

Agrobiodiversity and integrated seed systems to improve smallholder livelihoods

Crop and tree diversity are essential to agriculture sustainability and food and nutrition security. The diversity of species and varieties that are available for farmers and the ways through which this diversity is made accessible to them depend on seed systems. But what must seed systems be like to enhance agrobiodiversity and smallholders' livelihoods? Our authors take a look at the strengths and weaknesses of existing seed systems and experiences gained from a ten-year project in five countries on three continents.

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Seed systems (see Box) are at the origin of agriculture. Over millennia, for each crop present in the farm, the farmer had a strategy to select, multiply and use seeds for the next season. Remaining seeds were sold or exchanged for other seeds from neighbouring farms. Thus farmers themselves were breeders, seed multipliers, quality controllers and seed suppliers. As agricultural research and development has become more specialised and agricultural production has evolved towards industrialisation in many parts of the world, what used to be performed by farmers has been taken over by specialised actors – with a profound impact on the shaping of seed systems and on the diversity of crops and varieties that they supply to farmers.

Seed systems and their impact on farming

At present, several types of seed systems exist:

Formal seed systems:

small farmers usually underserved

On the one extreme, formal seed systems deliver seed of crop varieties that have been bred, registered and released by specialised organisations based on predetermined criteria and procedures created through national policies and laws. The seeds in this system are a result of investments in research and breeding governed by the principles to maintain varietal identity and purity, and to deliver seed of optimal physical, physiological, and sanitary quality. Actors who operate in the formal system produce and supply seed whose quality has been certified by official governmental organisations (or their appointed agents) according to existing laws and regulations, which are often based on internationally agreed standards. In developing countries, public and private investments in agricultural R&D and seed sector development have generally targeted the main staple crops (rice, maize, wheat), with much less investment in minor cereals (e.g. millets, sorghum), tubers, legumes, fruits and vegeta-



Ugandan banana farmers.

Photo: A. Vezina/ Bioversity International

bles. Commercial vegetable seed production is taking off in a number of developing countries, such as Kenya, India and Thailand, but often relies on exotic varieties of 'cosmopolitan' vegetables rather than native crops or locally bred varieties. In addition, commercial seed companies are reluctant to extend their business to geographical areas with poor market infrastructure, due to the difficulties involved in reaching these areas, and the lack of reliable information about the actual and potential demand for certified seed and other complementary inputs such as fertiliser, pesticides and irrigation systems. In consequence, remote areas, which is where many poor smallholder farmers live, remain underserved by 'formal sector' components of seed systems.

Informal systems: threatened diversity

On the other extreme, informal systems continue to be managed mostly by farmers and their communities. In these systems, farmers select and multiply seed of both landraces and improved varieties that are adapted to the local conditions. Seed distribution takes place based largely on the application of local indigenous

knowledge passed down over millennia, and is regulated by informally established norms. Informal systems prevail in many developing countries around the world, supplying at least 65–80 per cent of seeds in many of them. While high levels of crop and tree diversity have characterised local seed systems in many regions, this diversity is threatened or in the verge of disappearing in many territories because of climate change, decreasing quality of the seed and local communities' isolation as more and more farmers migrate to urban areas. Diversity is also affected by land use changes and conversion to high-input agriculture, which often leads to homogenisation of crops and varieties.

Integrated systems: combining two worlds

The functioning of informal seed systems and the role they play in ensuring seed availability and accessibility have attracted considerable attention in the last decade. A number of scholars have stressed the need to look for complementarities between formal and informal seed systems, the potential of informal seed systems to provide seed wherever the for-

mal sector is absent, or in addition to it, and the possibility to mobilise informal channels to distribute improved crop varieties from the formal system alongside farmers' varieties. Mixed or integrated systems have emerged in a number of countries. They combine formal and informal elements. For example, farmers and farmers' organisations working outside the formal channels cultivate, multiply and distribute both improved varieties developed by the formal sector and their own landraces; governmental and non-governmental organisations (NGOs) provide support for the certification and distribution of farmer-bred varieties and farmer-produced seed, in line with national rules and regulations.

So far, integrated seed systems facilitated by governmental organisations and NGOs have overly focused on the commercial and operational aspects of seed production, often overlooking the importance of the genetic quality of planting material. This is because, generally, these systems have relied on the same varieties used in the formal systems. So although they contribute to enhancing distribution of seeds, particularly in areas not served by the commercial seed sector, they do not add much to the diversity of crops and varieties that become available to farmers. Taking four Nepalese sites as illustrative examples, the Table presents the gradient from purely informal to purely formal seed systems, highlighting how some basic characteristics change along this gradient.

Against this background, in the last decade, the Alliance of Bioversity International and the International Centre for Tropical Agriculture (CIAT), in partnership with the Swiss Agen-

Seed systems comprise the actors and the institutions that govern the development, multiplication, processing, quality control, storage, distribution and marketing of seeds. (Maredia and Howard, 1999).

cy for Development and Cooperation (SDC) and research and development organisations in Bolivia, Burkina Faso, Nepal, Uganda and Uzbekistan, has led a project aimed at increasing crop diversity in seed systems, with a particular focus on informal and mixed or integrated systems. The following paragraphs summarise the project's main activities and achievements, and include reflections about the challenges that still persist.

Understanding crop diversity and farmers' preferences

The project's first step was to understand and characterise the varietal diversity of the target crops in the project sites. For this purpose, scientists, seed enterprises, governmental agencies and seed sellers were involved in a wide-scale participatory characterisation of varietal diversity together with farmers' communities. The farmers led the process of identifying the characteristics they wanted to focus on, based on their own contexts and preferences, and ranking varieties accordingly. They identified a number of characteristics that breeders often do not focus on, including adaptability/robustness, cooking requirements, taste and fodder values. In addition to increasing various actors' understanding of the actual and potential value of the varieties, this work allowed the

teams to identify and prioritise traditional and farmers' varieties for registration in the national catalogues of commercial varieties, and their subsequent commercialisation in the form of quality certified seed, as we explain below.

Building capacities and opportunities at community level

The project reinforced the technical capacities of farmers in the project, who produce and cultivate seed for themselves, local markets and seed industry, either individually or as part of farmers' associations and cooperatives. Thanks to combinations of training, new facilities, technical equipment and good quality foundation seed, farmers increased their capacities to produce quality seed of a broader range of varieties. The project also supported marketing and promotional activities. Ultimately, seed producer groups and individual farmers were able to sell more seed and at higher price in all five countries. A number of farmers in Uzbekistan, Nepal, Uganda and Bolivia have become custodian farmers. They maintain high levels of crop diversity on their farms, produce high quality seed for sale or distribution within their communities and train other farmers on good agricultural practices and seed production.

Specialisation in native varieties, landraces and traditional varieties improved through participatory plant breeding has given a comparative advantage to the seed producer groups and individuals involved in the project. In Nepal, Uganda and Uzbekistan, community-based seed producer associations have managed to establish long-term seed supply arrangements

Selected characteristics along the continuum of seed systems in Nepal

Seed system designation Illustrative locations in Nepal (village, district)	Informal – own seed Ghanpokhara, Lamjung	Informal – local seed Begnas, Kaski	Mixed Kachorwa, Bara	Formal Some crops and areas (mainly in Terai region)
Seed source	Own retention, limited exchange with neighbours or relatives	Own retention, neighbour farmers, relatives, seed cooperatives, including from neighbouring villages	Own retention, neighbours' relatives, seed co-operatives, seed dealers, seed industry	National agricultural research council and seed industry, directly or through seed dealers
Application of existing legal framework	0 Little to no contact with legal framework	+	++ Partial application	++++ Strict application
Integration of seed and crop markets	+	++	+++	++++
Access to new seeds and new varieties	+	++	+++	+++
Varietal richness (number of different varieties)	++	++++ Mostly landraces	+++ For rice, half are landraces, half are modern varieties	+
Expected allelic diversity (genetic diversity within varieties)	++++	++++	+++	+

Source: Adapted from Wyss et al. 2018. Scale: ++++ = high/numerous, +++ = medium, ++ = little/few, + = low/very few, 0 = none (explanations added where relevant)

with farmers' cooperatives and medium-size seed enterprises. Along all the steps, the involvement of seed quality control agencies and officers, as well as extension agents, has been crucial to helping farmers become familiar with regulatory aspects and with the individuals who enforce the rules. At the same time, officers and extension agents have become more aware of smallholder farmers' realities, needs and potential, particularly as holders and providers of seed diversity.

In Burkina Faso, Nepal and Uganda community seedbanks existed when the projects started to operate. Community seedbanks are local organisations whose core functions are to maintain, safeguard and exchange local and farmer-preferred seeds for local use. The project's efforts focused on improving the seedbanks' capacities to operate both as repositories of local genetic diversity and reliable seed providers for their communities. These objectives were largely met. In Uganda, the success of the existing community seedbanks encouraged the project team to support the opening of three more in different sites of the country. However, economic sustainability continues to be a challenge for community seedbanks. To address this challenge, in Nepal and Uganda, the cooperatives in charge of the seedbanks received assistance to open commercial branches. While these branches are demonstrating to be effective financial mechanisms, questions are being raised with regard to the possible negative effects they may have on the seedbanks' interests and capacities to continue conserving crop genetic diversity, and supplying such diversity to farmers under favourable conditions.

Initial steps towards an enabling policy environment

Discussions are slowly progressing in the five countries to develop policies and programmes from municipal to national levels to support informal and integrated seed systems. We see advances in this direction in the adoption of the Food and Agriculture Organization's Quality Declared Seed System in Uganda for areas where the presence of a formal seed sector is limited and for crops and varieties that are not usually produced by seed enterprises. Another example is the official commitment by district offices in Nepal to provide technical and financial support to community-based seedbanks and cooperatives as part of those districts' programmes for the conservation and sustainable use of agrobiodiversity. In Uzbekistan, the project has contributed to raising the profile of crop diversity in the existing policy



Scientists visit rice seed fields managed by farmers next to Pokhara, Nepal.

Photo: Isabel López Noriega/ Bioversity International

and legal frameworks. This has resulted in the adoption of Resolution #504 on "Measures on restoration of local varieties of agricultural crops with unique traits and features that are in danger of extinction and development of their foundation seed supply system", of the 24th August 2020, by the Cabinet of Ministries of Uzbekistan. Through this Resolution, the government commits to provide support to study, conserve, multiply and mobilise local agrobiodiversity, including farmers' varieties. With the Resolution, the government of Uzbekistan recognises and values the national heritage of interspecific and intraspecific crop diversity and the evolving role of farmers in coping with environmental and economic challenges.

Registration of farmers' varieties as a step towards wider commercialisation

The project has also contributed to advances in the registration of landraces and farmers' varieties in national catalogues of commercial plant varieties in Bolivia, Nepal and Uzbekistan. The process of applying for registration of these types of varieties has challenged countries' established standards and procedures, and has led to the adoption of flexibilities which, in some cases, have been normalised and integrated in the regular procedures. Thanks to these advances, landraces and farmers' varieties have changed their status from "informal" to "formal", resulting in small farmers being able to produce and distribute seed of these varieties with certified quality, for which they can request a higher price than that of informal seed. The opportunity to sell certified quality seed has also allowed them to reach markets beyond the local ones. The inclusion of landraces and farmers' varieties in national catalogues contributes to the diversification of crops in the seed market and the recognition of farmers as generators of crop diversity.

However, there are still some loose ends. In all three countries, most of the varieties registered so far bear the name of the seed authority that processed the registration, a public research institute or the national agricultural research organisation, and not those of the farmers who have conserved and developed those varieties. These governmental or research organisations, and not the farmers, are thus in charge of maintaining the varieties. This raises fundamental questions in relation to farmers' rights and responsibilities over the genetic resources that farmers generate and maintain. It is also important to note that despite the technical and procedural flexibilities that have been introduced in the mentioned countries, the length of the process for applying and the technical requirements still keep farmers from following the procedures by themselves. In these countries, it is too early to assess whether or not the transaction costs involved in variety registration are worth assuming. This will depend on farmers and other actors' capacities to effectively multiply and sell the seed of the registered varieties, which in turn will be very much influenced by farmers' demand for landraces and farmers' improved germplasm.

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