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Valuing crop diversity for tomorrow's agriculture: an equity issue

• May 2025

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Crop diversity refers to the plant materials used for agricultural production and is one of the foundations of food security. Farmers and rural communities have developed a vast body of knowledge on this subject, which is now an integral part of their culture and heritage. They contribute to the evolutionary processes that shape crop diversity[1]: by domesticating different plants and selecting different traits, they have modified – sometimes considerably – the genotypic (genetic) and phenotypic (generally visible) characteristics of wild species and populations. This selection process has been renewed over seasons and generations by farmers producing their own seeds. For example, nearly 80% of family farming in sub-Saharan Africa still relies on local seeds.

Adapting crops to changing environmental conditions or to new needs means guaranteeing access to crop diversity for as many people as possible. However, segmentation of the value chain – separating seed production, selection, distribution and conservation (the latter being formalized by the creation of international gene banks in the 1970s) – facilitated access to genetic diversity mainly for researchers and breeders, in support of a single model of agricultural production, namely industrial agriculture (Green Revolution).

Nowadays, providing a wider range of stakeholders with access to biological resources remains a major challenge, both in terms of conservation and contribution to agroecological transition, recognized as an appropriate response to the crises faced by agricultural and food systems.

The governance systems in place to manage crop diversity, be it research institutions, gene banks or agricultural production, maintain fundamental divisions and inequalities between players. All these are obstacles to the necessary collaboration between the different functions associated with the mobilization of diversity (characterization, conservation, multiplication, improvement, production, etc.).[2]

CIRAD and its partners are pursuing various approaches to encourage **a diversity of stakeholders to make full use of crop diversity, so as to promote the transition towards agroecological and climate-resilient farming systems.**

1. Schloen *et al.*, 2011
2. Louafi *et al.*, 2021

Key messages

- Unlike wild biodiversity, threatened by over-use, **crop diversity will be better conserved if it is used**, whether for food production, crop improvement or any other type of use. The less it is used, the more likely it is to disappear.

- As it is shaped by humans, **crop diversity is not just biological, it is also social and cultural**, so the concept of "diversity" and the governance frameworks associated with crop diversity cannot be limited to the biological dimension. They need to consider the diversity of stakeholders and their motivations, as well as the diversity of ways in which biological resources are exchanged and created.

- The resilience of agriculture heavily depends on crop diversity and its use in a range of pedoclimatic and cultural contexts. In a context of growing uncertainties, **encouraging the use of crop diversity** appears to be **an essential strategy to develop more robust and sustainable agricultural systems**.

- Access to crop diversity **is a major issue in a context of multiple crises – climatic, environmental or food**. This means increasing the ability of diverse groups of stakeholders (be it in terms of status, capacities and objectives) to make use of biological resources and associated knowledge, recognizing their respective actions as complementary rather than competing.

- **The governance systems in place**, whether it be research institutions, institutional collections or agricultural production, **perpetuate fundamental divisions and inequalities**, which act **as barriers to the need for collaboration between the different functions associated with the mobilization of diversity** (characterization, conservation, multiplication, improvement, production, etc.).

- **Accounting for the multiple dimensions of resources** (biological, but also social, cultural and political) **is a prerequisite for greater social and environmental justice in the use of crop diversity**. In this respect, multi-stakeholder varietal selection networks or participatory breeding programs have proved their worth.

- Developing **an institutional and legal environment for gene banks conducive to creating and mobilizing crop diversity can promote the integration of social, cultural and political dimensions, as well as the different mandates and objectives of the users of crop diversity.**

Point 1 •

Crop diversity: a wealth to be better harnessed to face environmental crises

On a global scale, making greater and better use of crop diversity to support the necessary transitions to new agricultural production models means increasing the resources and capacities of a larger number of stakeholders, and continuing to shape and use that diversity and the knowledge associated with the resources (see box "Crop diversity, a key to agroecological transition"). Unlike wild biodiversity and other exhaustible natural resources, whose main threat comes from overuse or degradation of the ecosystems that host them, conservation and sustainable use of crop diversity cannot be reduced to a question of allocating access and use rights across groups. As agricultural biodiversity only exists through human actions and agricultural systems that value it and contribute to shaping and maintaining it, **the challenge rather lies in increasing the capacity of the various stakeholders to maintain and enrich this diversity in different contexts to serve the diversity of needs**. It would thus be possible to recognize and encourage the coexistence of different farming systems as a lever for local resilience to climate change, and as a cornerstone of food security and environmental health.

So, rather than a risk of loss, it is more about losing the ability to shape and mobilize crop diversity for the greatest number of people[3]. This capacity depends on three closely related levels:

• **Technical:** increasing i) knowledge relating to the evolutionary and adaptive processes of crops, ii) development of the methods and tools needed to make judicious use of such complex diversity, and iii) strengthening the public research infrastructures responsible for contributing to these technical prerequisites.

• **Social:** broadening our understanding of the plurality of relationships that human groups have with crop diversity, and our knowledge of the rules that govern exchanges of such crop diversity between these human groups. This is necessary for recognizing, promoting and including the plurality of management methods existing for crop diversity and associated knowledge.

• **Political:** developing an institutional and legal environment that is conducive to creating and mobilizing crop diversity by a wider range of stakeholders.

Although current international policy and regulatory frameworks are designed to cover these three levels, their effective deployment and integration are still lacking. This is particularly clear in the Kunming-Montreal Global Biodiversity Framework (KMGBF), within which the conservation of genetic resources (Target 4), the promotion of agricultural production models that respect biodiversity (Targets 7 and 10) and the sharing of benefits and capacities (Targets 13 and 20) are dealt with in different targets[4] with few linkages between them. **However, if the ambitious transformative objectives of the Global Biodiversity Framework are to be achieved**, starting with Target 10 on transforming agricultural production systems, **the technical, social and institutional environment in which crop diversity is mobilized by a range of stakeholders in a diversity of contexts for various objectives needs to be more effectively taken into account.**

CIRAD is working to ensure that these three levels work together and complement each other, by encouraging the full mobilization of crop diversity by a wide range of stakeholders to **promote the transition to climate-resilient, agroecological farming systems.** In concrete terms, CIRAD proposes to tackle some of the challenges faced by agriculture by rethinking the governance frameworks for access to and use of biodiversity along the following two lines: implementing **new collaboration arrangements between researchers and stakeholders on the ground** (Point 2) and revisiting **the governance of gene banks** to make access to crop diversity more inclusive (Point 3).[5]

3. Louafi *et al.*, 2021
4. CBD/COP/DEC/15/4 decision (https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf)
5. Louafi *et al.*, 2021

Crop diversity, a key to agroecological transition

Agroecological transition is based on making better use of biodiversity (preservation of organisms that contribute to soil fertility and crop health, ecological management of pests, preservation of pollinators, etc.) and all associated knowledge. Paradoxically, the (intra- and inter-specific) diversity of crops does not receive the attention it deserves.

For a variety of reasons, the emphasis in agroecology has been on cultivation practices and their adaptation to specific soil and climate conditions and landscapes. Agronomists, who are experts in combining living organisms both at plot and landscape level, have been quicker than biologists and geneticists in taking up the challenges of agroecological transition.[6]

Thus, the role of crop diversity in agroecological transition remains insufficiently explored. In ecological and agronomic terms, strong links have been established with soil fertility, adaptation to climatic variations and natural protection against pests and diseases. Numerous studies have shown the central role of mobilizing a diversity of crops and seeds to promote the resilience of agricultural systems and preserve natural resources. In a context of multiple crises (climate, health, security, economy), crop diversity is an essential lever for guaranteeing the stability of food systems. It promotes food sovereignty by supporting diversified local production that is less dependent on industrial inputs and global markets, and less vulnerable to supply chain disruptions. On a socio-economic level, it contributes to farmer autonomy, promotes local knowledge and the development of short distribution channels, thereby strengthening food security for populations.

Point 2 •

Towards more equitable partnerships in research and development on crop diversity

A wide range of stakeholders participate in creating, circulating, conserving and using crop diversity. On every continent, they include producers and their various organizations, processors, traders, consumers, research institutions, breeders and collaborative networks managing one or more species on local, national, regional and international levels. All fulfil different functions within a complex network and are involved to varying degrees in the conservation of crop diversity, its exchange and direct use, as well as research or the development of products based on this diversity.

However, despite this great diversity of stakeholders, the different segments of the value-chain (production, breeding, distribution and conservation) are entrusted **to stakeholders and institutions that often operate in silos, and the policy and regulatory frameworks are structured around a series of binary divisions that do not reflect the plurality and complementarity of the dimensions of crop diversity and further widen the inequalities of access and use:** i) conservation vs. use; ii) *ex situ* vs. *in situ* conservation; iii) formal vs. informal seed systems; iv) farmers' rights vs. breeders' rights[7].

Not only does this series of divisions reduce the diversity of options and solutions for mobilizing crop diversity to meet the range of needs and situations, but it also raises significant obstacles to collaborative approaches between stakeholders.

Tackling global challenges, such as food security and nutrition, climate change, biodiversity loss and poverty, **requires more open, inclusive and responsible research and innovation** – one of the lessons learned from the Covid-19 pandemic[8]. Yet, governance issues on research and innovation on crop diversity and gene banks focus almost exclusively on i) conditions of **access to genetic material**, in relation to their legal status, ii) the establishment of monetary incentives based on the protection of innovations *via* **intellectual property rights**, and iii) **sharing of the market value derived from the use of genetic material**. Although essential, these three dimensions underestimate the diversity of motivations and capacities at stake in terms of innovation based on crop diversity – yet, **considering this diversity is crucial to meet the challenges of food security as well as health and environmental imperatives**, in a context of climate change. Several aspects need to be given greater consideration if regulatory frameworks are to evolve in this direction: the major issues of unequal power and capacity for use between different groups of stakeholders; the diversity of incentives and motivations for the use or creation of crop diversity by the different stakeholders concerned; the obstacles to collaboration and the mismatch between regulatory frameworks and technological advances[9].

6. Hainzelin, 2022
7. Louafi *et al.*, 2021
8. Welch *et al.*, 2022
9. Louafi *et al.*, 2023

For example, crop diversity sharing practices within the academic world itself vary widely, from one individual to another, from one function to another (conservation within dedicated infrastructures or breeding, for example) or from one discipline to another (anthropology, biology, biotechnology, bioinformatics, etc.). Reshuffling the deck to make better use of crop diversity therefore begins with a significant change in attitude at the level of research itself.

Contrary to popular belief, such divergent positions and practices also exist within the agricultural world, where **the various stakeholders (starting with producers themselves) far from share the same motivations. Many factors influence their seed exchange practices**[10]. Among small-scale farmers, there is intense circulation of crop diversity, involving a diversity of stakeholders: farmers, local traders or itinerant resellers, but also sometimes organizations such as cooperatives, public extension services or NGOs[11]. However, while social and cultural norms of mutual assistance, reciprocity and solidarity that encourage the circulation of crop diversity are often associated with these communities, the reality is more nuanced. This circulation is in fact governed by rules and customary laws specific to each society, which may, for example, prohibit exchanges between related clans, or favor exchanges between allied social groups[12]. Significant differences can also be observed depending on the status of individuals within these communities (expert, community leader)[13].

So, how can governance frameworks for research and innovation on cultivated diversity become more inclusive and collaborative, recognizing and accounting for this heterogeneity of practices and motivations?

Discussions on access and benefit sharing (ABS) could be the key to rebalancing the roles of players with different motivations, capacities and values. On an international level (the Convention on Biological Diversity – CBD, but also the International Treaty on Plant Genetic Resources for Food and Agriculture – ITPGRFA), the political and legal frameworks on ABS aim to find smooth and equitable exchange arrangements by and for these different stakeholders in order to promote the sustainable use of biodiversity. **In the KMGBF, Target 13** on ABS[14] aims to maximize the sharing of benefits from the use of genetic resources for the providers of those resources (countries or stakeholders) but also for the preservation of the ecosystems from which they originate, along with recognition of the communities that conserve them. While Article 15 of the CBD, as well as the Nagoya Protocol, define the ABS principles and rules (based on consultation between the competent institutions of user and provider countries to define the conditions of access to resources and the sharing of benefits arising from their use), **the way in which those rules are currently applied by many countries to regulate access to their national biodiversity remains mainly administrative, motivated by a rationale of sovereignty and monetary gain**. Here again,

When farmers and scientists work together: smart climate-resilient varieties for low-input cropping systems in Africa and Central America

Improving sorghum and rice varieties requires continuous efforts to ensure food security for poor rural and urban populations and provide income opportunities in regions vulnerable to climate change. For the past 20 years, CIRAD has been working with farmer organizations, research institutes and NGOs to identify and develop new sorghum varieties adapted to low-input agroecological cropping systems in West Africa and Central America, as well as new rainfed rice varieties for the Madagascan highlands – some of the regions most affected by climate change in the world. Analyses of the impact of these decentralized participatory breeding programs have revealed widespread adoption and dissemination of the varieties developed, due to their adaptation to the prevailing soil and climatic constraints, intensification objectives and local food preferences. In Burkina Faso, collaboration between stakeholders on these varieties has enabled farmer organizations to set up new seed production networks, generating both income and employment. A similar breeding process is being implemented in southern Madagascar.

The results of this type of collaboration, in which researchers are just one of many stakeholders, are therefore twofold: on the one hand, the development of varieties superior to farmers' traditional cultivars for gradual intensification and adaptation to climate change; and on the other hand, the establishment of a new framework enabling farmers, extension services and scientists to work together to select new varieties while developing better cropping systems. Today, farmers are calling for their participation in all stages of the experiments carried out on their plots, from the choice of the most suitable varieties and cultivation practices to the dissemination mechanisms of future seeds.

10. Coomes *et al.*, 2015
11. McGuire and Sperling 2016; Labeyrie 2021
12. Labeyrie *et al.*, 2016
13. Ricciardi 2015; Thomas and Caillon 2016
14. Target 13 of the global framework aims to "increase the sharing of benefits derived from genetic resources, digital sequence information and associated traditional knowledge".

this focus does not help to create the conditions of fairness and collaboration necessary for optimum mobilization of crop diversity by a large number of stakeholders and for a diversity of purposes[15].

If these limitations in policy and regulatory frameworks are to be overcome, general mechanisms and **changes in practices need to be put in place on an institutional level and on the scale of R&D projects involving the use of crop diversity, so as to promote collaboration and equity between stakeholders, and create a general environment conducive to benefit sharing**. CIRAD is committed to this issue, placing governance practices at the heart of ABS matters. It is in fact through a set of collaborative practices (mainly non-monetary) throughout the research and innovation process that it would be possible to deal structurally with the unequal capacity to use crop diversity, and to rebalance the power relations towards greater equity and benefit sharing[16]. Interestingly, such governance and collaboration practices apply equally to the use of genetic resources themselves and to the associated traditional knowledge held by local communities and indigenous peoples, or to the digital sequence information (DSI) associated with the resources, which include genomic sequence data and other data – proteomic, metabolomic, etc. – accessible from specialized databases.

Participatory breeding programs are other experiments in equitable collaborative governance, which highlight the collective and incremental nature of varietal innovation and the issues arising from it. In particular, the legal status of seeds developed from such programs deserves particular attention and further conceptualization and experimentation. Although financial motivations are not absent (these participatory breeding programs may lead to commercial use), the rules governing access, exchange and use of seeds developed within a participatory breeding framework cannot be reduced to private intellectual property rights (such as Plant Variety Protections or patents), or to the public domain (free access): they are subject to consultation between players with very different statuses and mandates, in order to **co-create ways of exploiting them that respect these different statuses and mandates and are based on values** (reciprocity, reputation, etc.) and **social motivations** that **are often much broader than those of ownership** (such as the attachment to seeds or the importance of the nutritional quality of varieties).

A partnership system for innovation and varietal improvement in West Africa

Iavao – CIRAD's platform in partnership for research and training (dP) focusing on innovation and varietal improvement in West Africa – has been keen to carefully build its resource exchange processes so as to maximize benefits while respecting the objectives and constraints of the stakeholders involved. This network is the result of close and long-lasting collaboration between ongoing breeding programs at national research centers on dry cereals (sorghum, millet, fonio) and associated legumes (groundnut, cowpea), and multidisciplinary research teams from the North and South involved in genetics and breeding, development and implementation of genetic analysis and phenotyping methodologies, characterization of food systems and analysis of supply chains. This platform is a tool for dialogue and operational collaboration (i) between the various stakeholders in the breeding system, who are committed to jointly defining objectives, analyzing results, adapting strategies, sharing resources and evaluating products and progress, and (ii) between the various research disciplines to facilitate the emergence of new analysis methods and tools facilitating the creation and adoption of new varieties. It encourages regional and transregional circulation of crop diversity between breeders, and between breeders and producers. Although this circulation is still mainly geared from breeders to producers, the conditions are in place to stimulate growing interest from producers, and a rebalancing of exchange flows (e.g. from producers to breeders) is also being discussed with a number of farmer organizations to enhance the value of the material held and improved over time by these organizations.

These networks or experiences of participatory breeding projects raise broader questions about collaboration methods, which are themselves likely to encourage a long-term commitment between various stakeholders, in particular farmer organizations and research. The experience of the CoEx (see box p.8) and SeedAttach (see the project file on Cirad.fr: https://tinyurl.com/2662d9yy) projects in West Africa have raised the need to address governance issues collectively, in order to co-create **new partnership arrangements and thereby overcome the inequalities that traditionally exist between researchers and practitioners in the field** [17].

15. Jankowski *et al.*, 2020
16. Jankowski *et al.*, 2020
17. Jankowski *et al.*, 2020; Louafi *et al.*, 2023

Coexistence of management systems for crop diversity

The CoEx project, funded by *Agropolis Fondation* from 2016 to 2020, conducted a collaborative survey on crop diversity management in West Africa. Bringing together scientists, farmer organizations and NGOs in Burkina Faso, Canada, France, Mali, Niger and Senegal, it analyzed seed acquisition, use and exchange practices, going beyond the traditional opposition between formal (certified) and informal (farmer) seed systems. CoEx highlighted a continuum between these systems and emphasized the importance for farmers of diversifying supply sources for food security and agricultural resilience[18].

However, deconstructing the binary vision and characterizing the plurality of crop diversity management practices with a more refined approach represents a definite challenge. To understand this complexity, CoEx adopted a framework integrating the interactions between seeds, stakeholders and institutions, seeking to describe and analyze the links between modes of access, choice of crops and diversity of crop use[19]. By involving farmers in the research protocols, in the analysis of the results (treated as common goods) and in the governance of the project itself, CoEx promoted innovative and collaborative project governance.

Point 3 •

Towards more inclusive governance of institutional seed collections

The institutional collections hosted by biological resource centers (BRCs) – so-called gene banks – are at the crossroads of the various stakeholders involved in crop diversity. They receive seeds (and associated information) from researchers, breeders, farmers, gardeners, associations and other gene banks. They work with both local stakeholders (farmers, cooperatives, farmer organizations, extension services, etc.) and international institutions (such as CGIAR, FAO, the *Global Crop Diversity Trust*, etc.), and with both for-profit and not-for-profit organizations. They operate on both a local level (collecting seeds from fields or supplying local varieties to community organizations) and a global level (notably through their contribution to the multilateral system of the International Treaty on Plant Genetic Resources for Food and Agriculture – ITPGRFA).

At a time when the challenges facing agriculture go far beyond increasing yields, in a context where communities, although interdependent, struggle to work

Gene banks and the ITPGRFA

The International Treaty on Plant Genetic Resources for Food and Agriculture, ITPGRFA, is a treaty adopted in 2004 by 153 Member States under the aegis of the Food and Agriculture Organization (FAO).

Its objectives are to:

- Ensure the conservation and sustainable use of plant genetic resources for food and agriculture (PGRFA).
- Guarantee easy access to those resources.
- Establish a fair and equitable sharing of the benefits arising from their use.

It has created a multilateral system covering 64 species (crops and forages) recognized as essential to global food security. The resources of this system are made available to researchers, farmers and companies under defined conditions, formalized in a Standard Material Transfer Agreement (SMTA), signed between a supplier and a user.

National or international gene banks are key players of this system: they conserve and provide access to a wide diversity of PGRFA collections, in accordance with the Treaty's rules. When resources from collections are used for commercial purposes, the ITPGRFA and the SMTA provide for a profit-sharing mechanism that feeds into a multilateral fund. By voluntarily placing themselves under the aegis of this multilateral system, stakeholders holding public collections (member states) or private collections (institutes, seed companies, professional organizations, etc.), guarantee that the resources they conserve are accessible to all members (signatory countries, research institutes, etc.) within a clear legal framework for access and benefit sharing.

18. Labeyrie *et al.*, 2021

19. Labeyrie *et al.*, 2021; Louafi *et al.*, 2023

together harmoniously, **to what extent could gene banks play a mediating role**? How could they increase a mobilization of crop diversity that goes beyond the needs of genetic research and breeding alone and really contributes to sustainable agricultural and food production?

These questions prompt us to consider new governance models for gene banks, based on a more dynamic and collective management of crop diversity. The technical choices (methods of characterization and multiplication, for example) and governance choices (regulatory frameworks for exchange, or decision-making processes on conservation priorities) in place in gene banks often emanate from the research institutes that manage them, and do not greatly facilitate collaboration with a diversity of stakeholders. **Major issues, such as farmer participation in the conservation, use and governance of these institutional collections, but also capacity building, North-South cooperation, technology transfer and information sharing, need to be much more embraced to increase the mobilization of genetic diversity**[20].

Opening the governance of institutional seed collections cannot be reduced to an offer of direct use of material by farmers. CIRAD believes that improving relations between farmer organizations, researchers and institutional collections requires a paradigm shift that challenges the established division between *in situ* and *ex situ* conservation. The idea is to revisit the dissemination of crop diversity and associated scientific knowledge, which is one of the pillars of gene bank mandates, while making better use of the non-scientific knowledge associated with such crop diversity[21]. This calls for us to question and broaden our thinking on several dimensions:

- stakeholders involved in partnerships mobilizing resources
- the types of collaborative activities undertaken with these stakeholders (research, multiplication, etc.)
- access and exchange arrangements
- the material exchanged (species, type of material within a species) and the knowledge (scientific and traditional or community) and data associated with this material
- decision-making mechanisms
- the arrangements for equitably sharing the benefits of the collaborative initiatives.

Ultimately, it is proposed to **discuss and rethink the mandate of gene banks and all their functions (collection, characterization, etc.)**, bearing in mind that the choices to be made involve differences in objectives, vision and values, that relate to both the resources themselves and the ways to best mobilize them. In short, these governance issues are at the crossroads of technical, research, management and societal issues associated with crop diversity.

20. Louafi *et al.*, 2021
21. Louafi *et al.*, 2021

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Recommendations

1 • Instill new institutional attitudes and practices in the academic sector with regard to the mobilization of crop diversity, whether it be conservation, evaluation or varietal innovation programs: engaging in transdisciplinary, multi-stakeholder initiatives that are co-constructed on the basis of real on-the-ground needs and constraints, and that promote links between research and sustainable use by stakeholders (particularly producers).

2 • Experiment ways of opening gene banks (as a major gateway to crop diversity) in order to i) give new types of stakeholders (farmers in particular) access to the resources conserved there, and ii) encourage the conservation, use and valuation of farmers' resources in participatory breeding programs, co-constructed between scientists and end-users.

3 • Encourage closer links between the seed industry, end-users (farmers) and academic or finalized research, in order to define ways of mobilizing crop diversity and developing innovations that promote social and agro-ecological impact and maximize sharing of the benefits arising from the use of the world's crop diversity.

4 • Develop financing mechanisms for donors and funding agencies that encourage the dynamic mobilization of crop diversity by and for a range of stakeholders, to meet both the global needs of biodiversity conservation, agroecological transition, and the social challenges of equity between stakeholders.

5 • In terms of multilateral and national policies, promote non-monetary processes based on equitable governance, as catalysts of the benefit-sharing principles intrinsically linked to the debate on the use of the world's biodiversity. On an international policy level, it is therefore proposed i) to establish a work program to better align Targets 4, 10 and 13 of the Global Biodiversity Framework (KMGBF[22]); and ii) to strengthen non-monetary benefit-sharing mechanisms within the multilateral system of the ITPGRFA. These directions should encourage governments and stakeholders to commit to multi-stakeholder collaboration, based on equity between players with different motivations and capacities, in order to make better use and value of crop diversity.

22. Target 4 sets the objective of "maintaining and restoring genetic diversity within and among populations of native, wild and domesticated species, in order to preserve their adaptive potential, in particular through *in situ* and *ex situ* conservation and sustainable management practices"; Target 10 commits to improving the links between biodiversity and agriculture through "the sustainable use of biodiversity", and "a substantial increase in the application of biodiversity-friendly practices"; Target 13 calls for taking the necessary measures at all levels to ensure the sharing of benefits related to the use of the world's genetic diversity.

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