Supplemental data for

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Supplemental Table 1. Genetic conservation strategies and techniques (Maxted *et al.*, 2020).

Strategies	Techniques	Definition
***Ex situ* conservation**	Seed storage	The sampling, transfer, and storage of seed at a low relative humidity (≈15 ± 3% RH), and sub-zero temperature (–18 ± 3 °C)[1].
	Cryopreservation	The sampling, transfer, and storage of germplasm (seed, pollen, shoot tips, dormant bud) samples at ultra-low temperature (-196°C).
	In vitro storage	The sampling, transfer, and maintenance of explants at low temperature in sterile, pathogen-free environment on nutrient media.
	Pollen Storage	The sampling, transfer and storage of pollen in sub-zero or cryo temperatures (≈-20°C or -196°C).
	Field gene bank storage	The sampling, transfer, and maintenance of living plants under field or plantation conditions.
	Botanic garden / Arboretum	The sampling, transfer, and maintenance of living plants in botanic gardens and tree species in arboreta.
***In situ* conservation**	Genetic reserve conservation	The location, management, and monitoring of genetic diversity of natural wild populations within formally managed, defined areas, designated for active, long-term conservation.
	Other effective area-based conservation measures (OECM)	The location, management, and monitoring of genetic diversity of natural or naturalised wild populations in informally managed, defined areas, designated for active, medium to long-term conservation. In practice, CWR or Wild Food Plants (WFP) populations are often found as weeds in on-farm systems or in anthropogenic/ruderal habitats (e.g., abandoned fields, historic sites, graveyards, verges).
	On-farm conservation	The location, management, and monitoring of genetic diversity of locally developed traditional crop varieties, with possible associated wild and weedy species or forms, by farmers often within traditional agricultural, horticultural, or agri-silvicultural cultivation systems.
	Home garden	The location, management, and monitoring of genetic diversity of locally developed traditional crop varieties or forms by a householder within their individual garden, backyard, or orchard cultivation systems for home consumption.

[1] This describes the methodology used for standard long-term seed storage, but higher temperatures (0–10°C) may also be used for medium-term storage of 'active collections'. While 'community seed banks' (CSB) may also employ air/sun-drying (or reactivable desiccants) of seed samples and the seed is stored in hermetic sealed foil/plastic/glass containers at even higher ambient temperatures.

Supplemental Table 2. Horizon scanning issues associated with CWR *in situ–ex situ* conservation in 2025 that require resolution by 2035.

CWR and WFP related issues
• Given European countries were provided with initial CWR checklists (Kell *et al.*, 2008) and many countries initial lists have been upgraded, few CWR or WFP-based genetic reserves have been established. One reason is that current lists are too comprehensive to facilitate immediate conservation implementation, national checklists should be prioritized to produce CWR inventories of the highest priority taxa, or the entire checklist graded into high, medium, and lower priority taxa to aid conservation implementation.
• Given European countries have CWR checklists, and many have prioritized inventories, therefore baseline information has already been used for global or regional assessment of threat and conservation status. However, most priority CWR have been IUCN threat assessment at the species, not subspecies level which more closely reflects patterns of genetic diversity, taxon level threat assessment and conservation status assessment is an urgent action.
• The IUCN threat assessment involves the estimate of threats affecting the assessed taxon. This information could be used as a basis to review the overall threats facing CWR and WFP, particularly those arising from climate change. Such a review should involve GIS modelling to help clarify the relationship between CWR and WFP, and these threats, thus informing conservation implementation.
• For CWR and WFP taxa identified as rare and threatened (Critically Endangered – CR, Endangered – EN, or Vulnerable – VU), recovery plans should be developed and implemented to improve the CWR taxa conservation effectiveness, which may involve population-assisted propagation and even augmentation from other local populations.
• Compared to CWR, there has been limited national progress in WFP conservation checklist or inventory development. The focus on WFP is overdue and experience gained from similar CWR conservation planning and implementation should now be applied or adapted for WFP.
• A dedicated CWR and WFP national strategy and action plan should be prepared, ideally as part of the National Biodiversity Conservation Strategy, or as a free-standing document.
• All CWR and WFP conserved *in situ* should be maintained on site with site and/or population management plans. It would be useful to make all plans available via the national PGR authority website to indicate active CWR conservation and as an aid to formulating CWR population management at other conservation sites and demonstrating CWR integration into broader biodiversity management.
• CWR and WFP *in situ* conservation should aim to maximise overall CWR and WFP conservation efficiency by representing the widest possible taxonomic and genetic diversity representation within minimum number of sites, so conservation of CWR and WFP populations in identified geographic hotspots is desirable. However, this focus should not preclude *ad hoc* siting of active conservation CWR and WFP sites for single taxa or in non-hotpots when opportunities arise or where they are identified as priorities.
• Conservation planning analyses, including CWR and WFP ecogeographic data collation, GIS analyses and field 'ground truthing' of potential conservation targets, should be used to help identify geographic CWR and WFP hotspots; look at the possible overlap with IUCN Key Biodiversity Areas (KBA), and determine the sites best suited for the establishment of genetic reserves.
• To conserve PGR diversity adequately, multiple genetic reserves will need to be established. To ensure sustainable and integrated diversity conservation of CWR and WFP sites and populations, these reserves should be grouped into a European Network for *In Situ* CWR Conservation and Use. This would facilitate

the use of tools and guidelines, assist population management and monitoring, including back-up of priority *in situ* populations in *ex situ* collections to aid user access to the resource.
• The preferred method of *in situ* CWR and WFP conservation is through genetic reserves, either in existing protected areas or in less formally established OECM sites. It can be argued that because CWR are often associated with disturbed, anthropogenic habitats, rather than the climax communities normally associated with PA OECM conservation may be more appropriate for CWR conservation (Jarvis *et al*., 2015). Overall CWR / WFP taxa, conservation tools and management guidelines should be applied alongside biodiversity protection in national networks located in OECM sites and protected areas. Critical analysis of OECM's potential for CWR and WFP conservation in pre-climax communities or on-farm sites should be particularly explored.
• The establishment of CWR and WFP GR sites will involve collation of passport, curatorial, management, characterization and evaluation data for targeted conserved populations by national PGR programmes and other allied conservation programmes. The passport, curatorial and management data held at national level should be included in agreed data structure and coordinated collation processes.
• A subset of the data collated for targeted CWR and WFP conserved *in situ* populations will have broader usage, notably the passport, and characterization and evaluation data should be uploaded to EURISCO to promote its use. Descriptors and process proposed by van Hintum and Iriondo (2022) are recommended for all European countries.
• Regular monitoring of priority CWR and WFP populations maintained in genetic reserves should be undertaken using both demographic and genomic techniques to check management success and promote utilization. Genomic monitoring might also be integrated with characterization and evaluation to identify user-desired traits, further facilitating user selection of conserved germplasm.
• Most CWR and WFP conservation is currently undertaken by professional conservation but there is potential for a greater role for citizen science to aid formal conservation efforts. A critical analysis of the capacity and potential of citizen science and local communities to play an enhanced role in CWR and WFP conservation, in partnership with the formal PGR community, should be undertaken.
• Years of experience have shown that it is difficult to promote conservation integration between agrobiodiversity and biodiversity communities. The lack of a joined-up approach results in unnecessary duplication and inefficiency, whereas better collaboration would promote mutual benefits and enhanced conservation outcomes.
• Despite significant advancements in CWR and WFP conservation science, awareness of their ecological and societal value remains limited among biodiversity conservationists and policy makers. To effectively conserve these vital resources, concerted efforts are needed to raise awareness among policymakers and translate this knowledge into concrete actions, including the development and implementation of national and European legislation.
• The effectiveness of current CWR and WFP conservation actions could be evaluated by a targeted genomic analysis of conserved and unconserved populations. Such analysis would not only demonstrate conservation effectiveness but would also identify conservation gaps to be filled.
• The sustainable exploitation effectiveness of current CWR and WFP conservation could be enhanced by more extensive genomic trait prediction and discovery in conserved CWR and WFP populations. This initiative might be undertaken in partnership with commercial companies.
• Whether CWR and WFP diversity is conserved in *in situ* genetic reserves in a PA or OECM, there is a growing assumption that all *in situ* conserved populations will be backed up with *ex situ* samples to provide long-term security and user access. However, the Access and Benefit Sharing rights associated for *in situ* maintainers (farmers, landowners, etc.) require clarification.

• Although CWR diversity is increasingly used in a widening array of crop breeding, it remains well below its full potential for exploitation. Further public support for pre-breeding of a wider range of crops with CWR genes or traits would be of significant benefit to public and commercial breeders.
• Raising public awareness of the ecological, economic, and societal value of CWR and WFP taxa, along with their inherent genetic diversity, is crucial. This increased awareness will underscore the importance of implementing more systematic approaches to the taxonomic, genetic conservation, and sustainable use of these critical resources for the benefit of present and future generations.
• To evaluate and monitor the success of CWR and WFP conservation and sustainable use, there is a need to develop and apply a set of taxonomic and genetic conservation indicators for PGR for which data could be regularly collated and analysed to monitor and assess the efficiency of PGR conservation and use, providing a basis for enhanced effectiveness.

Supplemental Table 3. Horizon scanning issues associated with LR *in situ–ex situ* conservation in 2025 that require resolution by 2035.

LR related issues
• Given that fewer than half of European countries have national LR checklists, there is an urgent requirement for the immediate preparation of national LR checklists and inventories. This could be achieved in two stages: first, a list of all LR found in a country, and second, producing a more detailed comprehensive list of all LR populations found in a country.
• As national LR checklists become available, it is likely that they will be too comprehensive to facilitate immediate conservation implementation; therefore, the checklist should be prioritized to produce LR inventories of the highest priority LR or the entire LR checklist should be graded into high, medium, and lower priorities to aid conservation planning and implementation.
• As national LR checklists become available, it will be feasible for the first time to conduct threat assessments of LR using the recently proposed specific methodology (Almeida *et al.*, 2024); such threat assessment can be used to aid active conservation planning and implementation.
• The threat assessment methodology proposed involves estimating the threats affecting the assessed LR; this information could function as a basis for a critical review of threats facing LR, particularly from climate change. The review should involve GIS modelling to help clarify the relationship between LR diversity and potential threat, thereby informing conservation implementation.
• The absence of comprehensive lists of all LR populations within a country severely hinders the development of national LR national strategies and action plans (Raggi *et al.,* 2022). To address this gap, a high priority must be placed on conducting thorough surveys to identify and map LR populations, gather comprehensive ecogeographic data, and perform gap analyses, which will provide the necessary basis for developing robust and effective national LR strategy and action plans.
• LR on-farm conservation should aim to maximise overall LR conservation efficiency, so maximum crop, varietal and inherent genetic diversity representation within minimum site number, thus conservation of LR populations in identified geographic hotspots is desirable.
• Conservation planning analyses including LR ecogeographic data collation, GIS analysis and field ‘ground truthing’ of potential conservation targets should be used to help identify geographic LR hotspots and sites best suited for the establishment of on-farm conservation sites.
• There is a requirement for guidelines for on-farm LR conservation that highlight the diverse communities involved (farmer, local communities, diversity networks and formal sector) and their collaboration to conserve the resource. Building upon existing proposals for *in situ* landrace propagation management (Caproni *et al.*, 2020) and community seed banking (Bartha *et al.*, 2021), practical guidelines for LR on-farm conservation and management need to be prepared.
• The establishment of nationally recognised LR on-farm diversity conservation sites will involve collation of passport, curatorial, management, and characterization and evaluation data for targeted conserved populations by national PGR programmes. The LR passport, curatorial and management data held at national level should be included in agreed data structure and coordinated collation processes.
• A subset of the data collated for targeted LR diversity conserved in on-farm populations will have broader usage, notably the passport, and characterization and evaluation data should be uploaded to EURISCO to promote its use. It is assumed that the descriptors and process used could be adapted from van Hintum and Iriondo (2022) and applied in all European countries.

• Regular monitoring of priority LR populations maintained on-farm, using both demographic and genomic techniques, should be used to check management success and promote usage. The genomic monitoring might be used to identify user desired traits to further aid user selection of conserved germplasm.
• The comprehensiveness and effectiveness of LR conservation and the diversity available to users have not been evaluated due to the lack of national LR checklists and inventories, but as LR national strategy and action plans become available, there is a requirement for implementation of systematic national *in situ* on-farm and *ex situ* LR conservation.
• Systematic LR conservation will require active on-farm conservation at multiple sites to effectively conserve LR diversity, these LR and their maintainers may be grouped into coherent networks composed of collaborating farmers (LR maintainers), community groups and formal conservation sector representatives. This would help maintainer use of tools, incentives, and guidelines to aid management and monitoring systems, including *ex situ* back-up.
• Biodiversity conservation using OECM is a recent innovation to promote wild species based conservation, but the concept might be applied to LR-based on-farm conservation. A critical analysis of the potential of OECMs for LR conservation would potentially expand the professional and public awareness of LR value, conservation, and encourage sustainable use.
• On-farm LR conservation often relies on nomenclatural identification of target LR, however, the congruence between nomenclatural distinction and actual genetic diversity within these populations remains largely unexplored. Conducting genomic analyses to investigate the relationship between nomenclatural and genetic identification of LR populations is crucial. Such analyses will clarify the extent to which nomenclatural classifications accurately reflect genetic reality and aid provide valuable insights for identifying and prioritizing conservation efforts, ultimately improving the effectiveness of conservation gap-filling initiatives.
• It is assumed that LR conserved on-farm will be backed-up with *ex situ* samples to provide long-term security and user access, but the Access and Benefit Sharing rights associated with off-farm back-up requires clarification and straightforward guidance to ensure farmer's protection.
• The lack of consistent and robust support for LR populations in most countries and at the regional European level poses a significant threat to LR diversity, which is exacerbated by the diverse implementation of support measures across the various countries. Moving beyond geographic or heritage designations and conservation varieties, a critical review of existing and potential incentives for LR maintenance is needed to inform the development and implementation of sustainable and effective support mechanisms.
• The sustainability of LR maintenance within farming systems is often linked to increased product value and niche market development. While an evidence-based database of best practices already exists (https://www.ecpgr.org/in-situ-landraces-best-practice-evidence-based-database), it is crucial to expand and systematically review this database to identify potential policy enhancements that can effectively support LR conservation.
• On-farm, more than any other form of conservation, requires a fully integrated and participatory approach that actively involves farmers, communities, diversity networks and formal PGR conservationists. Recognizing that farmers are the primary custodians of on-farm diversity, successful conservation strategies must prioritize their active engagement and support. A critical review of existing models for integrating the formal and informal sectors is required to develop more effective and sustainable approaches for conserving LR diversity.
• It seems possible that in some countries home gardens are reservoirs of LR diversity lost from commercial farming systems. To evaluate this hypothesis, there is a need for a critical review of evidence to determine whether home gardens consistently act as persistent reservoirs of high levels of LR diversity and contribute significantly to the overall conservation of these resources.

• All LR conservation is undertaken by farmers so their role is far from passive; their potential role as citizen scientists should be developed to aid formal conservation efforts. A critical analysis of the capacity and potential of farmers to take a more active leadership and practical role in LR conservation, in partnership with the formal PGR sector, should be undertaken.
• Despite the recent advances in LR conservation science, many biodiversity conservationists and policy makers still primarily view LR as heritage and heirloom resources, underestimating their critical value as genetic resources for crop production. To effectively conserve LRs, concerted efforts are needed to raise awareness of their full value spectrum, including their breeding potential. This increased awareness must translate into concrete national and European LR legislation prioritizing their protection and sustainable use.
• Beyond raising LR value awareness among conservationists and policy makers, it is crucial to educate the public about the value and economic potential of systematic LR conservation and use. This includes showcasing the unique and diverse qualities of LR products on mainstream supermarket shelves, connecting consumers with the benefits of supporting LR conservation.
• To test and monitor the threats impacting LR diversity and the success of its conservation and use, there is a need to develop and apply a set of taxonomic and genetic conservation indicators for PGR, for which data could be regularly collated and analysed to monitor and assess the efficiency of PGR conservation and use, providing a basis for enhanced effectiveness.