Proposed funder interventions

1. There are many examples of how farmers have limited access to formal gene banks or others sources of seed diversity to improve their local seed systems. One intervention could be to promote simple mechanisms for farmers to access seed diversity from formal and informal sectors, test it, then multiply and disseminate seeds to others farmers.
2. Many individuals and organizations in the Global South are in favour of farmers' participation and agrobiodiversity enhancement. However, they need to develop competencies, capabilities and capacities so that great ideas could be turned into practical tools to improve local seed systems. Another option could be to strengthen brokering capacity in individuals and organizations to link the informal and formal seed sector into a win-win balance.
3. Reinforcing agroecological practices as integral to local seed systems could be an alternative that would help diversify farming systems, increase farmers' independence, amplify economical options, strengthen social networks, and build the resilience of family farms in the face of climate change and political instability.

SUMMARY OF RECOMMENDATIONS FROM CONTRIBUTORS

INTERNATIONAL/NATIONAL: POLICY AND ADVOCACY

- Strengthen the capacity of farmers' organizations and social movements to address policy matters that are central to their seed, food and livelihood systems.
- Support the development of policies and laws that promote and strengthen community based agrobiodiversity management and remove harmful policies.
- Create space for the participation of farmer organizations and social movements at policy fora at various levels and strengthen and support them on policy matters that are central to their seed, food and livelihood systems (i.e., CBD, CGRFA, ITPGRFA and FAO Committee on Food Security (CFS), International Union for the Protection of New Varieties of Plants (UPOV) and the UN Framework Convention on Climate Change (UNFCCC).
- Support efforts to raise awareness of policy and decision makers about the key roles of agricultural diversity, *in situ* and on-farm conservation and community based diversity management.
- Divert public resources from subsidizing corporate consolidation of the seed industry to supporting and strengthening farmer seed systems.

INTERNATIONAL/NATIONAL: AGROBIODIVERSITY MANAGEMENT AND CONSERVATION

SUPPORT SCALING OF COMMUNITY SEED SYSTEMS

- Create a supportive framework for community based diversity management initiatives.
- Provide support to achieve scale through interaction with various levels of government and other key seed and food security actors.
- Enhance collaboration and effectiveness among seed and agroecology networks operating regionally and globally.
- Build links between agrobiodiversity conservation efforts to farmer associations wherever possible.
- Build capacity of CBOs and farmers' organizations to participate in global seed policy discussions.
- Support rural women's participation in seed dialogues as they are central to seed diversity.
- Build capacity of farmers' and community based organizations as well as national researchers and extension agents in a broad range of domains.

- Develop and adopt a special program for the formation and development of agrobiodiversity conservation and seed production at the community level involving specialists, experienced farmers, and scientists–agrarians.
- Start indigenous agricultural research stations in the United States northern plains region, for training of tribal leadership for food systems.
- Support tribal agricultural infrastructure.

ADVOCACY/INSTITUTIONAL REFORM/MONITORING (I.E., SEED LAW AND FAO)

- Support advocacy on the impact of seed laws that undermine local seed saving, and on trade, land and investment policies that are eroding community control of the commons, natural resources, ecosystems and biodiversity that are crucial to the long-term survival of family farming systems.
- Monitor intellectual property laws and the limits these impose—whether intentional or not—on farmers' ability to freely produce and exchange seed.
- Support the development of seed-related legislation at the international, national and regional levels.
- Reform FAO regional conferences to include seed dialogues and introduce seed and agroecology issues into the agendas of the Governing Body of the ITPGRFA at ministerial-level regional conferences.
- Create a required course in agricultural universities teaching the preservation of local seeds.
- Develop curricula and training courses, for local seed production and secondary school classes devoted to the issues of preservation of a variety of seeds.

INTERNATIONAL/NATIONAL: **RESEARCH**

POLICY AND INSTITUTIONAL ISSUES

- Evaluate if current national and international gene banks are accessible to farmers by taking a formal survey of major gene banks to ascertain who is accessing gene banks and for what purposes.
- Research the current and historic levels of funding for *in situ* seed storage. This data should be contrasted with the available information on *ex situ* storage funding.
- Explore the opportunity for a version of the Civil Society Mechanism for the Seed Treaty.
- Support the evaluation by farmers of agriculture-related UN agencies and CGIAR centres.

- Identify policy spaces and priorities, working with farmers, their associations and other CSOs at local, national and regional levels in order to secure official support for farmer seed systems in laws, policies, programs, budgets and projects.
- Support research on effective policy and legal mechanisms and incentives to support farmers and their organizations to make the best use of agricultural biodiversity and to have their voices and choices recognized and taken into consideration.

COMMUNITY SEED SYSTEMS

- Support participatory, transdisciplinary research in which farmers collaborate on equal footing with researchers and in which traditional knowledge and scientific knowledge are combined.
- Support research on novel ways to make markets work for the custodians of agricultural biodiversity.
- Support research on direct nutritional benefits of diversified food production, diversified diets, and the enhanced nutritional value of farmers' varieties and wild and semicultivated foods.
- Support research on seed-network-building methodologies and strategies.
- Support research on the functional contribution of seed diversity to agroecosystems properties, including the provision of regulating, supporting, provisioning ecosystem services.
- Support research on the characterization of genetic resources adapted to local conditions.
- Support research on low cost seed conservation technologies.

INTERNATIONAL/NATIONAL: EDUCATION AND KNOWLEDGE EXCHANGE

CAPACITY-BUILDING AND TRAINING

- Strengthen knowledge exchange and networking at the community, regional, national and international level, both farmer-to-farmer and among organizations and institutions via networking and relationship-building to develop a common understanding.
- Identify "champions" from different organizations at district and provincial levels (university lecturers, researchers, technicians and farmers) and train them on the job as innovation facilitators/brokers. Facilitate a learning cycle with stakeholders.
- Organize study, and exchange of experience between seed-keeping farmers of different regions through mobile seminars and meetings.
- Introduce local farmers to the best practices in other countries for creating a network of seed keepers, a gene bank, seed funds, seed storage, etc.

- Support collaborative partnerships with organic farming, transitional farming and farm coaching work, for community based tribal agriculture.
- Establish national networks of local seed-saving organizations—autonomous peasant networks led by people whose livelihoods depend on the continued use of peasant seeds.
- Create national and regional networks and strengthen existing ones. These could be food and agriculture biodiversity management networks, farmers' seed producer networks, community seed banks, fruit grower networks, networks of vegetable seed savers, farmer bakers, and rural women processors.

INSTITUTIONAL RECOMMENDATIONS

- Establish an Office for Farmer Seed Exchanges within the FAO Secretariat in Rome to record requests and responses to those requests. The office should operate in various languages, have a website disseminate print materials.
- Reinforce agroecological practices as way to diversify farming systems, improve farmers' independence and family farms' capacity to deal with climate and political change.
- Provide technical support to link farmers with public sector R&D systems.

RESEARCH

- Work with public health institutions to explore the link between nutrition and seed diversity.
- Create a database for farmers on gene banks' accessions, pests, diseases, climate conditions and include mapping.
- Shape research by all participants and use it as a tool towards planning concrete actions.

LOCAL/COMMUNITY: AGROBIODIVERSITY MANAGEMENT AND CONSERVATION

- Support baseline assessments of diversity.
- Support community based and farmer driven seed systems, including *in situ* and on-farm seed conservation and use, seed banking, and participatory applied research (PVS and PPB) aimed at the development of a broad and diverse base of adapted plant genetic resources.
- Create a supportive framework for community based diversity management initiatives.
- Strengthen farmers' and community based organizations that work to support community based and farmer driven seed systems (i.e., seed management, breeding techniques, marketing skills, community participation and bottom-up planning and decision making, participatory

varietal selection [PVS] and plant breeding [PPB], community seed banking systems, seed storage techniques and appropriate technologies).

- Support the launch, spreading, networking and deepening of local/regional initiatives and the piloting of new innovations.
- Support and link local peasant organizations implementing work on agroecology and dynamic management of biodiversity for food and agriculture at the field/landscape level.
- Research farmer seed strategies and storage by community, climate and crops, situated within the frame of climate change resiliency.
- Strengthen cultural practices and traditional knowledge that supports the use of diversity in a production.
- Support adding value at the local level through processing and marketing local varieties in local and regional markets via markets, seed and food fairs, and urban-rural linkages.
- Organize scientists and seed-growing farmers' meetings, field days, field schools, trainings, round tables, and the publication of recommendations, brochures, and manuals, etc.
- Create networks of local farmers engaged in the production of seeds, such as seed keepers' networks, associations, cooperatives, women's groups, men's groups in villages, and the regional and district level.
- Support smallholder farmers to have greater connectivity to the markets—both to access new technology, credit, insurance, and to market excess production.

LOCAL/LANDSCAPE AND REGIONAL: **EDUCATION/KNOWLEDGE EXCHANGE**

- Support the creation of and strengthening of existing national and regional networks of practitioners in the management of biodiversity for food and agriculture, such as farmers' seed producer networks, fruit grower networks, vegetable seed savers, farmer bakers, and rural women processors.
- Develop competencies, capabilities and capacities so that great ideas become practical tools to improve local seed systems.
- Strengthen the brokering capacity in individuals and organizations and link informal and formal seed sectors.
- Enhance farmers' access to seeds and information on various cultivars, even in remote villages, by seeding or inputting shops in target villages, seed fairs and mobile seed shops.
- Create a local value chain and local market by valuing specific varieties as healthy food. Farmers can be encouraged to add these to their existing portfolio, improving family nutrition and income generation.
- Identify appropriate seed growing farmers involved with local seed preparation so that they can teach that information to other farmers in their community.

GLOSSARY OF TERMS AND ACRONYMS

Agricultural biodiversity: See agrobiodioversity below.

Agrobiodiversity: All the components of biological diversity of relevance to food and agriculture. It includes the components of biological diversity that constitute the agroecosystem: the variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels, which sustain the functions, structure and processes of the agroecosystem. Managed by farmers, pastoralists, forest dwellers and fishers for many hundreds of generations, agrobiodiversity reflects the diversity of both human activities and natural processes, providing farmers and communities of Indigenous Peoples with stability, adaptability and resilience in their farming systems and constitutes a key element of their livelihoods.

Agroecological approaches: Approaches that integrate biological and ecological processes into food production, minimizing the use of non-renewable inputs that cause harm to the environment or to the health of farmers and consumers. It includes making productive use of the knowledge and skills of farmers and of people's collective capacity to work together to solve common agricultural and natural resource problems.

Agroecology: The application of ecological principles into the design and management of agricultural systems. Agroecology consists of three key interwoven facets: it is a scientific discipline involving the holistic study of agroecosystems, a set of principles and practices to enhance the ecological and socio-economic resilience of farming systems, and a movement seeking a new way of organizing agriculture and the relationship of farmers to society.

Agroecosystem: A system of agricultural production, including all organisms and environmental factors within it. With human assistance, this is a stable system with circular flows of material and energy.

Agroforestry: The integration of trees and shrubs into agricultural practices.

Agromorphology: The study of the form and structure of plants.

Aichi Biodiversity Targets: A set of 20 targets, grouped in five goals, which are part of the 2011-2020 strategic plan of the Convention on Biological Diversity.

Anthesis: The flowering period of a plant, from the opening of the flower bud.

Biocultural heritage (a.k.a. collective biocultural heritage): The knowledge and practices of Indigenous people as well as their biological resources, from the genetic varieties of crops they develop to the landscapes they create.

Biodiversity: The array of varieties of living organisms in a particular habitat or ecosystem, and in the world as a whole.

CBD: Convention on Biological Diversity, a multilateral treaty signed by 168 countries, which contains specific provisions related to agricultural biodiversity.

CBM: Community biodiversity management, an innovative approach to agricultural biodiversity conservation pioneered by LI-BIRD in Nepal.

CBR: Community biodiversity registers, a method for documenting agricultural species, part of the CBM approach pioneered in Nepal.

CBSS: Community based seed systems. See definition below.

CBCH: Collective biocultural heritage.See: biocultural heritage above.

Certified seed: Seed that meets the quality standards of national regulatory agencies within formal seed systems.

CFS: Committee on World Food Security, an intergovernmental body housed at the United National Food and Agriculture Organization (FAO), which serves as a forum for review of policies related to world food security.

CGRFA: The FAO Commission on Genetic Resources for Food and Agriculture.

CSO: Civil society organization.

Community biodiversity register: A record of traditional crop varieties in a community that is maintained by community members and may contain such information as the agromorphological and agronomic characteristics, agroecological adaptation, special uses, unique traits, place of origin, and custodian of the landrace. The method is used to document traditional knowledge on genetic resources and provide defensive protection and/or promote bioprospecting.

CGIAR: Consultative Group for International Agricultural Research, a consortium of 15 agricultural research institutions supported by governments, institutions and philanthropic organizations.

Community based seed system: A collective system established by a farming community or a group of farmers to produce, save, exchange or sell seeds.

Community seed bank: The most well-known form of community based seed system, a community seed bank (CSB) can take a variety of forms, ranging from an informal storage unit for seeds shared by multiple farmers to a formalized

institution controlled and operated by farmers to promote the saving, exchange and improvement of seed varieties, sometimes in conjunction with government agricultural agencies.

Conservation: The management of the natural and farm environment and its biological resources to ensure they are not destroyed in the process of development, but maintain their potential to meet the needs and aspirations of future generations.

Crop genetic diversity: The total number of genetic characteristics in the genetic makeup of the plant species used in agriculture and the close evolutionary related wild species.

Cultivar: A cultivated variety of a domesticated crop plant that is formally or informally named or otherwise recognized as distinct.

Custodian farmers: Farmers who play a major role in the maintenance of a wide range of diverse varieties of different crops.

Diversity fair: A gathering of farmers from one or more communities to show the range of traditional varieties they cultivate. Rather than giving prizes for the best individual variety (e.g., on the basis of yield or size), diversity fairs award farmers or cooperatives for the greatest crop diversity and related knowledge.

Diversity field fora: Men and women organized in teams (of usually 25-30 people) by gender to assess crop genetic diversity. This approach takes into account that the selection criteria by female and male farmers differs. The groups test both improved and local cultivars. Farmers are trained in seed multiplication. The seeds of the selected cultivars are multiplied and disseminated within and outside the groups. At weekly meetings farmers are informed about international and national conventions/legislation relevant to the exchange of plant genetic resources.

DUS: Distinctness, uniformity and stability; attributes required of a new variety in some jurisdictions for granting of certification and breeder's rights.

Dynamic conservation: Conservation of the biological, agroecological, and human cultural processes responsible for the continuing evolution of crop diversity in traditional systems.

Ecosystem services: The benefits to humans which arise from healthily functioning ecosystems, such as clean water, habitats for pollinators, and waste decomposition.

Ethnobotany: The scientific study of the traditional knowledge and customs of a people concerning plants and their medicinal, religious and other uses.

***Ex situ* conservation**: The removal of germplasm from the place it arose or is found growing, and stored off-site in a gene bank. It also refers to vegetative material in *in vitro* storage or plant accessions growing in living collections in a botanical garden or a field gene bank.

Farmer Field Schools (FFS): A group-based learning process used by a number of governments and international agencies whereby farmers are trained to train their fellow farmers. It was created predominantly to promote integrated pest management (IPM).

Farmers' rights: Term used to refer to the rights that should be identified and protected to support farmers' roles as conservators and generators of crop diversity.

Farmer managed seed systems: Methods used by a farmer or a group of farmers to produce, save, improve, exchange and sell seeds.

Functional diversity: The value and range of traits of the species and organisms that influence ecosystem functioning.

Genetic diversity: The genetic variability among or within a sample of individuals of a variety, population, or species.

Genetic resources (GR): Germplasm of plants, animals, or other organisms containing a diversity of characters with actual or potential value.

Germplasm: The reproductive material of individuals, a group of individuals, or clones representing genotypes, varieties, species, or cultures, held as accessions in an *in situ* or *ex situ* collection.

GFAR: Global Forum on Agricultural Research; has a secretariat based at FAO.

GCDT: Global Crop Diversity Trust also known as Crop Trust, is an independent international organization which exists to ensure the conservation and availability of crop diversity for food security worldwide.

Global North / Global South: General terms referring to geographic regions or countries primarily in the southern hemisphere or northern and western hemispheres facing linked or related socio-economic political challenges and opportunities.

Heirloom varieties: Open pollinated varieties or OPVs (see definition below) that have been passed down through various generations, and pass on similar characteristics in each generation. Heirloom fruits are often propagated through grafts or cuttings.

Hybrid seed: A plant variety produced through controlled pollination in which the pollen comes from a different strain or species of plant in order to increase certain desired characteristics. Hybrid seeds can be produced in breeding laboratories or through low-tech methods such as under row covers in isolated fields. Unlike open pollinated varieties or OPVs (see definition below), hybrid seeds typically cannot be saved from year-to-year because the second generation (F_2) does not have the same genetic characteristics as the first (F_1).

IBCHA: Indigenous Biocultural Heritage Area, a concept pioneered in Peru which incorporates contemporary science, conservation models and rights-based governance approaches, including the IUCN's Category V Protected Areas, as well as positive and defensive protection mechanisms for safeguarding the collective biocultural heritage of Indigenous Peoples.

***In situ* conservation**: The conservation of ecosystems and natural habitats and processes to maintain and recover viable populations of species in their natural habitat and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties. *In situ* conservation of domesticated resources focuses on farmers' fields as part of their agroecosystems.

Indigenous knowledge: May refer broadly to the understandings or traditions that exist in a local community, or more specifically to the cultural knowledge and ways of Indigenous Peoples.

Indigenous Peoples: People who inhabited a land before it was conquered by colonial societies and who consider themselves distinct from the societies currently governing those territories are called Indigenous Peoples. Indigenous Peoples have specific and protected rights under various international treaties and conventions, including the right to self-determination.

Informal seed system: A system of plant variety development, seed production, commercialization and exchange that does not necessarily follow the laws and regulations issued by the state to regulate the quality of plant varieties and seed available on the market.

Integrated pest management: An ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties.

IPRs: Intellectual property rights.

ITPGRFA (or the Plant Treaty): The International Treaty on Plant Genetic Resources for Food and Agriculture. Adopted by the FAO Conference in November 2001 and entered into force in June 2004. Regulates access to—and benefit sharing derived from the use of—PGRFA.

Landrace (also termed traditional variety, farmer variety, or folk variety): A crop variety, often harbouring some genetic variability, yet with a certain genetic integrity that has evolved in cultivation, usually in a traditional agricultural system over long periods, which has adapted to a specific local environment or purpose. Farmers recognize its characteristics, selected for traits they desire, and usually give it a meaningful name or nomenclature for identification.

Modern variety: A crop variety developed by modern plant breeders and often extended to other regions and countries; synonymous with a high yielding variety.

Nagoya Protocol: A supplementary agreement to the Convention on Biological Diversity (CBD) known as the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization, providing a legal framework for the implementation of sharing of benefits of the use of genetic resources, including plant varieties.

NGO: Non-governmental organization.

Nodal farmers: Farmers in a community or region who are important sources of seeds, information and expertise about growing traditional crops and varieties and as such are multiply linked in a network.

On-farm conservation: One approach to *in situ* conservation of genetic resources, focusing on conserving cultivated plant species in farmers' fields.

Open pollinated variety (OPV): This refers to pollination that happens by insect, bird, wind, humans or other natural mechanisms. OPVs generally produce plants roughly identical to the parent plant when they are pollinated by plants of the same strain. Therefore, if the plant is kept isolated from other strains, the seeds can be saved and planted again, year after year, with roughly the same yields. OPVs are also able to slowly adapt to local growing conditions and climate from year-to-year.

Participatory plant breeding (PPB): A breeding program in which farmers and breeders participate in all phases (parental selection, hybridization,

on-farm assessment, selection) to develop new varieties with improved traits preferred by farmers.

Participatory plant varietal selection (PVS): The selection of fixed lines (stable variety of released, advanced lines or traditional varieties) by farmers in their target environment using their own selection criteria.

Peasant farmer: A farmer who produces crops on a small area of land (typically under five hectares) for family consumption and for market exchange, using family labour throughout the farming cycle. Peasants typically live in villages; they engage in face-to-face relations with neighbouring farmers; they possess a diverse range of cultural and religious beliefs and practices; and they fall within a diverse range of social networks and local organizations.

PGRFA: Plant genetic resources for food and agriculture.

Plant breeder rights (PBR): Also known as plant variety rights, plant breeder rights are rights granted to the breeder of a new plant variety, which means the breeder has the control over the exploitation of the propagating material of that variety for a specified number of years.

PVP: Protocol on Plant Variety Protection, which contains rules proposed by the 19 member states of ARIPO (African Regional Intellectual Property Organization) to restrict the use of patented or certified plant varieties.

Quality-declared seed (QDS): An alternative system for seed quality assurance developed by the FAO for countries with limited resources. It is less demanding and less expensive than full seed certification systems.

Resilience: The capacity of an ecosystem or a species to absorb or recover from disturbances.

Social institution: Complex positions, roles, norms, and values lodged in particular types of social structures and that organize relatively stable patterns of human activity with respect to fundamental problems in producing life-sustaining resources in reproducing individuals, and in sustaining viable societal structures within a given environment.

Species: A group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding. They share a common ancestor more recently than with individuals of related species and have similar ecology and morphology. Criteria for species delimitation are not always clear-cut, as speciation is an ongoing evolutionary process.

Species diversity: The number and frequency of species, usually measured at the level of an ecological community.

SoWBFA: State of the World's Biodiversity for Food and Agriculture (report to be released in 2017 by the FAO Commission of Genetic Resources for Food and Agriculture).

Traditional variety: Synonym for landrace (see definition above).

UPOV: International Union for the Protection of New Plant Varieties, a multilateral treaty established to provide intellectual property protections for plant breeders on an international basis. Also refers to the intergovernmental organization established to enforce the convention.

Variety: A taxonomic infraspecies subdivision of a species comprising selectively bred or naturally occurring populations or individuals that differ from the rest of the species in distinct but minor characters. The term "cultivar" is a synonym for domesticated species.

Vegetatively propagated crops: Crops propagated through vegetative propagation, such as through genetically identical vegetative parts, such as tubers, corms, buds, stolons, or stem cuttings, rather than through botanical seed. Also known as clonal propagation.

Wild relative: A non-cultivated species that is more or less closely related to a domesticated species. It is not normally used directly for agriculture, but can occur in agricultural ecosystems and serves as source of useful genes. The category includes the direct evolutionary progenitor of the crop as well as less-related species but usually congeneric in the same genus.

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