Report on the Regional Survey of Ex Situ Conservation and Characterization of Orphan Crops in Latin America

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Introduction

Latin America and the Caribbean (LAC) harbor exceptional diversity of orphan crops that contribute to food security, nutrition, climate resilience, and rural livelihoods. Despite their importance, information on the conservation, characterization, and utilization of these genetic resources remains fragmented across countries and institutions, limiting opportunities for regional collaboration and investment.

To address this gap, we developed and implemented a regional questionnaire entitled "Ex situ conservation and characterization of orphan crops in germplasm banks" to assess the current status of orphan crop conservation and characterization across LAC. The survey was conducted with support from the John Templeton Foundation and built on the established Latin American and Caribbean Community of Practice (LAC-CoP) of National Genebanks, as well as recent regional efforts to strengthen collaboration and technical capacity among genebanks.

The questionnaire was disseminated through the LAC-CoP network and additional institutional contacts, reaching organizations in 13 countries (Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Mexico, Paraguay, Peru, and Uruguay). It collected institutional and technical information on the ex situ conservation of 25 orphan crops spanning pseudocereals, legumes, Andean roots and tubers, tropical fruits, and palms and trees. Respondents provided information on collection size, conservation methods, characterization activities (phenotypic, genomic, and nutritional), institutional priorities, and the main constraints affecting conservation and utilization.

The survey provides one of the first regional overviews of orphan crop conservation in Latin America and the Caribbean, identifying shared collections, technical capacities, priority gaps, and opportunities for regional collaboration. The findings are intended to guide future research, capacity development, and investments that strengthen the conservation and sustainable use of orphan crop genetic resources.

Results

Participating countries and institutions

The questionnaire collected responses from 23 participants (65% male and 35% female) affiliated with 16 institutions across 13 countries (**Table 1**; **Figure 1**). Peru contributed the highest number of respondents (n = 5), followed by Ecuador (n = 3), while Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, El Salvador, Guatemala, Mexico, Paraguay, and Uruguay each contributed one respondent. Participants from Paraguay and Uruguay indicated that their institutions do not currently conserve orphan crops. The remaining participating institutions reported conserving at least one of the 25 orphan crops included in the survey. The pseudocereals and legumes category included quinoa (*Chenopodium quinoa*), chía (*Salvia hispanica*), amaranth (*Amaranthus caudatus* / *A. hypochondriacus*), kañiwa or cañihua (*Chenopodium pallidicaule*), and lupino or tarwi (*Lupinus mutabilis*). The Andean roots and tubers category comprised mashua (*Tropaeolum tuberosum*), oca (*Oxalis tuberosa*), ulluco (*Ullucus tuberosus*), maca (*Lepidium meyenii*), yacón (*Smallanthus sonchifolius*), arracacha (*Arracacia xanthorrhiza*), achira (*Canna indica* / *Canna edulis*), and ajipa or Andean jicama (*Pachyrhizus ahipa*). Tropical native fruits included maracuyá (*Passiflora edulis*), granadilla (*Passiflora ligularis*), pitahaya or dragon fruit (*Hylocereus* spp. / *Selenicereus* spp.), acerola or West Indian cherry (*Malpighia emarginata*), guaraná (*Paullinia cupana*), naranjilla or lulo (*Solanum quitoense*), and tamarillo or tree tomato (*Solanum betaceum*). Finally, the trees and palms category included butiá (*Butia capitata* / *Butia odorata*), inchi (*Caryodendron orinocense*), sacha inchi (*Plukenetia volubilis*), cas or sour guava (*Psidium friedrichsthalianum*), and pejibaye or peach palm (*Bactris gasipaes*).

Table 1. List of participating institutions and countries in the questionnaire.

Country	Institution
Bolivia	INIAF/ banco nacional de germoplasma
Brazil	Embrapa Recursos Genéticos e Biotecnologia
Chile	Red de Bancos de Germoplasma INIA
Colombia	AGROSAVIA Corporación Colombiana de Investigación Agropecuaria
Costa Rica	CATIE
Cuba	INIFAT-Banco Central de Germoplasma de Cuba
Ecuador	Instituto Nacional de Investigaciones Agropecuarias (INIAP)
El Salvador	Centro Nacional de Tecnología Agropecuaria y Forestal (CENTA)
Guatemala	Instituto de Ciencia y Tecnología Agrícolas
México	Centro Nacional De Recursos Genéticos del INIFAP
Paraguay	Instituto Paraguayo de Tecnología Agraria IPTA
Peru	Centro de Investigación en Cultivos Andinos (CICA), UNSAAC
	Instituto Nacional del Innovación Agraria (INIA)
	Universidad Nacional Toribio Rodriguez de Mendoza de Amazonas
	Universidad Nacional de San Cristóbal de Huamanga (UNSCH)
Uruguay	Facultad de Agronomía Universidad de la República

Patterns of Ex Situ Conservation of Orphan Crops in Latin America and the Caribbean

Respondents provided estimates of accession numbers, conservation methods, and collection status. We found clear regional patterns in the conservation of orphan crops across Latin America and the Caribbean (**Figure 2**). Andean countries, particularly Peru, Bolivia, and Ecuador, reported the greatest diversity of the list of conserved orphan crops, spanning all four crop groups evaluated (pseudocereals and legumes, Andean roots and tubers, Tropical native fruits and trees and palms). Peru exhibited the broadest representation across institutions and crop categories, with multiple large collections of pseudocereals and legumes, as well as Andean roots and tubers. Similarly, Bolivia and Ecuador consistently reported medium to large collections for crops such as quinoa (*Chenopodium quinoa*), amaranth (*Amaranthus* spp.), kañiwa (*Chenopodium pallidicaule*), lupino (*Lupinus mutabilis*), oca (*Oxalis tuberosa*), ulluco (*Ullucus tuberosus*), and mashua (*Tropaeolum tuberosum*). In contrast, countries such as Cuba, Guatemala, and Mexico, reported fewer conserved crop types and generally smaller collections.

Figure 1. *Geographic distribution of questionnaire respondents participating. The map shows the number of participants per country, with darker shades indicating a higher number of respondents.*

Quinoa, amaranth, and lupino are among the most broadly conserved orphan crops in the region, represented across multiple countries and institutions. Conversely, crops such as sacha inchi (*Plukenetia volubilis*), inchi (*Caryodendron orinocense*), butiá (*Butia* spp.), and pejibaye (*Bactris gasipaes*) were conserved by relatively few countries, suggesting more restricted regional distribution or lower levels of ex situ conservation investment. Crop biology strongly influences the conservation strategy adopted by institutions (**Figure 2**). Seed-based conservation predominated for pseudocereals and legumes, particularly quinoa, amaranth, kañiwa, and lupino, which were mainly represented by seed icons across countries. This pattern likely reflects

the orthodox seed storage behavior and relative ease of long-term seed conservation for these species. Conversely, field or living collections were more frequently associated with tropical fruits, trees, and palms, including pejibaye, maracuyá, granadilla, and butiá. The predominance of field conservation for these crops likely reflects challenges associated with recalcitrant seeds, perennial growth habits, or vegetative propagation requirements.

Andean roots and tubers showed more heterogeneous conservation strategies, with both seed and field conservation represented depending on the species and country. Crops such as oca, mashua, ulluco, and yacón were frequently associated with field conservation in Andean countries, although some institutions also reported seed-based collections. This mixed strategy may reflect the need to complement orthodox seed conservation with clonal or field maintenance to preserve genetic integrity and facilitate regeneration. Orphan crop conservation capacity in LAC is unevenly distributed, with stronger and more diverse efforts concentrated in Andean countries. It also highlights that conservation approaches are closely linked to crop reproductive biology and management requirements, emphasizing the need for diversified conservation strategies and regionally coordinated efforts to strengthen the conservation and characterization of underutilized crop diversity.

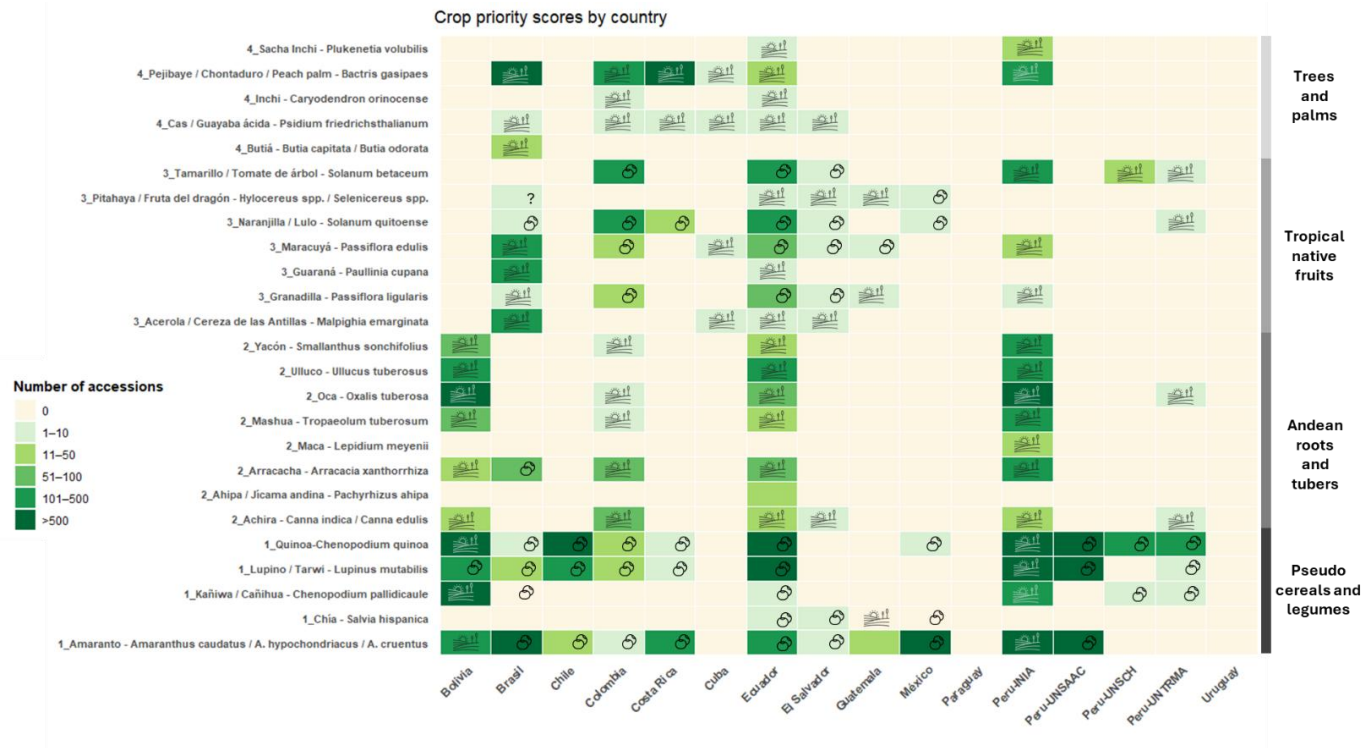

Figure 2. *Distribution and estimated size of orphan crop collections conserved across participating institutions in LAC. Rows represent the 25 orphan crops included in the questionnaire, grouped into four categories: pseudocereals and legumes, Andean roots and tubers, tropical native fruits, and trees and palms. Columns correspond to participating countries and institutions. Color intensity indicates the approximate number of conserved accessions per crop, ranging from small collections (1–10 accessions) to large collections (>500 accessions). Icons indicate the reported conservation method, including seed-based conservation (seed icon) and field or living collections (field icon).*

Patterns of Characterization of Orphan Crop Collections in LAC

We found that characterization efforts for orphan crops in LAC remain uneven and are still primarily focused on phenotypic evaluation (**Figure 3**). Among the participating countries, phenotypic characterization was the most commonly reported activity, with 8 countries and institutions indicating that they had characterized at least one orphan crop collection, compared with only five institutions reporting genotypic/genomic and nutritional characterization. These results suggest that, while basic phenotypic evaluation is relatively widespread across the region, more specialized characterization approaches remain limited to a smaller subset of institutions with access to molecular, genomic, or biochemical capacities.

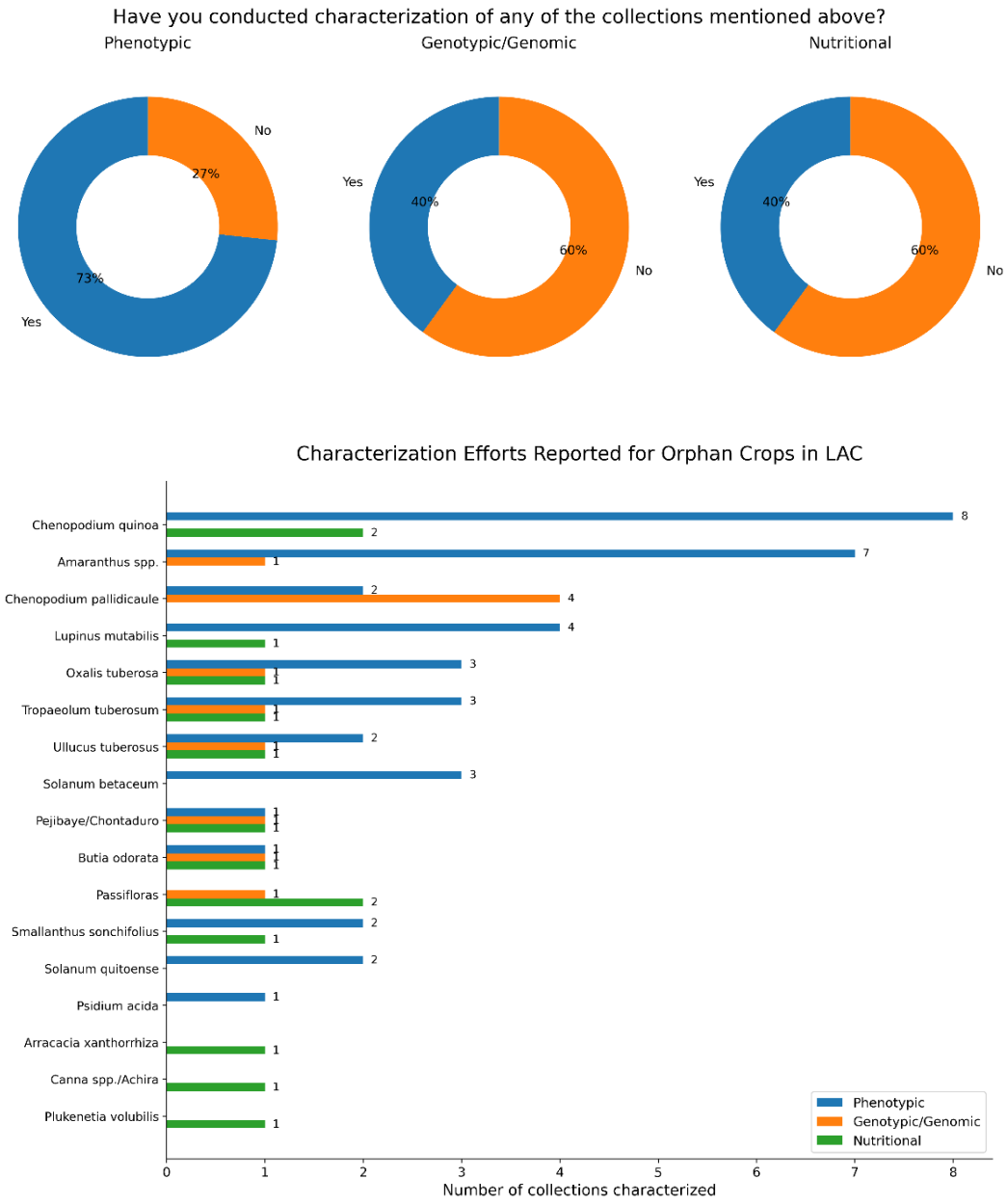

Figure 3. *Characterization efforts reported for ex situ orphan crop collections conserved in LAC. The left panel summarizes the number of institutions reporting phenotypic, genotypic/genomic, and nutritional characterization activities. The right panel shows the number of collections mentioned for each crop according to characterization type. The figure also highlights the countries reporting characterization activities for each category, illustrating regional differences in characterization capacity across LAC institutions.*

Characterization efforts are concentrated in a relatively small number of crops. Quinoa (*Chenopodium quinoa*) was the most frequently characterized species, particularly through phenotypic evaluations, followed by amaranth (*Amaranthus* spp.) and lupino or tarwi (*Lupinus mutabilis*). In contrast, several crops showed little or no evidence of systematic characterization despite being conserved in multiple countries, indicating important gaps between conservation and utilization efforts. Nutritional characterization was especially limited across most crop groups, with only a few species, such as quinoa and sacha inchi (*Plukenetia volubilis*), being mentioned more than once for this type of evaluation.

The questionnaire also suggests regional differences in characterization capacity. Phenotypic characterization was reported by institutions in Bolivia, Colombia, Costa Rica, Chile, Ecuador, Guatemala, Peru, and Uruguay, whereas genotypic/genomic characterization was concentrated in fewer countries, mainly Bolivia, Colombia, Ecuador, Peru, and Uruguay. Similarly, nutritional characterization activities were reported only by Bolivia, Costa Rica, Ecuador, Peru, and Uruguay. These patterns suggest that advanced characterization capacities are concentrated in a limited number of countries and institutions, potentially restricting the broader use of orphan crop diversity in breeding, nutrition, and climate adaptation programs.

Participants identified a broad range of orphan crops as priorities for future characterization efforts, with particular emphasis on species of nutritional, cultural, and agricultural importance in the region. Amaranth (*Amaranthus* spp.) was the most frequently prioritized crop, being mentioned by four participants, followed by pejibaye or chontaduro (*Bactris gasipaes*) and lupino or tarwi (*Lupinus mutabilis*), each mentioned by three participants. Quinoa (*Chenopodium quinoa*) was the fourth most frequently prioritized species, with two mentions. Several additional crops were mentioned once, including cañihua (*Chenopodium pallidicaule*), yacón (*Smallanthus sonchifolius*), tree tomato (*Solanum betaceum*), and diverse tropical, root, and palm species.

Although orphan crop conservation efforts are relatively widespread across the region, ***characterization activities remain fragmented and uneven among crops and countries***. The results emphasize the need for coordinated regional initiatives to strengthen genomic, phenotypic, and nutritional characterization capacities and to better connect conserved diversity with downstream research and use.

Challenges and Support Needs for the Conservation of Orphan Crops in LAC

Institutions participating in the survey identified several common challenges limiting the effective conservation of orphan crops in LAC (**Figure 4**). The most frequently reported constraint was the high **cost of maintaining**

field collections, followed by **lack of infrastructure** and **shortage of trained personnel**. Respondents also highlighted challenges associated with **short seed viability**, **insufficient regeneration capacity**, and **lack of standardized conservation protocols**. Biological constraints, including seed recalcitrance and vulnerability to pests and diseases, were mentioned less frequently but remain important for specific crop groups, particularly tropical fruits, trees, and palms. Additional challenges reported by participants included **insufficient collecting efforts**, **lack of research and standardized protocols for seed conservation**, and limited personnel and **financial resources for characterization activities**. Overall, the results suggest that many institutions face a combination of operational, technical, and financial limitations that restrict both the long-term conservation and effective use of orphan crop diversity.

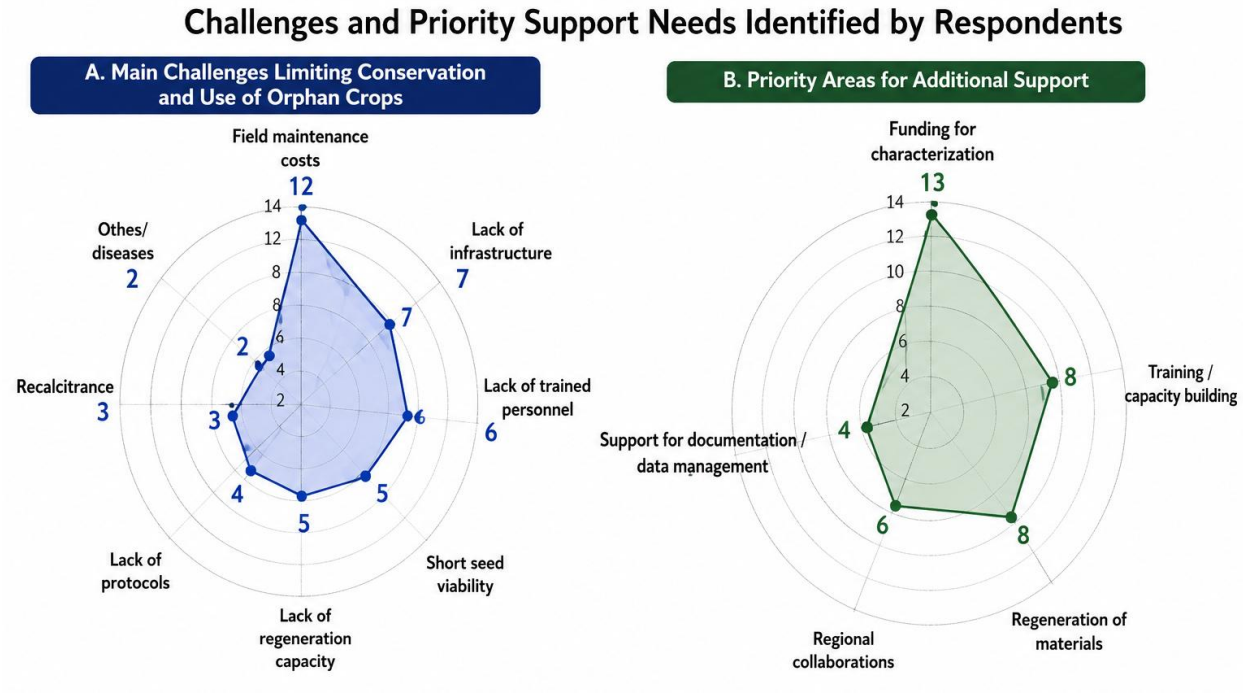

Figure 4. *Main challenges and priority support needs identified by institutions participating in the regional survey on orphan crop conservation in Latin America and the Caribbean (LAC). (A) Principal constraints affecting the conservation of orphan crops, including high field maintenance costs, lack of infrastructure, shortage of trained personnel, limited regeneration capacity, and challenges associated with seed viability and conservation protocols. (B) Priority areas where additional support would strengthen conservation efforts, highlighting the need for financing for characterization activities, capacity building, regeneration of materials, regional collaboration, and improved documentation and data management systems.*

Participants also identified priority areas where additional support would most strengthen orphan crop conservation efforts in the region (**Figure 5**). **Financing characterization activities** emerged as the most important need, followed by **capacity building and training**, **regeneration** of conserved materials, and **stronger regional collaborations**. Support for documentation and data management was also identified as a relevant, although comparatively lower, priority. These results indicate that institutions recognize the importance of moving beyond conservation alone toward more integrated strategies that improve characterization, data accessibility, and collaborative use of orphan crop genetic resources. Collectively, the

responses highlight the need for coordinated regional initiatives that combine technical training, sustainable funding, regeneration support, and shared data platforms to strengthen the conservation and utilization of orphan crops in LAC.

Conclusion

This regional survey provides one of the first coordinated overviews of the ex situ conservation and characterization of orphan crops across LAC. The results reveal substantial diversity conserved within national and institutional genebanks, particularly in Andean countries, but also highlight important asymmetries in conservation capacity, characterization efforts, infrastructure, and technical resources across the region.

The survey further demonstrates that, although phenotypic characterization activities are relatively widespread, advanced genomic and nutritional characterization efforts remain limited to a smaller number of institutions and crop groups. Respondents consistently identified the need for greater investment in characterization, regeneration, technical training, regional collaboration, and data management to strengthen the long-term conservation and strategic use of orphan crop diversity.

Beyond documenting the current status of orphan crop conservation, this survey establishes an important regional baseline for future collaborative action. The findings will inform regional workshops co-organized by the Alliance of Bioversity International and CIAT and the American Society of Plant Biologists (ASPB), bringing together genebank curators and researchers to exchange experiences, strengthen technical capacity, and promote collaborative crop-based working groups. More broadly, the results provide a foundation for future regional initiatives aimed at harmonizing conservation and characterization approaches, improving access to high-quality characterization data, and strengthening the contribution of orphan crop genetic resources to food security, nutrition, climate resilience, and sustainable agricultural development across Latin America and the Caribbean.

Acknowledgements

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We also acknowledge the continued efforts of national genebanks, universities, and research organizations dedicated to the conservation, characterization, and sustainable use of orphan crop genetic resources across the region.

The opinions expressed in this publication are those of the authors and do not necessarily reflect the views of the John Templeton Foundation.