cousin

Crop Cousins, promise for the future

D1.1 Policy Synthesis

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Authors (Name, Organisation)	Konstadinos Mattas (AUTH), Christos Staboulis (AUTH), Stefanos Nastis (AUTH), Efthimia Tsakiridou (AUTH), Christian Schöb (URJC), Kata Fodor (ESSRG), Agnes Neulinger (ESSRG), Bálint Balázs (ESSRG) Sylvain Aubry (FOAG), Karin Metzlaff (EPSO)
Contributors (WPs involved)	AUTH, URJC, ESSRG, FOAG, EPSO
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Version history

Version	Description	Organization	Date
0.1	Draft Structure (TOC)	AUTH	30/04/2025
0.2	First complete draft version	AUTH, URJC, ESSRG, FOAG, EPSO	28/05/2025
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1	Final version	AUTH, URJC, ESSRG, FOAG, EPSO	20/06/2025

List of abbreviations

Abbreviation	Full Term
ABS	Access and Benefit-Sharing
CBD	Convention on Biological Diversity
CWR(s)	Crop Wild Relative(s)
CSB(s)	Community Seed Bank(s)
CGRFA	Commission for Genetic Resources for Food and Agriculture
ECPGR	European Cooperative Programme for Plant Genetic Resources
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FP	Framework Programme
IFP	Indigenous Food Plant
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
NAFTA	North American Free Trade Agreement
NGO	Non-Governmental Organization
NUCs	Neglected and Underutilized Crops
PGR	Plant Genetic Resources
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RSHG	Regional Stakeholder Group
SAG	Stakeholder Advisory Group
SDG(s)	Sustainable Development Goal(s)
SME(s)	Small and Medium-sized Enterprise(s)
SLR	Systematic Literature Review
TFP	Total Factor Productivity
WP	Work Package
UN	United Nations
UPOV	International Union for the Protection of New Varieties of Plants

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1 Context of the Deliverable

Within COUSIN, Work Package 1 (WP1) "Co-creating the contexts for Crop Wild Relatives", focuses on establishing the institutional, regulatory, and societal conditions necessary for the conservation and use of crop wild relatives (CWRs). In the framework of WP1, D1.1 "Policy Synthesis" contributes directly to Task 1.3 "Synthesis of existing and new findings and policy recommendations" (Months 01–60, led by AUTH, with contributions from URJC, ESSRG, FOAG, and EPSO). Its purpose is to synthesize existing policy-relevant findings related to CWRs, drawing from a diverse body of literature, previous EU projects (e.g., PGRForum, AEGRO, PGRSecure, Farmers' Pride, DYNAVERSITY, CWR Project, BOLD), and international policy frameworks. This synthesis serves as a foundation for future participatory engagement with the COUSIN Stakeholder Advisory Group (SAG) and Regional Stakeholder Groups (RSHG), through which the findings will be further validated, refined, and transformed into actionable policy recommendations. By aligning scientific knowledge with institutional needs and stakeholder perspectives, D1.1 "Policy Synthesis" supports the broader goal of COUSIN to mainstream CWRs as a strategic resource for sustainable, climate-resilient agriculture in Europe and globally.

2 Introduction

This deliverable presents the first analytical output of WP1 of the COUSIN project and lays the groundwork for future stakeholder engagement and policy formulation related to CWRs at a European level.

Building on the context outlined in the previous section, the aim of this deliverable is to provide a structured synthesis of existing policy-relevant knowledge regarding the conservation and use of CWRs. By combining insights from peer-reviewed literature and major European and international projects, the synthesis offers an evidence-informed foundation for identifying policy gaps, best practices, and opportunities to align scientific potential with institutional frameworks.

This synthesis is especially timely given current policy developments such as the implementation of the EU Green Deal, the reform of the Common Agricultural Policy (CAP), and ongoing efforts to operationalize the Farm to Fork Strategy. It also contributes to the global agenda on agrobiodiversity, as framed by the Convention on Biological Diversity (CBD), the Commission for Genetic Resources for Food and Agriculture (CGRFA) and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).

The deliverable is intended to serve a dual audience: (1) researchers and project partners working to mobilize CWRs in formal and participatory breeding programs, and (2) policymakers and stakeholders engaged in biodiversity, agriculture, and food system governance.

The report is structured as follows: Section 3 outlines the methodological approach; Section 4 documents outputs from previous projects; Section 5 presents the results of the systematic literature review; Section 6 synthesizes key insights and discusses policy relevant implications; and Section 7 offers concluding reflections. The final sections include references and annexes.

3 Methodology

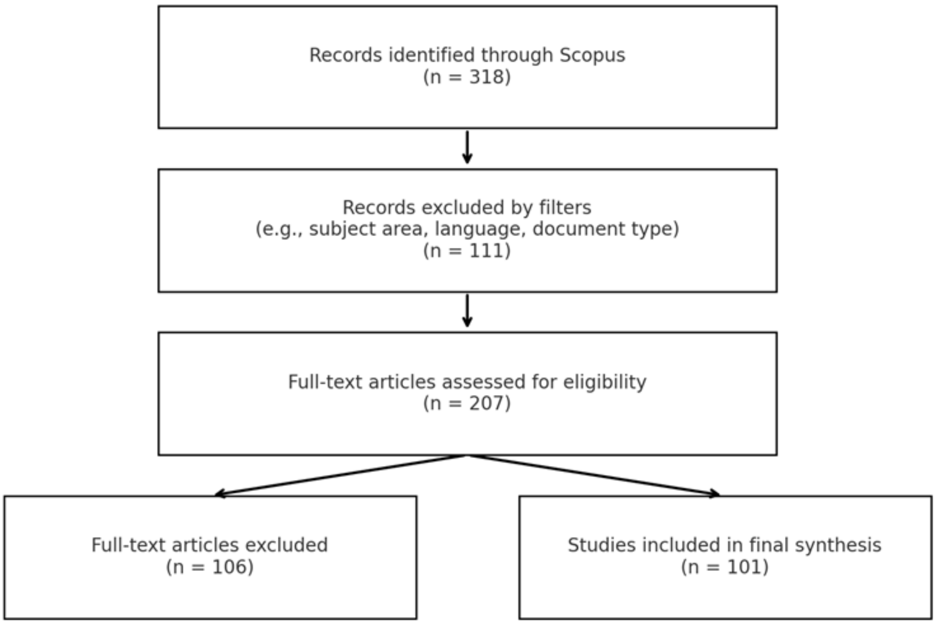
The analytical approach of this deliverable is structured around two complementary components: (1) a systematic review of peer-reviewed literature on policy-relevant outcomes related to CWRs, and (2) a review of outputs from past European and international projects relevant to the conservation and use of CWRs. Together, these components aim to provide a comprehensive and structured knowledge base that informs both the technical and institutional dimensions of CWRs policy development within the COUSIN project framework.

In the framework of the first component, a structured literature review was conducted using the Scopus database, applying a search strategy designed to capture publications addressing the intersection of CWRs, crop genetic diversity, and agricultural policy. The following search string was used: ALL ("crop genetic divers*" OR "crop wild relatives" AND "agricultural policy" OR "policy implications" OR "policy outcome"). The search was limited to: - Publication years: 2005–2025 - Document types: peer-reviewed articles and reviews - Language: English - Subject areas excluded: immunology, engineering, nursing, medicine, chemical engineering, chemistry. The exact search string used in the Scopus database was the following: ALL ("crop genetic divers*" OR "crop wild relatives" AND "agricultural policy" OR "policy implications" OR "policy outcome") AND PUBYEAR > 2004 AND PUBYEAR < 2026 AND (EXCLUDE (SUBJAREA , "IMMU") OR EXCLUDE (SUBJAREA , "ENGI") OR EXCLUDE (SUBJAREA , "NURS") OR EXCLUDE (SUBJAREA , "MEDI") OR EXCLUDE (SUBJAREA , "CENG") OR EXCLUDE (SUBJAREA , "CHEM")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re")) AND (LIMIT-TO (LANGUAGE , "English")).

The term "crop genetic diversity" was included in the search strategy to ensure the retrieval of relevant literature that may not explicitly use the term *"crop wild relatives"* but still addresses related concepts, challenges, and policy frameworks. Crop wild relatives are a subset of the broader category of genetic diversity within crops, and many policy discussions—particularly those concerning biodiversity conservation, genetic resource management, and sustainable agriculture—refer to "crop genetic diversity" as a more general umbrella term.

This search yielded an initial 318 results, which were reduced to 207 documents (after applying the filters described in the search string). All 207 documents were screened in detail based on title, abstract, and full text, using PRISMA guidelines (Page et al., 2021). During this process, 106 articles were excluded due to reasons such as a lack of policy relevance, no implications to crop wild relatives, or insufficient conceptual alignment with the scope of the review. As a result, 101 studies were included in the final qualitative synthesis. The PRISMA flow diagram below illustrates the screening and selection process.

Figure 3.1. PRISMA flow diagram



The screening process was guided by the objective of identifying peer-reviewed literature that provides policy-relevant insights into the conservation, use, and expansion of CWRs or crop genetic diversity more broadly. To ensure conceptual coherence, we also considered papers that, while not naming CWRs explicitly, addressed policy issues within domains such as in situ/ex situ conservation, seed systems, participatory breeding, or agrobiodiversity, provided that these could be reasonably linked to the conservation and use of CWRs.

Given that CWRs are often discussed within broader frameworks of agrobiodiversity and plant genetic resources, the review included studies that:

- Directly reference CWRs or the genetic diversity of crops as part of their core focus.
- Present policy outcomes, policy recommendations, or discuss policy implications relevant to the conservation, use, or governance of these resources.
- Address institutional, legal, economic, or governance dimensions that influence the management of CWRs or crop genetic diversity.
- Provide conceptual or empirical evidence that can inform the design or evaluation of agricultural or biodiversity-related policies.

Studies were excluded if they:

- Focused solely on technical or genetic research (e.g. molecular breeding, transgenic development) without discussing policy relevance.

- Addressed general biodiversity, ecosystem services, or sustainable agricultural practices without clear linkage to CWRs, crop genetic diversity, or associated policy frameworks.

Both title/abstract and full-text screening were performed to assess eligibility. Where ambiguity existed, full-texts were reviewed in detail to determine alignment with the review's conceptual focus.

Two different methods were used to conduct a deeper analysis of the selected studies. First, each study was systematically analyzed using a structured data extraction template, which recorded key information including the study's thematic area (environmental, economic, or societal), policy frameworks addressed, policy outcomes and implications, policy instruments mentioned, and challenges identified. This qualitative synthesis allowed for consistent classification of studies and informed the thematic breakdown presented in Sections 5.3 to 5.5 (each paper was tagged by its dominant dimension—environmental, economic, or societal—based on a keyword scan and qualitative assessment). We chose to structure the presentation of results into these three distinct dimensions to ensure a comprehensive and policy-relevant analysis of the benefits, challenges, and implications related to the conservation and use of CWRs. This classification also mirrors the way the relevant literature is organized, as most studies approach CWRs through one or more of these three lenses. This approach supports clearer identification of policy-relevant findings, targeted recommendations, and gaps across these interconnected domains. Additionally, a quantitative overview of the included literature was developed and is presented in Section 5.1, covering trends in publication year, journal source, geographic focus, article type, and citation frequency. This multi-level analytical approach ensured a comprehensive understanding of the policy-relevant dimensions emerging from the literature on CWRs. Second, a bibliometric analysis was conducted using VOSviewer software to identify co-occurring themes and clusters based on abstracts and keywords. This analysis helped map the thematic landscape of the literature and provided a basis for structured thematic interpretation presented in Section 5.2.

As previously mentioned, a structured mapping of relevant EU-funded projects was conducted in parallel with the literature review (second component of the analytical approach). The aim was to extract lessons and policy-relevant outcomes from previous efforts focused on CWR conservation and use. These include projects such as GenRes Bridge, AEGRO, PGRSecure, Farmers' Pride, DYNAVERSITY, the Crop Wild Relatives Project, and Root2Res, among others (see full list below). The results of this project-based analysis are presented in Section 4 and complement the findings from the literature review.

4 Documentation of relevant projects' research efforts

In summary, there is an urgent need for improved conservation of CWRs in Europe. Currently, there is a lack of coordination and conflicting policies harming in situ conservation efforts and the collaboration of multiple stakeholders implicated in the use and maintenance of CWRs. The documents reviewed advocate for a comprehensive, legally supported European system for CWR conservation, use, and benefit-sharing, harmonizing both in situ (on-farm) and ex situ (genebanks) approaches. This can only be achieved through a coordinated and multi-faceted approach involving policy changes, technological advancements, and increased collaboration among stakeholders to ensure the long-term survival and sustainable use of Europe's CWRs.

4.1 Identification of relevant EU-funded projects

This subsection outlines the selection of EU-funded projects relevant to CWR conservation and use. Priority was given to initiatives with explicit policy outputs or strong institutional relevance, forming the basis for the policy analysis in the sections that follow. First, a list of relevant EU projects was compiled whose theme was related to CWRs. In total, the documentation of 22 projects was examined:

- AEGRO
- PGRSecure
- PGRForum
- Farmers' Pride
- DYNAVERSITY
- Crop Wild Relatives Project
- BOLD (Biodiversity for Opportunities, Livelihoods and Development)
- Crop Trust
- GenRes Bridge
- ECPGR
- AGENT
- Pro-Grace (Promoting a Plant Genetic Resources Community for Europe)
- Pro-Wild (Protect and promote Crop Wild Relatives)
- InnOBreed (Innovative Organic fruit Breeding and uses)
- INCREASE (Intelligent Collections of Food Legumes Genetic Resources for European Agrofood Systems)
- Root2Res (Root phenotyping and genetic improvement for rotational crops)
- FruitDIV
- INVITE (INnovations in plant VarIety Testing in Europe)
- PHENET (Tools and methods for extended plant PHENotyping and EnviroTyping services of European Research Infrastructures)

- FREECLIMB (Fruit Crops Resilience to Climate Change in the Mediterranean Basin)
- TRANSFER
- WILD-ROOTS

For those projects where a policy perspective was explicitly laid out and recommendations developed, a content analysis was carried out. This concerned the following projects:

- PGRSecure
- Farmers' Pride
- DYNAVERSITY
- Crop Trust
- GenRes Bridge
- ECPGR
- Root2Res

4.2 Policy related learnings from prior projects

This subsection synthesizes the main policy insights and recommendations derived from selected EU-funded projects that addressed CWRs. The findings are organized into four thematic areas. These themes reflect recurring priorities across projects and provide a structured basis for policy-oriented discussion.

I. Establishing a European framework:

- Establish a European Plant Germplasm System.
- Create a technical EU infrastructure for organizing CWRs conservation.
- Develop a legal basis for in situ and ex situ conservation within the EU.
- Create a regulatory framework for equitable access, benefit-sharing, and sustainable use of in situ CWRs.
- Create incentive mechanisms and schemes to support in situ conservation.
- Design an information technology support framework for in situ conservation, comparable to existing gene bank systems.

II. Addressing Gaps in current policy and practice:

- Raise awareness and build capacities for national landrace diversity inventories.
- Promote landrace conservation within Natura 2000 sites.
- Strengthen Community Seed Banks (CSBs) for landrace dissemination.
- Stimulate EU support for registering landraces as conservation varieties.
- Recognize the contribution of landrace conservation to the EU's "Farm to Fork" strategy.
- Use existing biodiversity infrastructure for in situ CWRs conservation.
- Explore cost-effective conservation tender mechanisms for on-farm conservation.
- Integrate CSBs into national conservation programs.

- Facilitate PGR exchange across geographical borders.

III. Strengthening international collaboration and policy:

- Support national governments in establishing a European in situ PGR network.
- Encourage expressions of interest in joining the network.
- Explicitly address agrobiodiversity in national biodiversity strategies.
- Link funding to long-term conservation strategies.
- Implement seed laws to facilitate the registration of heterogeneous varieties.
- Pass plant health laws with exemptions for conservation.
- Establish and maintain national PGR programs.

IV. Long-term sustainability and collaboration:

- Enable dynamic and networked agrobiodiversity use and conservation.
- Support a transition to more sustainable food production systems.
- Recognize the multi-dimensional nature of dynamic agrobiodiversity management.
- Build robust links and agricultural biodiversity, primarily through crop wild relatives.
- Support breeding for diversity.
- Ensure full implementation of the ITPGRFA.

4.3 Key policy areas

To support more targeted policy design, this subsection introduces three typologies that categorize policy recommendations based on their instrument type, governance level, and conservation focus. These frameworks help to systematize the complex array of proposals emerging from previous projects and can serve as practical tools for policy makers working to advance CWRs strategies.

Table 4.1 provides a structured overview of the key policy areas. The success of CWRs conservation in Europe hinges on the effective implementation of these interconnected policies.

Table 4.1. Policy areas and recommended measures for the conservation and sustainable use of CWRs

Policy Area	Measures
Legal Framework	Establish a legal basis for in situ and ex situ conservation.
	Monitoring of the implementation of the existing regulatory framework for ABS (Access and Benefit Sharing).
	Pass plant health laws with exemptions for conservation.
Governance & Coordination	Establish a European Plant Germplasm System and a European in situ PGR network.
	Strengthening collaboration between national governments, NGOs, and other stakeholders.
	Utilize existing biodiversity conservation infrastructure (Natura 2000, etc.).
Incentives & Awareness	Develop incentive mechanisms for in situ conservation (e.g., payments for ecosystem services).

	Raise awareness among European countries about national landrace diversity.
	Foster public-private partnerships.
Information & Technology	Create information technology support framework for in situ conservation.
	Encourage data sharing and open access.
Sustainable Use	Support sustainable use of CWRs, including through breeding programs and traditional practices.
	Advocate for evaluation criteria emphasizing yield stability and adaptability under stress.

4.4 Perspectives of stakeholders

Stakeholders have diverse perspectives on CWRs conservation. Yet, their perspectives are interconnected and often influence each other. Documents suggest that the success of CWR conservation depends on finding ways to align these diverse perspectives and foster collaboration among stakeholders. Previous policy recommendations argue for a more inclusive and participatory approach to policy making that takes these various viewpoints into account.

Based on previous project documents, and also on the role of each stakeholder, several stakeholder perspectives emerge. Their perspectives of each one of the six stakeholders' group (farmers and land managers, academia, NGOs and civil society, breeders and seed companies, consumers, policy makers) are summarized in the following:

1. The first group of stakeholders concerns farmers and land managers. Their perspective centers mainly on the practicalities of on-farm conservation. According to their beliefs, they need incentives (financial, regulatory) to participate in conservation strategies, including compensation for potential reduced yields or for the adoption of altered farming practices, which could create additional costs. Farmers and land managers also need access to diverse, locally adapted varieties, including landraces, and support for sustainable farming methods. Moreover, they express their concerns about potential bureaucratic hurdles and complex regulations of such efforts.
2. The second group of stakeholders includes academia. When it comes to academia, their perspective lends weight to the scientific understanding of CWRs diversity, genetic resources, and breeding techniques. They advocate for robust data collection, analysis, and sharing to inform conservation strategies. Moreover, academics often assume timely and cost-free access to CWR materials to support research needs. However, this expectation does not always reflect the logistical, institutional, or practical constraints that may limit the actual availability and distribution of such resources. This group of stakeholders also highlights the need for research to address challenges such as climate change adaptation and the development of sustainable management practices.
3. The third group of stakeholders concerns NGOs and civil society. They often act as advocates for conservation, bringing public attention to the issue and pushing for stronger policy action. NGOs and

civil society may represent the interests of farmers and other stakeholders, putting emphasis on participatory approaches and equity in benefit-sharing. Their perspective focuses on promoting public awareness and ensuring the inclusion of diverse voices in policy making.

4. The fourth group concerns breeders and seed companies. When it comes to the point of view of breeders and seed companies, their perspective is tied to the economic value of CWRs. They require clear regulations regarding access and benefit-sharing, to ensure legal security and facilitate the development of new crop varieties. However, breeders and seed companies may also have concerns about the costs and complexities of compliance with these regulations.
5. The fifth group involves consumers. As regards consumers, although not explicitly detailed, it could be said that they have a considerable stake in the long-term availability of diverse and resilient food systems. Their perspectives are shaped to a great extent by their desire for safe, high-quality food produced sustainably. Moreover, they express their disappointment at not being actively involved in policy discussions.
6. The last group of stakeholders includes policy makers. According to their perceptions, they face the challenge of balancing competing interests, resource limitations, and the complexities of European governance structures. Their perspective is shaped by the need for effective, coordinated policies that encourage cooperation and achieve conservation goals across different national contexts.

4.5 Typology ideas

This subsection introduces three typologies that categorize policy recommendations based on instrument type, governance level, and conservation focus. These frameworks help to systematize the complex array of proposals emerging from previous projects and can serve as practical tools for policy makers working to advance CWRs strategies.

The following typology (Table 4.2) categorizes recommendations based on the type of policy instrument used to achieve them.

Table 4.2. Typology by policy instrument

Policy Instrument Category	Examples of Policy Recommendations
Legal and Regulatory	Establish a legal framework for access and benefit sharing; Seed laws; Plant health regulations.
Financial	Payments for Ecosystem Services (PES); Subsidies for on-farm conservation; Funding for research; Agroecological schemes.
Institutional	Establish a national/European CWRs agency; Strengthen existing networks; Foster collaboration.
Awareness & Education	Public awareness campaigns; Educational programs; Training for farmers and stakeholders.

Technological	Develop information technology systems; Support research on CWR use and breeding.

The following typology (Table 4.3) classifies recommendations according to the level of government responsible for implementation.

Table 4.3. Typology by level of governance

Governance Level	Examples of Policy Recommendations
International	Global agreements on access and benefit sharing; International collaborations on research and conservation.
EU	EU-wide legislation on CWRs conservation; EU funding for conservation projects; European-level networks.
National	National policies on seed saving and landrace conservation; National funding for genebanks; National inventories.
Regional/ Local	Regional partnerships for CWRs conservation; Local incentives for farmers; Community-based conservation.

The following typology (Table 4.4) organizes recommendations based on their primary goal within CWR conservation.

Table 4.4. Typology by focus area

Focus Area	Examples of Policy Recommendations
In Situ Conservation	Incentives for on-farm conservation; Policies protecting wild populations; Integration into existing protected areas.
Ex Situ Conservation	Funding for genebanks; Development of standardized conservation protocols; Access and benefit-sharing regulations.
Sustainable Use	Support for participatory breeding; Development of CWR-based products; Promotion of traditional knowledge.
Research & Development	Funding for CWRs research; Development of new technologies; Collaboration between scientists and stakeholders.
Capacity Building	Training programs for farmers and stakeholders; Educational materials; Support for human resource development.

5 Systematic literature review

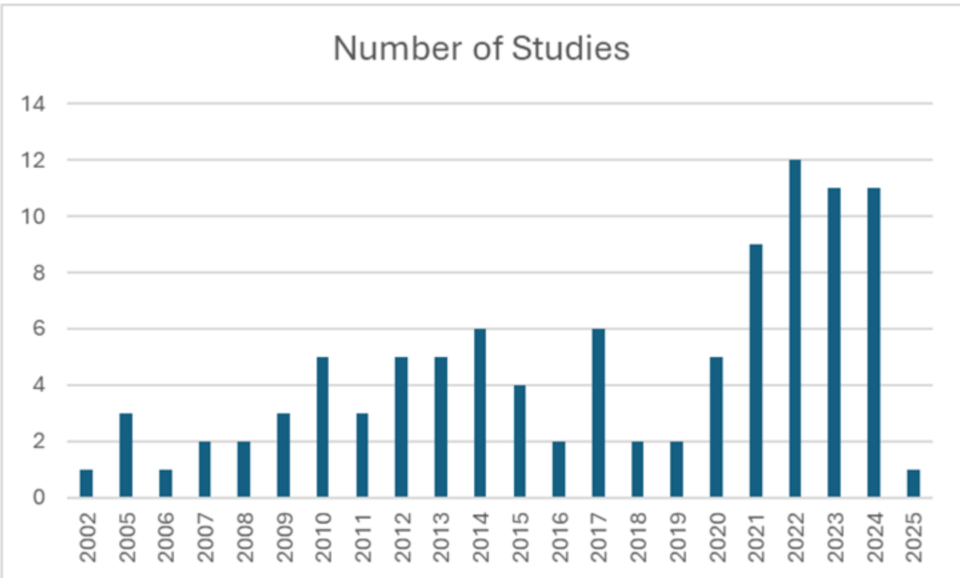
5.1 Statistical overview of the literature review

This section provides a descriptive analysis of the 101 peer-reviewed publications included in the systematic literature review on CWRs and policy-oriented outcomes. The analysis captures publication trends, distribution of journals in which the studies were published, document types, citation metrics, thematic areas, and their geographical focus.

Publication Trends

The included studies span the period from 2005 to 2025, with a notable increase in publication activity over the last five years (Figure 5.1). Peaks in output are observed particularly in the years 2021–2024, reflecting a growing academic interest in agrobiodiversity, sustainable agriculture, and the policy relevance of CWRs in the context of climate change and food system transformation.

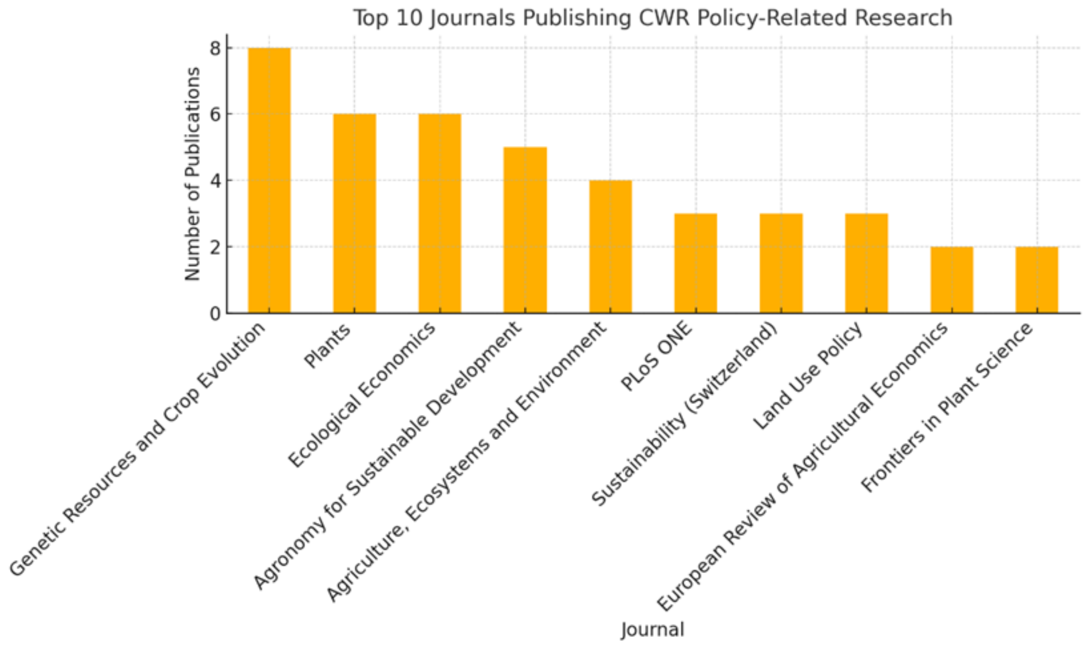
Figure 5.1. Publication activity over the years



Journal Distribution

The 101 papers are distributed across a wide range of journals, demonstrating the interdisciplinary character of CWRs research. The top ten journals publishing relevant literature include *Agronomy for Sustainable Development*, *Ecological Economics, Sustainability*, and *Land Use Policy*, among others (Figure 5.2). This highlights the thematic spread of CWRs policy research across agronomy, biodiversity conservation, and environmental protection domains.

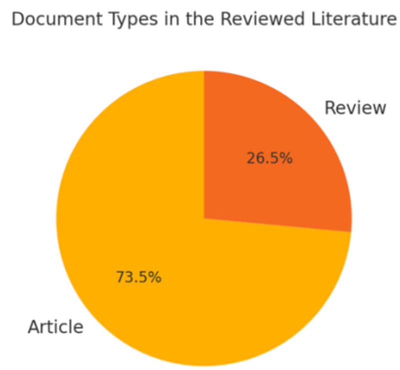
Figure 5.2. Top ten journals publishing relevant literature



Document Types

Among the included publications, 74% are empirical articles and 26% are review papers (Figure 5.3). This distribution illustrates a balanced integration of conceptual development and applied research in the policy discourse around CWRs.

Figure 5.3. Type of document



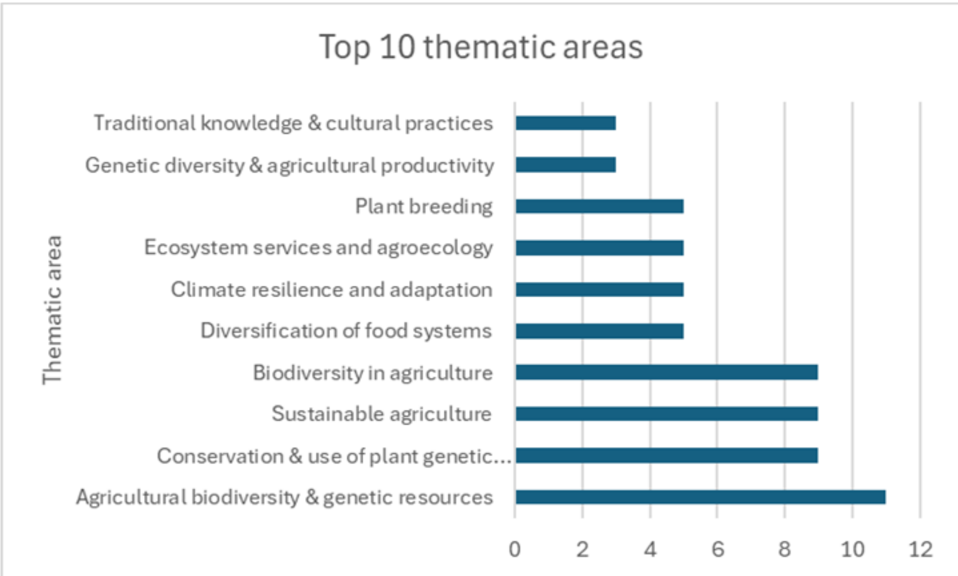
Citation Metrics

The number of citations per article ranges from 0 to 446, with an average of 36.1 citations and a median of 12 citations. This indicates a considerable overall visibility, with several papers achieving substantial academic impact. The most cited works typically addressed broad topics such as biodiversity governance, crop diversification for resilience, and participatory breeding systems.

Thematic Areas

As indicated in figure 5.1, the reviewed literature spans a wide range of thematic areas, reflecting the multidisciplinary nature of policy-relevant research on CWRs. The most frequently addressed topics include biodiversity conservation, genetic resources, and sustainable agriculture, emphasizing the environmental and genetic dimensions of CWR use. Participatory breeding, seed systems, climate change, food security, and traditional knowledge also appear across multiple studies, indicating a strong linkage between CWRs conservation and broader discussions on agrobiodiversity and rural resilience.

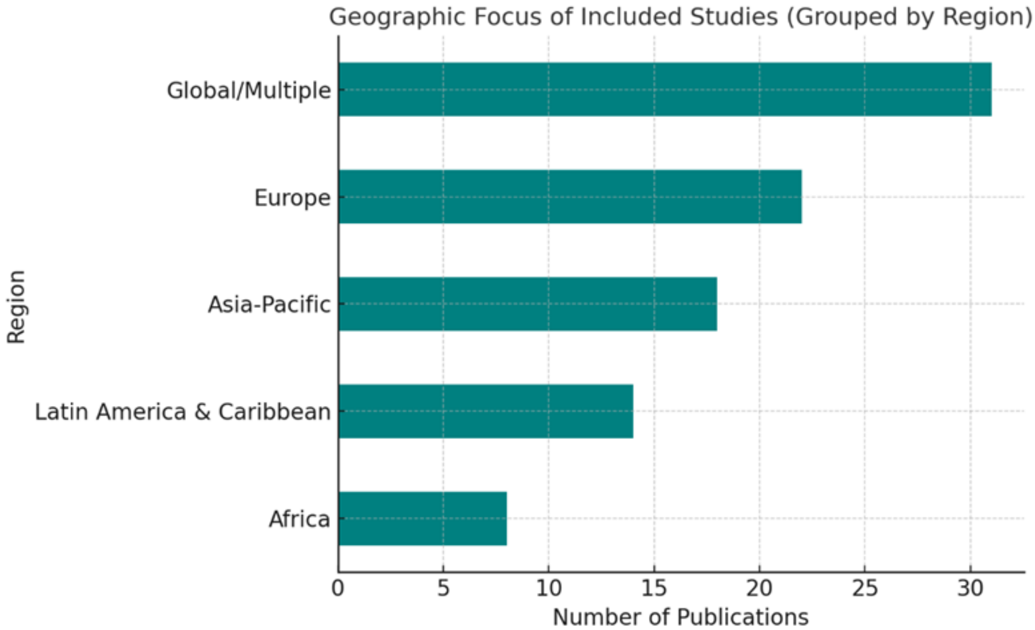
Figure 5.4. Top ten thematic areas



Geographical Focus

The studies included in this review span a broad range of geographic contexts. As shown in Figure 5.5, the majority of research focuses on European contexts, when it comes to continent ranking, reflecting the strong institutional interest and policy activity surrounding CWRs within the European Union and neighboring countries. Among European countries, Greece and Italy are the leading countries in terms of publications related to policy-oriented results for CWRs. Research with a primary focus on Asia-Pacific, Latin America & the Caribbean and Africa, is also well represented, often emphasizing local agrobiodiversity, traditional knowledge, and adaptation strategies in diverse agroecological settings. Countries like China, Nepal and Mexico have a predominant presence in the field. A significant number of studies also adopt a global or multi-regional lens, highlighting the transboundary nature of CWRs conservation and use.

Figure 5.5. Geographical focus of the included studies

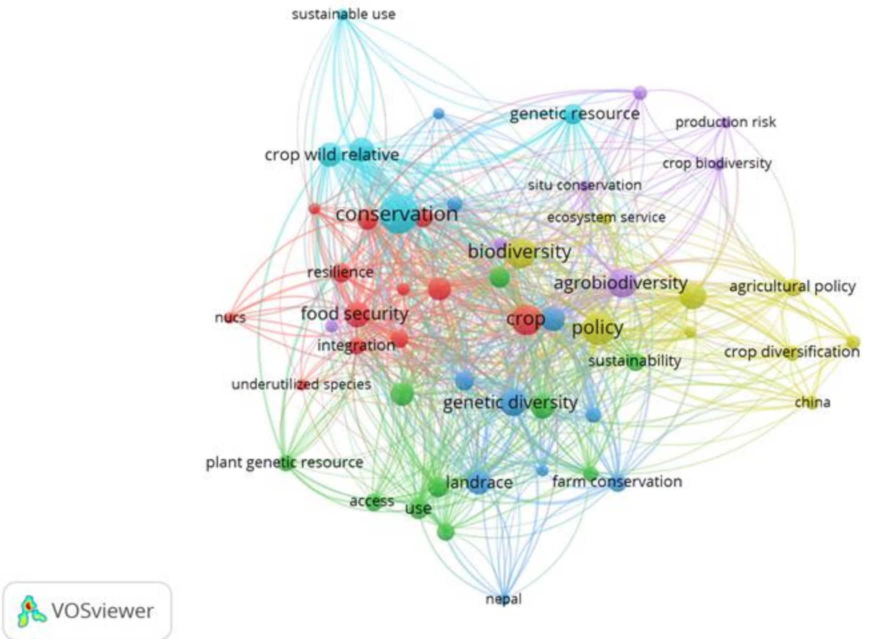


5.2 Bibliometric analysis

To complement the systematic review, a bibliometric analysis was conducted using VOSviewer to map the thematic landscape of the selected 101 studies. The analysis was based on the co-occurrence of terms within abstracts and keywords, resulting in a focused network of 53 high-frequency terms, extracted using a minimum occurrence threshold of 5. The resulting network visualization co-occurrence map revealed six distinct thematic clusters, each representing a key dimension in the academic discourse on CWRs, agrobiodiversity, and related policy implications (Figure 5.6).

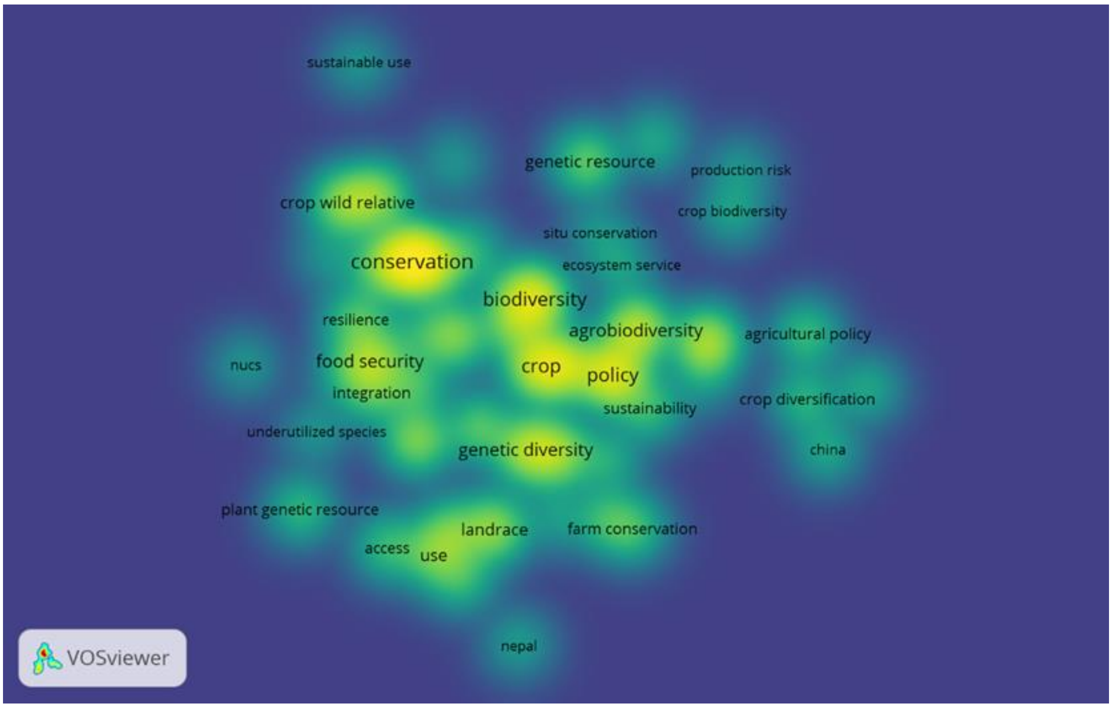
Keywords in this network are connected by co-occurrence link. The outcome maps were then used for visualization and exploration of network data. The map presents the keywords grouped into non-overlapping clusters, where the circles and keywords are connected by curved lines of various sizes (link strength). The higher the value and the thickness of line, the stronger the link between keywords (Van Eck & Waltman 2020). Moreover, the size of the circle is proportional to the co-occurrence of the keywords. The distance between keywords in the visualization map indicates the relatedness of the keywords in terms of co-occurrence links. This means, the closer two keywords are located to each other, the stronger the relatedness (Van Eck & Waltman 2018).

Figure 5.6 Network visualization of keyword co-occurrence generated with VOSviewer



The density visualization (Figure 5.7) provides a complementary perspective, emphasizing areas of highest keyword concentration within the network. Warmer colors (yellow and red) indicate clusters of intense research focus, whereas cooler colors (green and blue) denote less frequent but still connected topics.

Figure 5.7 Density visualization of keyword co-occurrence generated with VOSviewer



The six thematic clusters identified in the bibliometric analysis reflect distinct but interconnected dimensions of policy-relevant research on CWRs:

1. **Climate resilience and agroecological sustainability (highlighted in red)**. The red cluster focuses on the interconnection between climate change adaptation, agroecology, and sustainable agriculture. Included terms such as “climate resilience”, “food security”, “underutilized species”, and “neglected and underutilized crops (NUCs)” emphasize an emerging policy narrative: integrating CWRs and alternative crops into agroecological strategies to strengthen food systems under changing environmental conditions. The cluster aligns closely with global policy priorities around climate-smart agriculture and the United Nations Framework Convention on Climate Change (UNFCCC) objectives.
2. **Access, agricultural biodiversity, and genetic resource use (highlighted in green)**. The green cluster centers on the management and governance of plant genetic resources, with a focus on access and benefit-sharing mechanisms (ABS). It reflects policy-relevant debates around equitable development, sustainable use, and the fair distribution of benefits arising from genetic resources, connecting closely to international agreements such as the Nagoya Protocol of the CBD and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).
3. **On-Farm conservation and smallholder engagement (highlighted in blue)**. The blue cluster focuses on the socio-ecological aspect of agrobiodiversity conservation. Particularly, it highlights the importance of smallholder farmers and Indigenous communities as protectors of CWRs. It could be said that the content of the blue cluster advocates for participatory approaches in conservation policy, in line with global targets such as FAO's Global Plan of Action for Plant Genetic Resources.
4. **Agricultural policy, ecosystem services, and sustainability (highlighted in yellow).** Regarding the yellow cluster, it reflects the growing policy discussion that links agricultural sustainability, ecosystem services, and biodiversity conservation. Terms like "ecosystem services" “productivity” and "agricultural policy" are highly significant, indicating the necessity of integrated policy frameworks that strike a balance between environmental protection and productivity enhancement. It could be said that the results of this cluster are aligned with frameworks like Green Deal, Farm to Fork Strategy, and generally, with concepts which aspire to incorporate biodiversity values into agricultural decision making.
5. **In situ conservation, wild relatives, and risk mitigation (highlighted in purple)**. The purple cluster explores the role of in situ conservation of CWRs as a strategy for risk management in agriculture. It emphasizes how crucial is to preserve genetic diversity in natural habitats in order to protect against production risks associated with pests, diseases, and climate variability. Arguably, the aforementioned reflect the growing recognition in policies advocating for ecosystem-based adaptation and integrated biodiversity conservation approaches under conventions such as the CBD (Convention on Biological Diversity).

6. **CWRs as genetic resources for sustainable use (highlighted in turquoise)**. This last cluster focuses on the notion of the exploitation of CWRs as a strategic resource for sustainable agriculture. Including terms like "genetic resource" and "sustainable use," it underscores the necessity of embedding CWRs into breeding programs, seed system innovations, and national genetic conservation strategies. Arguably, the cluster resonates with global initiatives promoting genetic resource mainstreaming for food security and resilience-building, including targets under the Post-2020 Global Biodiversity Framework.

The terms and thematic clusters identified through the bibliometric analysis will serve a dual purpose within the COUSIN project. In addition to informing the current policy synthesis, the extracted terminology provides a structured inventory that will guide the development and formatting of the subsequent questionnaire survey, designed to elicit expert consensus on key policy priorities for CWRs through Delphi method (Deliverable 1.5 "Policy Brief 2: overall policy recommendations and effectiveness assessment).

5.3 Environmental dimension

The environmental contributions of CWRs are widely acknowledged across the literature as critical to the sustainability and resilience of agri-food systems (Bragdon et al., 2009; Dulloo et al., 2010; Ebert, 2020; Sharma and Wagh, 2025). Many of the studies reviewed emphasize the ecological value of CWRs in enhancing ecosystem resilience, safeguarding genetic diversity, and supporting climate change adaptation (Ureta et al., 2012; Ng' Uni et al., 2019; Kagi et al, 2023; Padmavathi et al., 2023). Far from being passive conservation targets, CWRs are presented as active agents in agroecosystems, contributing to the stability and sustainability of food production systems. The present section tries to synthesize the environmental contributions observed in the literature, across four major thematic areas, namely, biodiversity conservation, climate resilience, ecosystem services, and the identification of prevailing challenges and policy gaps.

5.3.1 Biodiversity conservation (in situ and ex situ approaches)

The conservation of CWRs through both in situ and ex situ strategies remains a central pillar for maintaining and enhancing agricultural biodiversity. Work in this area underlines the need for policy frameworks that support the identification, prioritization, and protection of CWRs within agricultural and natural landscapes.
For instance, Hochkirch et al. (2023), upon examining widespread gaps in species protection across Europe, based on Red List data, highlight the underrepresentation of many wild relatives in current conservation schemes. Their work calls for more targeted policy measures that embed wild relatives within broader biodiversity and landscape protection frameworks. Moreover, the same authors conclude that policy decisions require comprehensive, spatially explicit information on species' distributions and threats.
Other scholars propose modernized approaches to biodiversity conservation, arguing that static conservation tools must evolve to fit dynamic, human-modified environments (Jago et al., 2024). Their findings advocate for hybrid models that blend in situ and ex situ mechanisms to support biodiversity within and beyond protected areas. In the same line, Notaro et al. (2017) examine the policy landscape for small millet

conservation in India and highlight misalignments between in situ and ex situ strategies. Their findings underscore the need for coordinated conservation efforts that value underutilized species and integrate them into both national biodiversity plans and agrobiodiversity use frameworks.

There are also publications that attempt to provide a critical assessment of institutional and ecological barriers to in situ CWR conservation Heywood (2008). Key challenges include the limited ecological representativeness of existing protected areas and poor coordination between biodiversity and agricultural sectors. According to the same author, in order to overcome the previously mentioned obstacles, more ecologically grounded and cross-sectoral policy frameworks are required.

Fresta (2022), recognizing that CWRs are sources of genetic diversity valuable for crop improvement to address the challenges faced by agriculture in withstanding stressors and providing high quality primary commodities, offers a detailed national inventory of crop wild relatives in the Maltese Islands. The study provides critical baseline data to support species prioritization and conservation planning, serving as a model for other countries seeking to integrate CWRs into national biodiversity strategies. This foundational step is essential for informing evidence-based policy and identifying gaps in conservation coverage at a national scale.

In summary, these studies collectively emphasize that effective biodiversity conservation requires more than technical solutions. What is demanded is well-aligned policy frameworks, institutional coordination, and reliable data on species distribution and conservation status. Strategic integration of CWRs into broader biodiversity and agricultural agendas will be key to safeguarding the genetic resources needed for future food system resilience.

An overview of representative studies on biodiversity conservation approaches is presented in Table 5.1.

Table 5.1. Studies on biodiversity conservation (in situ and ex situ)

Study (Title, Year)	Thematic Sub-Area	Key Finding/Content Summary	Policy Implication/Recommendation
Hochkirch et al. (2023). A multi-taxon analysis of European Red Lists reveals major threats to biodiversity.	Biodiversity Conservation.	Identifies taxon-specific gaps and overlapping threats in European Red List assessments.	Policies are needed to promote sustainable agriculture and mitigate threats to biodiversity.
Jago et al. (2024). Adapting Wild Biodiversity Conservation Approaches to Conserve Agrobiodiversity.	Agrobiodiversity Conservation.	Explores how traditional conservation tools can be modernized for agricultural landscapes.	Implementing adapted conservation approaches can enhance both in situ and ex situ biodiversity outcomes.
Heywood (2008). Challenges of In Situ Conservation of Crop Wild Relatives.	In situ Conservation of CWRs.	Examines technical and institutional barriers to effective	Identifies key policy gaps and proposes strategies to overcome in situ conservation challenges.

		in situ CWR conservation.	
Notaro et al. (2017). A Policy Analysis to Promote Conservation and Use of Small Millet Underutilized Species in India.	Agrobiodiversity Conservation; Policy Frameworks.	Highlights inconsistencies between in situ and ex situ efforts in small millet conservation.	Recommends policy reforms to harmonize both strategies and support underutilized crop diversity.
Fresta, L. (2022). An Inventory of Crop Wild Relatives of the Maltese Islands.	Biodiversity Planning and Baseline Assessment.	Establishes a national-level CWR inventory and conservation priorities for Malta.	Provides actionable data to inform policy, prioritize species, and integrate CWRs into national strategies.

5.3.2 Climate resilience and adaptation

Climate change poses significant threats to agricultural systems, biodiversity, and global food security. In this context, CWRs offer critical resources for enhancing climate resilience and adaptation. The reviewed literature emphasizes the role of genetic diversity—both in the wild and in managed systems—in buffering against climatic extremes.

Nabhan et al. (2022) explore the comparative richness of wild and cultivated food plant species across the Arid American and Mesoamerican centers of diversity. Their findings demonstrate that these landscapes, shaped by Indigenous stewardship, host a broad spectrum of climate-resilient species. The study highlights the adaptive value of maintaining this plant diversity as a strategy for advancing food sovereignty and climate resilience in culturally and ecologically sensitive regions.

Aerts et al. (2017) focus on the case of wild Arabica coffee in Ethiopia, revealing how rising temperatures and shifting environmental patterns threaten this important genetic resource. Their work stresses that conserving wild populations in situ, especially in biodiversity hotspots, is crucial to maintaining adaptive traits essential for future breeding, since climate change poses an important threat to global coffee production. Their work illustrates how conservation of CWRs is instrumental in supporting long-term resilience in coffee cultivars. Moreover, they emphasize the urgency of preserving wild coffee genetic resources, as vital reservoirs of traits that enhance agricultural sustainability and resilience to environmental variability.

Zuza et al. (2024) emphasize crop species diversity, including indigenous species, as a system-level response to climate stress and food insecurity. By examining species diversification across agricultural landscapes, they argue that agrobiodiversity not only improves productivity but also stabilizes food systems against climate volatility. The study calls for policy support to integrate species diversity into national adaptation strategies and agroecological planning, emphasizing the urgency of preserving plant genetic resources for sustainable agriculture and resilience to changing environmental conditions.

In the same line, Heider et al. (2021) provide empirical evidence of intraspecific variation in heat-stress tolerance among sweet potato landraces. Their findings highlight the importance of conserving within-species diversity, particularly in CWRs and traditional varieties, to maintain farming systems' resilience, which is increasingly threatened by climatic variability, in particular extreme heat events. They identify canopy temperature depression, chlorophyll content and storage root-flesh colour as predictors of heat tolerance and, therefore, as potential traits for breeding consideration. By identifying and promoting heat-tolerant traits, especially those rooted in landraces, policymakers and breeders can work towards sustainable solutions to the challenges posed by global warming.

Finally, Kapazoglou et al. (2023) offer a broad review of the abiotic stress tolerance potential found in CWRs. They document how wild species provide resilience to drought, salinity, and high temperatures—traits that are often absent in modern cultivars. The study calls for increased investment in both conservation and pre-breeding programs to harness this untapped adaptive potential.

The above-mentioned studies underscore the urgent need for mainstream CWRs and crop diversity into climate adaptation policies. Strengthening conservation frameworks, supporting farmers' access to diverse genetic resources, and promoting diversified production systems are essential to building climate-resilient agri-food systems.

Key research contributions related to climate resilience and adaptation are synthesized in Table 5.2.

Table 5.2. Studies on climate resilience and adaptation

Study (Title, Year)	Thematic Sub-Area	Key Finding/Content Summary	Policy Implication/Recommendation
Nabhan et al. (2022). Comparing Wild and Cultivated Food Plant Richness Between the Arid American and the Mesoamerican Centers of Diversity, as Means to Advance Indigenous Food Sovereignty in the Face of Climate Change.	Indigenous Agriculture; Climate Resilience; CWR Use.	Highlights how wild and cultivated plant diversity contributes to climate-resilient Indigenous food systems.	Recommends incorporating traditional knowledge and CWRs into national climate adaptation and food security policies.
Aerts et al. (2017). Conserving Wild Arabica Coffee: Emerging Threats and Opportunities.	Biodiversity Conservation; Climate Change Impacts.	Assesses how climate change threatens wild Arabica coffee populations in their native habitat.	Promotes in situ conservation and local engagement as key components of adaptation strategies.
Zuza et al. (2024). Crop Species Diversity: A Key Strategy for Sustainable Food System Transformation and Climate Resilience.	Agricultural Biodiversity; Climate Resilience.	Emphasizes crop diversity as a system-level response to climate risks.	Advocates for supportive policy frameworks that promote species diversification in agriculture.
Heider et al. (2021). Intraspecific Diversity as a Reservoir for Heat-Stress Tolerance in Sweet Potato.	Crop Diversity; Climate Change Adaptation.	Demonstrates that intraspecific genetic variation enhances climate resilience.	Suggests that conservation policies should include heat-tolerant CWR traits in breeding strategies.
Kapazoglou et al. (2023). Crop Wild Relatives: A Valuable Source of Tolerance to Various Abiotic Stresses.	Abiotic Stress Tolerance; Genetic Diversity; Climate Resilience.	Reviews the potential of CWRs to confer tolerance to heat, drought, and salinity.	Advocates for increased investment in the conservation and breeding use of stress-tolerant wild relatives.

5.3.3 Ecosystem services and agroecological practices

CWRs and broader agrobiodiversity contribute significantly to ecosystem services that support resilient and sustainable agricultural systems. Agroecological practices, when aligned with biodiversity conservation, can enhance natural processes such as nutrient cycling, pest regulation, pollination, and landscape restoration. The reviewed literature provides strong evidence that agroecology, as a holistic and biodiversity-based approach, is essential for maintaining ecosystem functions while ensuring food production and rural sustainability.

Vogt (2021) introduces the concept of "agricultural wilding" as an innovative strategy to reintegrate ecological complexity into agricultural landscapes. By increasing the presence and function of wild productive systems, this approach enhances biodiversity corridors and strengthens ecosystem services such as soil formation, water retention, and species interactions. The study advocates for policy frameworks that support rewilding principles within agri-environmental subsidies and land use planning.

Cheatham et al. (2009) expand the view of ecosystem services by analyzing plant disease management within an ecological framework. Their findings show how disease resistance strategies can affect and be affected by wider ecosystem processes such as microbial balance, soil health, and habitat complexity. To address these complexities, Cheatham et al. (2009) call for policies that support conservation and optimal use of genetic resources as a means to protect the above-mentioned ecosystem processes.

As indicated by Chappell and LaValle (2011), biodiversity conservation and food security are not contradictory concepts. Their study provides evidence that agroecological models can support productive food systems, while also protecting ecosystem integrity. This dual-functionality of agroecology is framed as a policy opportunity to shift away from intensive, biodiversity-reducing systems toward multifunctional, sustainability-oriented farming landscapes.

Finally, Delaney and von Wettberg (2023) highlight how agroecological food production can enhance genetic diversification, particularly through the use of underutilized and wild species. They conclude that we can re-expand the genetic base of our food, fodder, and cover crops, in particular by using CWRs, by wide crosses, genome-assisted selection, and participatory breeding. Policy recommendations focus on incentivizing agroecological innovation and the inclusion of CWRs in farming system design.

The above-mentioned studies demonstrate that agroecology and ecosystem service enhancement are mutually reinforcing. CWRs, when integrated through agroecological frameworks, not only support food system transformation but also ensure the ecological foundations upon which sustainable agriculture depends.

Key studies exploring the linkages between CWRs, ecosystem services, and agroecological practices are summarized in Table 5.3.

Table 5.3. Studies on ecosystem services and agroecological practices

Study (Title, Year)	Thematic Sub-Area	Key Finding/Content Summary	Policy Implication/Recommendation
Vogt, M. A. (2021). *Agricultural Wilding: Rewilding for Agricultural Landscapes Through an Increase in Wild Productive Systems*.	Agrobiodiversity; Conservation Strategies; Sustainable Agriculture.	Introduces "agricultural wilding" as a method to re-integrate natural ecological processes into agricultural landscapes.	Advocates integrating rewilding and biodiversity corridors into agri-environmental policies.
Cheatham et al. (2009). *Beyond Yield: Plant Disease in the Context of Ecosystem Services*.	Plant Health; Ecosystem Services.	Discusses the broader ecosystem implications of plant disease management.	Suggests integrating disease resistance strategies with ecological conservation practices.
Chappell, M. J., & LaValle, L. A. (2011). *Food Security and Biodiversity: Can We Have Both? An Agroecological Analysis*.	Agroecology; Biodiversity and Food Systems.	Argues that agroecological approaches can reconcile food production with biodiversity protection.	Proposes agroecology-focused agricultural policies to achieve biodiversity and food security goals simultaneously.
Delaney, S., & von Wettberg, E. J. B. (2023). *Toward the Next Angiosperm Revolution: Agroecological Food Production as a Driver for Biological Diversity*.	Agroecology; Biodiversity Enhancement.	Emphasizes the role of CWRs and agroecology in advancing plant diversity and sustainable food systems.	Encourages policy incentives for agroecological innovation and use of underutilized and wild species.

5.3.4 Environmental challenges and policy gaps

Despite widespread recognition of the importance of CWRs for environmental resilience, substantial policy and governance gaps persist. These challenges often manifest as weak institutional coordination, fragmented planning, or misalignment between conservation goals and broader agricultural or land use agendas. The selected literature identifies critical environmental obstacles that hinder the effective integration of biodiversity into national and international policy frameworks.

Notaro et al. (2017) highlight the institutional disconnect between in situ and ex situ conservation efforts in India, particularly regarding underutilized species like small millets. The study emphasizes that without policy mechanisms to harmonize conservation approaches, valuable genetic resources remain neglected and vulnerable. Reforming conservation frameworks to bridge these divides is essential for long-term environmental stewardship.

Di Gregorio et al. (2024) assess the coherence of EU legislation in integrating biodiversity and climate goals, focusing on the CAP and other environmental directives. The study identifies inconsistencies and practical enforcement gaps that weaken the effectiveness of biodiversity policy. They recommend improved legislative alignment and enforcement mechanisms to ensure that biodiversity objectives are not undermined by economic or administrative priorities.

French (2017) examines whether forage CWRs are dependent upon pastoral activities. The study argues that in situ and ex situ conservation of CWRs is increasingly important because they provide plant breeders with novel sources of genetic diversity to adapt crops to changing climate conditions. However, the study stresses that current land use planning often disregards these long-term ecological patterns. The study calls for environmental policies that incorporate historical data into spatial planning tools to ensure the continuity of ecologically important landscapes.

Heywood et al. (2007) provide a foundational critique of biodiversity conservation planning. They argue that CWRs are often excluded from formal conservation agendas, despite their ecological and agricultural significance. The study calls for the full integration of CWRs into biodiversity strategies, agri-environmental schemes, and land use governance structures.

Literature around relevant issues demonstrate that addressing environmental challenges in CWR conservation requires both conceptual and structural shifts in policy. A move toward integrative planning, long-term ecological thinking, and incentive-based biodiversity management is essential to close the gap between conservation science and environmental governance.

The key challenges and corresponding policy gaps identified in selected studies are synthesized in Table 5.4.

Table 5.4. Studies on environmental challenges and policy gaps

Study (Title, Year)	Challenge Area	Key Challenges Identified	Policy Gaps and Needs
Notaro et al. (2017). A Policy Analysis to Promote Conservation and Use of Small Millet Underutilized Species in India.	Conservation of underutilized crops.	Institutional disconnect between in situ and ex situ approaches.	Recommends integrated conservation policy reform.
Di Gregorio et al. (2024). Getting (ECO)Ready: Does EU Legislation Integrate Biodiversity and Climate Goals?	Regulatory coherence and integration.	Finds a mismatch between EU biodiversity objectives and actual legislative tools in CAP and environmental law, hindering practical implementation.	Recommends improved legislative coherence and the development of enforcement mechanisms to bridge biodiversity–climate policy integration.
French (2017). Palaeoecology and Gis Modeling Reveal Historic Grasslands as "hotspots" of Biodiversity and Plant Genetic Resources.	CWRs conservation - Long-term environmental planning.	Land use and conservation planning ignore long-term ecological patterns.	Calls for incorporating ecological history into planning tools.
Heywood et al. (2007). Conservation and Sustainable Use of Crop Wild Relatives.	Biodiversity planning and conservation gaps.	CWR conservation is often excluded from national biodiversity agendas.	Urges stronger policy integration of CWRs into sustainability frameworks.

In conclusion, the environmental dimension of CWRs stands as a cornerstone in advancing sustainable agriculture, biodiversity conservation, and climate resilience, since CWRs are indicated as a means of enhancing genetic diversity of cultivated crops. However, the reviewed literature suggests that to harness fully CWRs potential as drivers of environmental sustainability, a more integrated approach is needed, which will focus on aligning conservation efforts with ecosystem management and climate adaptation policies.

5.4 Economic dimension

The economic relevance of CWRs is increasingly reflected in the literature, particularly in terms of their contributions to agricultural innovation, risk management, and long-term food system resilience (Bangwayo-Skeete et al., 2012; Antonelli et al., 2022; Lassalas et al., 2024). A considerable number of these studies delve into the economic implications of CWRs utilization, particularly in relation to breeding, productivity gains, and the mitigation of production risks. The relevant literature highlights the strategic potential of CWRs to contribute to both input efficiency and yield stability outcomes, which are essential for ensuring financial sustainable and market-oriented agriculture. However, literature also indicates that this potential is often hindered by institutional, financial, and regulatory barriers. This section synthesizes the economic insights found in the reviewed studies, organized around four core thematic categories, namely, productivity and breeding gains, risk mitigation and economic stability, economic barrier and constraints to CWRs utilization, and the identification of prevailing economic challenges and policy gaps.

5.4.1 Productivity and breeding gains from CWR utilization

CWRs and traditional landraces are increasingly recognized not only for their contribution to crop resilience, but also for their direct role in achieving breeding gains that translate into long-term economic benefits. A growing body of literature consents that the strategic integration of CWRs into breeding programs can significantly improve cultivars' adaptive capacity, productivity, and profitability. In this backdrop, Kumar et al. (2020) demonstrate how barley landraces, shaped by generations of local adaptation to edaphic stress, harbor valuable traits that can be leveraged to reduce input dependency and maintain yields under challenging soil conditions. These traits represent pre-adapted genetic capital that breeding programs can mobilize to develop varieties that are both productive and cost-efficient. The associated breeding gains, in terms of yield stability and reduced input costs, highlight a clear economic incentive to support the conservation and use of such genetic diversity.

In the same line, Kapazoglou et al. (2023) further underscore the economic significance of breeding gains derived from CWRs. The study details how traits conferring abiotic stress tolerance (e.g. drought, salinity, and heat resistance) are critical targets in modern breeding pipelines. The deployment of such traits enables the development of cultivars that perform reliably under climate variability, safeguarding farmer incomes, and stabilizing food production. According to their findings, breeding programs focusing on introgression of wild genetic material into cultivated crops will result in climate-resilient varieties with low-input requirements. These benefits present a strong justification for mainstreaming CWRs into agricultural innovation policies.

Omer et al. (2007) provide additional support by showing that biodiversity conservation within high-intensity production systems can deliver both productivity gains and ecological resilience. Their results support the view that increasing productivity is consistent with biodiversity conservation and that policies to promote sustainable agriculture can focus on developing high-yielding sustainable technologies. These results underscore the compatibility, and even synergy, between breeding objectives and conservation goals.

Lastly, Jin et al. (2008) demonstrate that wheat varietal diversity contributes significantly to Total Factor Productivity (TFP) across major wheat-growing regions in China. Their findings establish a clear link between genetic diversity and economic performance, suggesting that promoting varietal diversity can be a viable strategy for stabilizing productivity and ensuring long-term economic growth in the agricultural sector.

In sum, productivity and breeding gains represent a crucial metric through which the value of CWRs can be quantified and justified in economic terms. Policies that enable the conservation, characterization, and targeted use of these resources in breeding pipelines will be instrumental in enhancing both productivity and economic resilience of the agricultural sector.

Table 5.5 below presents representative studies that demonstrate the productivity and breeding contributions of CWRs, along with their policy implications.

Table 5.5. Studies on productivity and breeding gains from CWR utilization

Study (Title, Year)	**Thematic Sub-Area**	**Key Finding/Content Summary**	**Policy Implication/Recommendation**
Kumar et al. (2020). Barley Landraces: Ecological Heritage for Edaphic Stress Adaptations and Sustainable Production	Agricultural Biodiversity, Crop Improvement	Conserving barley landraces provides direct economic benefits, including reduced dependence on external inputs (fertilizers, chemicals) and enhanced adaptation to soil stress, ultimately boosting sustainable productivity and farm profitability.	Policies should economically support barley landrace conservation and use, highlighting their role in sustainable agricultural practices and cost-efficient production.
Kapazoglou et al. (2023). Crop Wild Relatives: A Valuable Source of Tolerance to Various Abiotic Stresses	Abiotic Stress Tolerance, Crop Improvement	Utilizing CWRs significantly enhances the economic resilience of agriculture by providing genetic resources that improve crop yields under abiotic stress conditions (e.g., drought, heat, salinity), thus securing stable and profitable production.	Advocates policies promoting conservation, breeding programs, and research investments focused explicitly on economic resilience through the exploitation of CWR traits.
Omer et al. (2007). Biodiversity Conservation and Productivity in Intensive Agricultural Systems	Biodiversity Conservation, Agricultural Productivity	Demonstrates biodiversity conservation within intensive agriculture systems can result in significant productivity gains.	Calls for policies aligning biodiversity conservation objectives explicitly with agricultural productivity incentives.

Jin et al. (2008). Farmers' Adoption of Maize (Zea mays L.) Hybrids and the Persistence of Landraces in Southwest China: Implications for Policy and Breeding	Crop Improvement, Genetic Resource Use	Highlights how landraces persist alongside hybrids due to local preferences and risk mitigation, indicating their long-term productivity and breeding value.	Suggests policies that support the integration of landraces into breeding programs and agricultural extension services for sustainable crop improvement.

5.4.2 *Risk mitigation, resilience, and economic stability*

CWRs and broader agrobiodiversity play a key role in enhancing the resilience of agricultural systems. Their use contributes to managing climate variability, buffering against yield instability, and reducing farmers' exposure to environmental and economic shocks. In the reviewed studies, there is broad evidence that varietal diversity has a natural insurance function.

Bangwayo-Skeete et al. (2012) present evidence from Ethiopia showing that increased crop biodiversity, achieved through the maintenance of traditional crop varieties, helps farmers better cope with production risks, which associated with environmental fluctuations. Their findings highlight the importance of genetic diversity in reducing volatility in output. The study supports biodiversity-friendly policy frameworks aligned with the Convention on Biological Diversity.

Antonelli et al. (2022) provide insights from Uganda on how crop and income diversification can reduce household vulnerability to climate shocks. Although the study does not directly assess CWRs, it illustrates how diversification strategies, including those that incorporate underutilized or wild relatives, can stabilize rural livelihoods. Their findings support public investment in diversification as a means to enhance adaptive capacity and reduce systemic risks.

Di Falco and Perrings (2005) contribute a foundational perspective by framing crop diversity, including that derived from CWRs, as a form of natural risk management. They caution that agricultural assistance programs can unintentionally disincentivize the maintenance of genetic diversity. Their work reinforces the case for policy instruments that explicitly integrate conservation of CWRs with long-term risk mitigation goals.

Melvani et al. (2020) show how traditional farming systems in Sri Lanka, characterized by high floristic diversity, enable diversified livelihood strategies that enhance resilience. While not focused solely on CWRs, their study highlights the broader landscape value of wild plant diversity in reducing vulnerability to environmental and economic disruptions. These findings point to the need for policies that safeguard traditional agroecosystems and the diversity they contain.

Taken together, these studies emphasize that CWRs are not only genetic resources for breeding but also valuable assets in managing risk and enhancing stability. Agricultural and environmental policies should recognize this dual role by supporting CWR conservation, integration into farming systems, and their contribution to buffering against future uncertainty.

Selected studies that illustrate the role of CWRs in reducing economic risk and enhancing resilience are presented in Table 5.6.

Table 5.6. Studies on risk mitigation and economic stability

Study (Title, Year)	Thematic Sub-Area	Key Finding/Content Summary	Policy Implication/Recommendation
Bangwayo-Skeete et al. (2012). Crop Biodiversity, Productivity and Production Risk: Panel Data Micro-Evidence from Ethiopia	Biodiversity, Productivity, Risk	Demonstrates that greater crop biodiversity reduces production risk and improves productivity for smallholders in Ethiopia.	Supports biodiversity-friendly agricultural policies grounded in the Convention on Biological Diversity.
Antonelli et al. (2022). Crop and Income Diversification for Rural Adaptation: Insights from Ugandan Panel Data	Climate adaptation, Livelihood resilience	Analyzes how crop and income diversification strategies help Ugandan rural households adapt to climate shocks, reducing welfare variability and downside risk.	Recommends policies that support diversification as a means to enhance resilience and economic stability in rural communities.
Di Falco, S., & Perrings, C. (2005). Crop biodiversity, risk management and the implications of agricultural assistance	Biodiversity, Agricultural Policy	Provides theoretical and empirical analysis on how crop biodiversity functions as a risk management tool, and how agricultural assistance programs can influence biodiversity levels.	Highlights the need for agricultural policies that align financial assistance with biodiversity conservation goals to effectively manage risk and promote economic stability.
Melvani et al., (2020). Multiple livelihood strategies and high floristic diversity increase the adaptive capacity and resilience of Sri Lankan farming enterprises	Agroecology, Resilience, Livelihoods	Demonstrates how traditional land-use systems with high floristic diversity support diversified livelihood strategies that buffer economic and environmental shocks.	Recommends policy integration of traditional knowledge and agroecological practices to strengthen the adaptive capacity and resilience of farming communities.

5.4.3 Economic barriers and constraints to CWR utilization

Despite their proven value in enhancing financial resilience, productivity, and breeding innovation, the wider utilization of CWRs is frequently hindered by persistent economic and institutional barriers. These constraints include limited access to markets, infrastructure deficits, misaligned subsidies, and the absence of tailored financial or regulatory incentives. The studies presented in Table 5.7 provide insight into how the above barriers hinder the utilization of CWRs, and also, what policy responses could be devised to overcome these barriers.

Zhang et al. (2022) document the institutional and economic challenges faced by Indigenous Food Plant (IFP) farmers attempting to integrate into formal agri-food value chains in Cape Town. The study identifies complex licensing requirements, lack of access to planting materials, and poor distribution infrastructure as key barriers that limit the commercial potential of underutilized crops. Policy reforms are recommended to streamline administrative processes and enhance economic opportunities for IFP producers.

Song et al. (2021) show how national agricultural subsidies in China have unintentionally discouraged crop diversity by promoting monoculture. While the study centers on cultivated diversity, the dynamics they reveal (policy incentives working against diversification) are equally applicable to CWR integration. Misaligned subsidies can create economic disincentives for maintaining or incorporating wild or underutilized species. The authors emphasize the need for spatially differentiated policies that reflect regional agroecological conditions and support diverse cropping systems.

In the same line, Gauchan et al. (2005) provide direct evidence of how market incentives (or the lack thereof) affect farmers' decisions to conserve traditional varieties, such as rice landraces in Nepal. The study finds that without access to premium markets or risk-reducing mechanisms, the conservation of genetic diversity is economically unattractive. These insights extend to CWRs, which also suffer from market invisibility and lack of immediate financial return. The authors advocate for market-based instruments such as price premiums, niche marketing, and targeted value chain development to support on-farm conservation.

Finally, Tacconi et al. (2022) identify broader systemic barriers to on-farm agrobiodiversity, including inadequate infrastructure, weak institutional coordination, and policy neglect. These structural conditions not only affect cultivated diversity but also undermine the feasibility of integrating CWRs into diversified production systems. The study highlights the importance of context-specific, integrated policy strategies that address the real-world constraints faced by farmers managing diverse agroecosystems.

In summary, economic constraints are a critical bottleneck to the broader utilization of CWRs and associated biodiversity. Effective policy responses must include coordinated investment in infrastructure, targeted financial incentives, and regulatory reforms that lower barriers to participation in conservation and value chain integration.

Selected studies that document these barriers and propose relevant policy responses are summarized in Table 5.7.

Table 5.7. Studies on economic barriers and constraints to CWR utilization

Study (Title, Year)	Thematic Sub-Area	Key Finding/Content Summary	Policy Implication/Recommendation
Zhang et al. (2022). Opportunities and Challenges of Indigenous Food Plant Farmers in Integrating into Agri-Food Value Chains in Cape Town	Indigenous crops, Value chains, Institutional barriers	Identifies economic and institutional barriers hindering the commercialization of IFPs, such as complex licensing, limited seed access, and cultural perceptions.	Calls for policy reforms to simplify licensing, improve seed access, support grower capabilities, and promote cultural acceptance of IFPs.
Song et al. (2021). Policy-Oriented versus Market-Induced: Factors Influencing Crop Diversity across China	Policy incentives, Market dynamics, Crop diversity	Analyzes how government grain subsidies promoting monocropping have led to a decline in crop diversity by counteracting market forces that encourage diversification.	Recommends aligning policy incentives with market dynamics through regionally differentiated cropping regulations to enhance crop diversity.
Gauchan et al. (2005). Market-based incentives for conserving diversity on farms: The case of rice landraces in Central Tarai, Nepal	Market incentives, On-farm conservation, Rice landraces	Demonstrates that farmers' willingness to maintain rice landrace diversity depends on market incentives and price premiums, as well as risk mitigation.	Suggests introducing market-based instruments such as niche marketing, value-chain support, and price premiums to incentivize conservation of agrobiodiversity, including landraces and potentially CWRs.
Tacconi et al. (2022). Drivers and Constraints of On-Farm Diversity: A Review	On-farm diversity, Structural constraints, Agrobiodiversity	Reviews key constraints such as poor infrastructure, lack of market access, and insufficient policy support that hinder on-farm agrobiodiversity conservation.	Emphasizes the need for context-specific support and integrated strategies to reduce economic and infrastructural barriers to diversification.

5.4.4 Economic challenges and policy gaps

Despite the recognition of the value of CWRs and broader agrobiodiversity, significant economic challenges and policy gaps continue to hinder their effective conservation and utilization. These challenges stem from misaligned subsidy schemes, fragmented policy frameworks, and limited market support for diverse cropping systems. The studies in Table 5.8 highlight a range of structural and economic issues that must be addressed to unlock the full potential of CWRs and related agrobiodiversity for sustainable agriculture and food systems. Di Falco and Perrings (2005) highlight how agricultural assistance programs, particularly those aimed at stabilizing farm income or reducing risk, may inadvertently discourage biodiversity conservation. These programs frequently struggle to incorporate biodiversity goals adequately, resulting in the neglect of CWRs and other diverse genetic resources. Aligning subsidy schemes with conservation objectives is therefore essential to avoid undermining agrobiodiversity.

Gauchan et al. (2005) bring attention to the weak market incentives for farmers to maintain traditional varieties, which often share the conservation challenges of CWRs. In the absence of niche markets, price premiums, or value-added chains, the economic rationale for in situ conservation becomes tenuous. This underscores the need for market-based instruments that can complement regulatory approaches and make the maintenance of genetic diversity attractive in commercial terms.

Tacconi et al. (2022) emphasize structural and institutional limitations, including fragmented policy environments and lack of supportive infrastructure, that hinder the viability of diverse and resilient farming systems. Without integrated policies and better coordination among institutions, efforts to conserve CWRs or embed them within diversified cropping systems remain marginal. The authors recommend that future policies adopt an enabling framework, capable of addressing both infrastructural and economic bottlenecks.

Zhang et al. (2022) illustrate how economic and institutional barriers, such as complex licensing processes and limited seed system access, exclude underutilized and indigenous crops from formal value chains. These findings are highly relevant for CWRs, which often suffer from similar invisibility in both markets and policy agendas. Addressing these constraints requires comprehensive reforms that decrease entry barriers and provide incentives for the utilization of diverse genetic materials in commercial production.

Finally, Capitanio et al. (2016) provide evidence that CAP subsidy structures, by emphasizing productivity over crop diversity (which they characterize as “important public good”), may reduce spatial crop diversity on farms. This demonstrates the need to revisit subsidy rationale in the relevant policy frameworks and integrate incentives that actively promote crop diversification, including the use of CWRs and landraces.

The above-mentioned studies call for a forward-looking policy agenda that internalizes the economic value of agrobiodiversity, addresses systemic disincentives, and supports market and institutional innovations. Bridging these policy gaps is essential to ensure that CWRs will become functional components of resilient and sustainable agricultural systems.

Table 5.8 summarizes key economic challenges and related policy gaps as identified in the relevant literature.

Table 5.8. Studies on economic challenges and policy gaps

Study (Title, Year)	Gap Area	Key Gaps Identified	Policy Needs/Recommendations
Di Falco & Perrings (2005). Crop Biodiversity, Risk Management, and the Implications of Agricultural Assistance	Agricultural subsidies and biodiversity incentives	Demonstrates that agricultural assistance programs aimed at reducing revenue risk may unintentionally discourage biodiversity conservation, including the use of CWRs.	Recommends aligning risk-reduction schemes with biodiversity objectives to prevent negative impacts on agrobiodiversity.
Gauchan et al. (2005). Market-based incentives for conserving diversity on farms: The case of rice landraces in Central Tarai, Nepal	Market-based conservation, Incentives	It shows that farmers lack adequate market incentives to maintain genetic diversity due to weak value chains and absent price premiums.	Calls for policy support for niche markets, value-added chains, and price supports to make on-farm conservation economically viable.
Tacconi et al. (2022). Drivers and Constraints of On-Farm Diversity: A Review	Institutional and structural policy gaps	Finds that policy fragmentation and lack of institutional capacity undermine economic viability of diverse farming systems.	Advocates for integrated policies that reduce infrastructural and economic constraints to support diversification, including CWR integration.
Zhang et al. (2022). Opportunities and Challenges of Indigenous Food Plant Farmers in Integrating into Agri-Food Value Chains in Cape Town	Value chain access, Institutional and cultural barriers	Highlights economic and institutional exclusion of underutilized crops (analogous to CWRs) due to seed access issues, licensing barriers, and market invisibility.	Suggests reforms in licensing, seed systems, and support for commercialization to enable wider use of diverse genetic resources.
Capitanio et al. (2016). CAP Payments and Spatial Diversity in Cereal Crops: An Analysis of Italian Farms	Agricultural policy, CAP subsidy structure	Identifies that CAP subsidies can unintentionally reduce spatial crop diversity by favoring monocultures.	Proposes integrating crop diversification incentives into CAP design to enhance resilience and maintain agrobiodiversity.

The evidence shows that CWRs utilization can lead to productivity enhancement, breeding innovation, and provide crucial buffers against financial risks. Yet, major challenges persist. These are the limited market access, the insufficient incentives for farmers and breeders, and the misalignment of the relevant policies with the actual needs. Overcoming these barriers requires targeted policy reforms, the creation of robust market-based incentives, and significant investment to strengthen infrastructure and knowledge transfer.

5.5 Societal dimension

The societal value of CWRs is often the one that gets the least attention in relevant literature. However, it is recognized as a critical factor influencing the success of conservation and sustainable use strategies (Negi et al., 2013; Sharma et al., 2022; Ebert et al., 2023). A wide breadth of papers covers subjects related to the importance of cultural traditions, participatory approaches, and equitable access to CWR resources (Scaramuzzi et al., 2021). These studies underscore that the effectiveness of CWR strategies hinges not only on genetic and ecological factors, but also on the active involvement of people and communities. Whether through traditional seed systems, local knowledge, or inclusive decision-making, the societal context provides both the foundation and the enabling conditions for meaningful CWR engagement. This section brings together policy-relevant findings classified around four thematic categories, namely, cultural and traditional knowledge, stakeholder participation, social equity in access and use of CWR resources, and lastly, the identification of main societal challenges and policy gaps.

5.5.1 Cultural and traditional knowledge in CWR conservation

Upon examining the literature, it is noted that cultural and traditional knowledge systems play a fundamental role in the conservation and sustainable use of CWRs. These systems are shaped by generations of local observation, experimentation, and adaptation, embedding biodiversity management within the cultural identities and everyday practices of farming communities. For instance, Korpelainen et al. (2023), In the context of household food systems, show how home gardens function as decentralized, culturally embedded spaces for conserving plant genetic resources, including CWRs. These gardens are not only repositories of traditional varieties but also tools for food and nutrition security. The authors argue that it is important to recognize that home gardens and their plant genetic resources are dynamic systems, since they are influenced by cultural and social factors, as home gardens are typically managed by people having different goals and preferences, which change over time. The authors argue also for the inclusion of home gardens in biodiversity conservation strategic planning and support for the intergenerational transmission of local cultivation knowledge.

In the same context, González et al. (2022) examine family farming practices in Costa Rica as an expression of territorialized food systems rooted in cultural values. These systems help preserve native biodiversity and resist pressures from industrial monoculture expansion. As indicated in their study, traditional indigenous systems have been able to conserve natural resources, especially forest resources, while new peasant agriculture systems, yet to be consolidated, follow a diversified system that respects natural resources capable of developing healthy and sustainable agricultural production. The study emphasizes the importance of policies that strengthen the cultural and ecological functions of family farming landscapes.

Zimmerer (2014) further explores how agrobiodiversity is preserved across complex livelihood transitions, including migration and rural-to-urban shifts. They argue that cultural landscape knowledge is continuously adapted and mobilized through nontraditional networks, allowing for conservation practices that transcend spatial and economic constraints. This study offers new insights regarding the importance of social inclusion, participation, planning, and empowerment activities of specific groups that must be priorities in the delimitation, design, and deployment of agrobiodiversity management options and policy.

In Sri Lanka, Melvani et al. (2020) document how diverse livelihood strategies and traditional forest gardens enhance farmers' adaptive capacity to climate stress. These systems, reliant on high floristic diversity and local agroecological knowledge, are positioned as both biodiversity conservation tools and resilience strategies. Particularly, authors stress that the skills and knowledge of traditional farmers must be "harnessed" when shaping policies for climate resilient farming models characterized by higher plant and crop species richness and crop diversity.

Lastly, Nasab et al. (2022) present an ethnobotanical study of wild food plants in Sirjan, Iran, underscoring the importance of traditional plant use knowledge in local diets and cultural identity. Moreover, authors argue that there is an urgent need to review indigenous knowledge on the traditional uses of wild edible plants so as to apply this knowledge in modern agricultural policies. The authors warn of its erosion and advocate for policy measures that preserve and promote such knowledge through domestication and educational initiatives.

The above-mentioned studies demonstrate that cultural heritage and traditional ecological knowledge are not peripheral to conservation; they are central to the sustainable and inclusive governance of CWRs. Policy frameworks must move beyond technical interventions to embrace culturally embedded practices and community knowledge as core elements of biodiversity strategy.

Table 5.9 summarizes key contributions that highlight the relevance of traditional knowledge and cultural practices in CWR conservation.

Table 5.9. Studies on traditional knowledge and cultural practices

Study (Title, Year)	**Thematic Sub-Area**	**Key Finding/Content Summary**	**Policy Implication/Recommendation**
Korpelainen et al. (2023). The Role of Home Gardens in Promoting Biodiversity and Food Security.	Home gardens, In situ conservation, Cultural knowledge.	Highlights the role of home gardens as culturally rooted systems for conserving plant diversity, including CWRs, and enhancing household food security, especially in peri-urban and rural settings.	Suggests integrating home gardens into biodiversity policy frameworks and supporting local initiatives that preserve and transmit traditional cultivation knowledge.
González et al. (2022). Family Farming as a Key Element of the Multifunctional and Territorialized Agrifood Systems as Witnessed in the South Pacific Region of Costa Rica.	Family farming, Territorialized food systems, Cultural landscape management.	Examines how family farming contributes to agrobiodiversity and cultural preservation in Costa Rica, while facing pressure from industrial monocultures.	Advocates for policies that strengthen family farming systems, promote endogenous development, and safeguard multifunctional landscapes against industrial encroachment.
Zimmerer (2014). Conserving Agrobiodiversity amid Global Change, Migration, and Nontraditional Livelihood Networks:	Cultural landscape knowledge, Agrobiodiversity resilience.	Demonstrates how cultural landscape knowledge is adapted and shared across mobile and dispersed rural populations, maintaining biodiversity.	Advocates for policy frameworks that support nontraditional and trans local conservation practices grounded in community knowledge.

The Dynamic Uses of Cultural Landscape Knowledge.			
Melvani et al. (2020). Multiple Livelihood Strategies and High Floristic Diversity Increase the Adaptive Capacity and Resilience of Sri Lankan Farming Enterprises.	Forest gardens, Traditional agroecology, Climate resilience.	Demonstrates that Sri Lankan farmers employing diverse livelihood strategies and maintaining high floristic diversity, particularly through traditional forest gardens, exhibit greater resilience to climate variability.	Recommends integrating traditional agroecological practices into national adaptation strategies and supporting community-led conservation efforts.
Nasab et al. (2022). An Ethnobotanical Survey of Wild Food Plants in Sirjan, Kerman, Iran.	Wild food plants, Indigenous knowledge, Food security.	Documents the traditional knowledge of 66 local informants regarding 37 wild food plant species in Sirjan, highlighting their importance in daily diets and cultural practices. Emphasizes the need to preserve this knowledge for future food security.	Suggests exploring domestication and promotion of commonly used wild food species, integrating indigenous knowledge into modern agricultural policies.

5.5.2 Stakeholder participation and local engagement

Stakeholder participation and local engagement are essential pillars in the effective conservation and use of CWRs and broader agrobiodiversity. As the literature increasingly demonstrates, successful strategies are often grounded not only in scientific planning but in the meaningful involvement of farmers, communities, and local institutions who steward genetic resources on the ground. These actors bring experiential knowledge, adaptive practices, and social networks that are indispensable for dynamic conservation.

In this context, Jarvis et al. (2011) provide a foundational framework linking farmer engagement with the sustainable use of traditional crop varieties. Their framework is based on categorizing into four main groups the issues or constraints that farmers face, which may decrease their ability to benefit from the conservation and crop genetic resources within their agricultural production systems: (1) the lack of sufficient diversity of traditional crop varieties within the production system; (2) the lack of access by farmers to available diversity, (3) the limitations in information on and the performance of varieties available in key aspects, and, (4) the inability of farmers and communities to realize the true value of the materials they manage and use. Their heuristic approach emphasizes that on-farm conservation thrives under participatory conditions that empower farmers as active custodians of biodiversity.

Labeyrie et al. (2021), based on a literature review, analyze the role of agrobiodiversity networks that link farmers, researchers, and civil society actors. These multi-actor interactions foster collaborative knowledge production and innovation in biodiversity-based agriculture. The study underscores that such networks are key vehicles for enhancing farmers' access to agrobiodiversity and should be explicitly supported by agricultural policy frameworks.

Pautasso et al. (2013) offer a broad review of seed exchange networks and participatory approaches, emphasizing their role as informal institutions for biodiversity maintenance and genetic resource management. These networks promote resilience by enabling decentralized, farmer-led seed flows and innovation. The authors advocate for policy integration of these networks while preserving their adaptability and community-rooted character.

Llamas-Guzmán et al. (2022), in their work, provide a detailed case study from Mexico, illustrating how traditional seed exchange among farming households supports the maintenance of native maize, beans, and squash varieties. Maintaining native varieties and free exchange of seeds among farmers is key to preserving agrobiodiversity and achieving sustainable agriculture in peasant communities. They conclude that these seed exchange networks are not only repositories of genetic diversity, but also expressions of social cohesion and local identity. The study recommends legal recognition and targeted support for these grassroots seed systems.

Finally, Mburu and Wale (2006) examine the conditions under which local organizations comprising of farmers, local formal and informal institutions, and public conservators in Ethiopia and Kenya succeed in conserving crop genetic resources. Their findings reinforce the importance of building enabling institutional conditions tailored to local realities. Authors claim that such knowledge would be important in the setting up of relevant policy and institutional frameworks.

Together, these studies demonstrate that stakeholder participation is not a peripheral element but a central driver of agrobiodiversity conservation. Policies must go beyond top-down directives to cultivate inclusive, collaborative, and context-sensitive strategies that empower local actors and foster long-term sustainability.

Table 5.10 summarizes selected studies that emphasize the value of stakeholder participation and local engagement in advancing CWR-related goals.

Table 5.10. Studies on stakeholder participation and local engagement

Study (Title, Year)	Thematic Sub-Area	Key Finding/Content Summary	Policy Implication/Recommendation
Jarvis et al. (2011). An Heuristic Framework for Identifying Multiple Ways of Supporting the Conservation and Use of Traditional Crop Varieties within the Agricultural Production System.	Farmer participation, On-farm conservation, Seed systems.	Proposes a framework connecting farmer-led conservation with sustainable use of traditional varieties, highlighting diverse participatory pathways.	Recommends policies that enhance farmer access to genetic resources and institutional support for participatory approaches.
Labeyrie et al. (2021). Networking Agrobiodiversity Management to Foster Biodiversity-Based Agriculture: A Review.	Multi-actor governance, Knowledge networks.	Reviews the emergence of agrobiodiversity networks and their role in linking farmers, researchers, and NGOs for collaborative management.	Supports policy recognition of informal networks and recommends scaling up collaborative governance models.
Pautasso et al. (2013). Seed Exchange Networks for Agrobiodiversity Conservation: A Review.	Seed systems, Farmer networks, Informal institutions.	Reviews how seed exchange networks sustain agrobiodiversity, enabling adaptation and co-management of genetic resources.	Recommends integrating these networks into formal policy support while preserving their flexibility and autonomy.
Llamas-Guzmán et al. (2022). Seed Exchange Networks of Native Maize, Beans, and Squash in San Juan Ixtenco and San Luis Huamantla, Tlaxcala, Mexico.	Traditional seed systems, Community-based conservation.	Documents local seed exchange as a mechanism for conserving native crops and social cohesion.	Calls for public support and legal recognition of community seed practices.
Mburu & Wale (2006). Local Organizations Involved in the Conservation of Crop Genetic Resources: Conditions for Their Emergence and Success in Ethiopia and Kenya.	Local governance, Institutional development.	Analyzes enabling conditions for local organizations managing crop genetic resources, emphasizing stakeholder-driven strategies.	Suggests promoting context-specific support for local institutions in agrobiodiversity management.

5.5.3 Social equity and access to CWR resources

Social equity and fair access to CWRs and their benefits are fundamental to the sustainability and inclusiveness of agrobiodiversity conservation. The reviewed literature consistently points to persistent disparities in resource access, decision-making, and benefit-sharing among various social groups. The literature review reinforces findings from Section 4.3, particularly regarding inequitable access to genetic resources and the weak implementation of benefit-sharing mechanisms.

Against this backdrop, Richerzhagen et al. (2005) offer a detailed evaluation of Costa Rica's national ABS system and its alignment with international regimes. Their findings reveal that despite the country's early adoption of ABS mechanisms, practical challenges such as limited institutional coordination, lack of transparency on benefit sharing, and unequal benefit distribution persist. The study highlights the need for more coherent and enforceable ABS frameworks to ensure that access is fair and that benefits reach local stewards and indigenous communities.

The study by Zhang and Dannenberg (2022) explores the structural inequalities faced by indigenous food plant farmers in Cape Town of South Africa. These farmers face exclusion from regional commercial agri-food value chains due to inadequate institutional support, low market visibility, and resource constraints. The authors call for targeted policy interventions that enhance both market access and the legitimacy of indigenous food systems, since the (re-)introduction of indigenous food plants (IFPs) into agriculture can support a more sustainable and resilient food production.

Keleman (2010) examines how Mexico's agricultural policy reforms following the North American Free Trade Agreement (NAFTA) have systematically marginalized small-scale maize farmers, who steward and manage the country's reserve of maize (Zea mays) genetic diversity. By prioritizing industrial production (agricultural support is oriented primarily toward high-tech production) and export-oriented models (structural barriers to small-scale farmers' access to research and extension institutions), post-NAFTA policies have undermined on-farm conservation and discouraged in situ management of maize diversity. The study underscores the importance of policy coherence and inclusion in supporting smallholders, who act as de facto custodians of genetic diversity.

Together, these studies underline that achieving equity in CWRs conservation requires more than technical solutions. It demands deliberate attention to social structures, legal frameworks, and power dynamics that determine who has access to resources, decision-making processes, and benefits. Future policies must address these inequities to ensure that conservation outcomes are both effective and just.

Table 5.11 presents selected studies that examine social equity issues in relation to CWRs.

Table 5.11. Studies on social equity and access to CWR resources

Study (Title, Year)	Thematic Sub-Area	Key Finding/Content Summary	Policy Implication/Recommendation
Richerzhagen et al. (2005). The Effectiveness of Access and Benefit Sharing in Costa Rica: Implications for National and International Regimes.	Access and benefit sharing (ABS), International policy frameworks.	Assesses Costa Rica's ABS framework, highlighting implementation challenges related to equity, institutional coordination, and fairness in benefit distribution.	Recommends improving national ABS mechanisms and ensuring alignment with international obligations to promote fair access and equitable benefit sharing.
Zhang & Dannenberg (2022). Opportunities and Challenges of Indigenous Food Plant Farmers in Integrating into Agri-Food Value Chains in Cape Town.	Market inclusion, Indigenous food systems, Social justice.	Explores barriers faced by smallholder indigenous food plant farmers in entering urban value chains, including limited institutional support and market access.	Calls for targeted interventions to address systemic inequalities and enhance the visibility and viability of indigenous food systems.
Keleman (2010). Institutional Support and In Situ Conservation in Mexico: Biases Against Small-Scale Maize Farmers in Post-NAFTA Agricultural Policy.	Policy bias, Smallholder exclusion, In situ conservation.	Analyzes how post-NAFTA agricultural reforms have disadvantaged small-scale maize farmers, undermining their role in on-farm conservation.	Advocates for realigning agricultural policy to support smallholder-led biodiversity conservation through inclusive and localized support mechanisms.

5.5.4 Societal challenges and policy gaps

The effective conservation and use of CWRs and agrobiodiversity cannot be achieved without addressing the societal dimensions that influence access, stewardship, and participation. As the literature shows, systemic societal barriers—such as the underrecognition of traditional knowledge, the marginalization of local communities, and inadequate benefit-sharing mechanisms—can significantly undermine biodiversity policy goals.

According to the study of Jarvis et al. (2011), the need for institutional frameworks that recognize and support farmer-led conservation systems is critical to make conservation strategies inclusive and equitable. A key gap is the insufficient policy recognition and support for the knowledge, practices, and decision-making processes of farming communities. To bridge this gap, the authors call for inclusive policies that empower local actors, build on their experience, and strengthen their capacity to manage genetic resources. The policy implication derived from this study is to integrate these community-based efforts into national and global biodiversity frameworks, ensuring that farmers are not only participants but recognized stewards of agricultural diversity.

Wale (2008) focuses on the governance dimension, identifying fragmented policy-making processes and limited stakeholder involvement as key barriers to effective genetic resource management. Drawing from Ethiopian experience, the study calls for inclusive and transparent governance systems that empower local communities, civil society, and farmer organizations to actively shape biodiversity policies.

Richerzhagen et al. (2005) assess the implementation of ABS mechanisms in Costa Rica, one of the early adopters of such frameworks. The study highlights the gap between legal design and practical enforcement, noting that local knowledge holders often receive little in return due to institutional fragmentation and lack of capacity. Effective ABS requires not just policy commitments, but enforceable, equitable mechanisms that deliver tangible benefits to custodians of agrobiodiversity.

Zhang and Dannenberg (2022) explore the challenges faced by indigenous food plant farmers in South Africa. Their findings illustrate how structural exclusion from policy processes and formal markets constrains the visibility and viability of indigenous knowledge systems. To address these disparities, the study recommends targeted interventions that create space for indigenous producers within national food system policies.

Nasab et al. (2022) document the rich ethnobotanical knowledge in Iran related to wild food plants. However, they also show that this knowledge is at risk due to generational shifts, urbanization, and the lack of institutional recognition. Protecting and promoting traditional knowledge requires integrating it into formal conservation and education systems.

These gaps and challenges are illustrated by representative studies in Table 5.12 below.

Table 5.12. Representative studies on societal challenges and policy gaps

Study (Title, Year)	**Gap Area**	**Key Gaps Identified**	**Policy Needs/Recommendations**
Jarvis et al. (2011). An Heuristic Framework for Identifying Multiple Ways of Supporting the Conservation and Use of Traditional Crop Varieties within the Agricultural Production System.	Underrecognition of traditional knowledge systems.	Formal conservation undervalues local knowledge and lacks farmer-centered mechanisms.	Institutionalize participatory approaches (e.g., community biodiversity registers); provide legal and financial support for farmer-led conservation.
Wale (2008). Challenges in Genetic Resources Policy Making: Some Reflections Based on Lessons from Ethiopia.	Policy fragmentation and stakeholder exclusion.	Ineffective coordination and limited participation by farmers and civil society in policy processes.	Build inclusive governance systems that ensure meaningful participation of diverse stakeholders.
Richerzhagen et al. (2005). The Effectiveness of Access and Benefit Sharing in Costa Rica.	Inequitable benefit-sharing implementation.	ABS policies are inconsistently applied, limiting fair returns to local knowledge holders.	Strengthen enforceability and equity within ABS frameworks, ensuring benefits reach local communities.
Zhang & Dannenberg (2022). Opportunities and	Marginalization of	Indigenous farmers lack access to markets	Implement inclusive food system policies that legitimize

Challenges of Indigenous Food Plant Farmers in Cape Town.	indigenous knowledge and producers.	and recognition in formal policy.	and promote indigenous knowledge and access.
Nasab et al. (2022). An Ethnobotanical Survey of Wild Food Plants in Sirjan, Kerman, Iran.	Erosion of cultural and ecological knowledge.	Local plant-use traditions are disappearing due to lack of institutional support and cultural shifts.	Promote the legal protection and documentation of traditional knowledge within conservation programs.

In conclusion, the societal dimension must be fully integrated into CWR policy design and implementation. Traditional knowledge systems, community-based conservation, and equitable access mechanisms are not merely complementary—they are prerequisites for delivering inclusive, effective, and durable outcomes. The reviewed literature clearly supports the need for targeted policy measures: the legal recognition of traditional and local knowledge holders; institutional frameworks that ensure meaningful participation of farmers, civil society, and marginalized groups; and the development of fair and transparent benefit-sharing mechanisms.

6 Synthesis of existing findings and policy recommendations

6.1 Integration of project and literature evidence

A comparative review of project experiences (Section 4) and systematic literature analysis (Section 5) reveals strong convergence on the key enablers and persistent challenges affecting CWRs conservation and use. Both streams of evidence emphasize that durable progress depends on collaborative, multi-actor governance and on more effective policy integration across agricultural, biodiversity, and innovation sectors.

Projects and stakeholder consultations expose the complexities of fragmented policies, insufficient funding, and difficulties in scaling successful pilot actions. Stakeholder perspectives highlight the critical importance of supporting local knowledge systems, ensuring equitable benefit-sharing, and strengthening institutional capacity at all levels.

These practical lessons are echoed and deepened in the literature, which consistently documents the lack of integration of CWRs in breeding and conservation programmes, insufficient economic incentives for uptake, and participation gaps—particularly among marginalized groups. Policy incoherence, underinvestment, and the need for participatory, context-adapted approaches are cross-cutting themes in both evidence streams.

In summary, evidence from both practice and research demonstrates that barriers to effective CWR policy are multi-dimensional, interlinked, and require holistic, coordinated solutions.

6.2 Cross-dimensional synthesis

Table 6.1 synthesizes the main challenges and priority policy recommendations for the conservation and use of CWRs across environmental, economic, and societal dimensions. This synthesis intentionally integrates both the lessons learned from research projects documented in Section 4, and the systematic evidence and analysis presented in Section 5. By drawing on both practical experience and academic research, the table highlights areas of consensus, persistent barriers, and actionable steps that can support more effective and inclusive CWR strategies going forward.

Table 6.1. Cross-dimensional synthesis of the main challenges and priority policy recommendations for CWRs

Dimension	Key Challenges	Priority Policy Recommendations
Environmental	- Fragmented conservation strategies (in situ/ex situ) - Insufficient integration of CWRs into breeding programs - Policy incoherence- Underfunded long-term conservation.	- Integrate CWRs in all biodiversity/agriculture policies - Create stable, long-term funding mechanisms - Promote multi-level conservation approaches.
Economic	- Lack of economic incentives for adoption - Market failures for CWR-based innovations - High costs/risks of pre-breeding - Weak alignment of conservation and productivity goals.	- Provide market/regulatory incentives (e.g. subsidies, procurement) - Support pre-breeding and public-private partnerships - Align conservation with productivity benefits.
Societal	- Erosion of traditional/local knowledge - Limited stakeholder participation - Inequitable benefit-sharing - Weak capacity in local organizations- Social inequities.	- Recognize and support traditional knowledge holders - Institutionalize participatory governance - Develop transparent benefit-sharing frameworks - Build community capacity and promote inclusion.

6.3 Key takeaways for CWR policy action

Drawing together insights from projects' research efforts and the systematic literature review, several essential lessons emerge for shaping future CWR strategies:

- **Collaborative governance is essential:** Solutions with lasting impact depend on the active involvement of farmers, breeders, researchers, policymakers, and local communities in shared decision-making and implementation.
- **CWRs remain insufficiently mainstreamed in policy:** Both practical and research evidence find that CWRs are often overlooked or under-prioritized in major agricultural, environmental, and innovation frameworks.
- **Stable funding and sustained investment are missing:** Short project cycles and fragmented funding undermine long-term efforts.
- **The value of local and traditional knowledge is under-recognized:** Effective mechanisms for acknowledging and using community-based knowledge—especially from indigenous people—are rare.
- **Policy coherence across sectors is needed:** Aligning agriculture, biodiversity, and innovation policy is fundamental to unlocking the potential of CWRs.

Based on the integrated evidence from both project experience and systematic analysis, the following actions are recommended for policymakers, practitioners, and the research community:

- **Integrate CWR objectives at all governance levels,** ensuring that conservation and sustainable use of CWRs are embedded in agricultural, biodiversity, and climate strategies.
- **Establish long-term, stable funding mechanisms** to support research, breeding, conservation, and innovation related to CWRs.
- **Institutionalize participatory platforms** for the co-design and implementation of CWR policy, involving all relevant stakeholders, including marginalized groups and traditional knowledge holders.
- **Promote knowledge exchange and capacity-building,** particularly for local actors and knowledge holders, with explicit attention to gender equity and inclusion.
- **Strengthen cross-sectoral policy alignment** through enhanced collaboration among ministries and agencies responsible for agriculture, biodiversity, and innovation.
- **Provide market and regulatory incentives** for the development and adoption of CWR-derived crops and practices, including support for value chains.
- **Ensure transparent and equitable benefit-sharing frameworks,** with particular focus on communities that conserve and steward CWRs.

7 Conclusions

The conservation and sustainable use of CWRs stands at a pivotal moment for European and global agri-food systems. The insights gathered in this deliverable underscore that effective action is both possible and necessary—provided it is grounded in collaboration, coherent policy, and genuine inclusion.

Moving forward, it is crucial that policymakers, researchers, and practitioners shift from fragmented, short-term approaches to long-term, systemic strategies. This means fostering stronger integration of CWRs into mainstream policy agendas, building durable funding and governance structures, and ensuring that all stakeholder voices—especially those of local communities and knowledge holders—shape the solutions.

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9 ANNEX

Table 9.1. Titles of Included Studies and Main Policy Outcomes/Implications

No.	Title (Year)	Policy Outcomes & Implications
1	A Critical Analysis on Multifaceted Benefits of Mixture of Cover Crops over Pure Stand (2022).	Implementing policies that promote cover crop mixtures can lead to improved soil health, increased biodiversity, and more resilient cropping systems.
2	A multi-taxon analysis of European Red Lists reveals major threats to biodiversity (2023).	Policies needed to promote sustainable agriculture and habitat conservation.
3	A Multifaceted Evaluation Approach for Greek Native Neglected and Underutilized Forest Fruit Trees and Shrubs as Natural Sources of Antioxidants (2023).	Encourages policy support for the cultivation, commercialization, and conservation of native underutilized species. Demonstrates economic and biodiversity benefits that align with national and regional sustainability goals.
4	A Policy Analysis to Promote Conservation and Use of Small Millet Underutilized Species in India (2017).	Calls for reforms to promote small millets through food security integration and institutional capacity strengthening.
5	Adapting Wild Biodiversity Conservation Approaches to Conserve Agrobiodiversity (2024).	Implementing adapted conservation approaches could enhance the preservation of agrobiodiversity, contributing to food security, climate resilience, and sustainable development goals.
6	Agricultural Biodiversity and Farm Level Technical Efficiency: An Empirical Investigation (2017).	Findings imply that promoting biodiversity may reduce poverty, improve resilience, and mitigate deforestation pressures, supporting broader development and conservation goals.
7	Agricultural Public Policy: Green or Sustainable? (2014).	Findings show that grassland subsidies are generally effective under both green and sustainable goals. For moderate biodiversity targets, crop subsidy reductions are cost-effective from a green perspective, while grassland subsidies remain key to social equity and sustainability.
8	Agricultural Wilding: Rewilding for Agricultural Landscapes Through an Increase in Wild Productive Systems (2021).	Proposes agricultural wilding as a tool for enhancing in situ conservation of CWRs and improving landscape connectivity. Supports biodiversity-friendly agriculture and policy innovation for rewilding practices.
9	Agrobiodiversity-Oriented Food Systems between Public Policies and Private Action: A Socio-Ecological Model for Sustainable Territorial Development (2021).	Highlights the importance of coordinated public-private efforts to support agrobiodiversity conservation and suggests policies recognizing agrobiodiversity resources as territorial commons.
10	Agroecology and Sustainable Livelihoods: Towards an Integrated Approach to Rural Development (2011).	Supports the design of holistic agricultural and rural development policies by merging ecological and socio-economic sustainability concepts.

11	An Ethnobotanical Survey of Wild Food Plants in Sirjan, Kerman, Iran (2022).	Implementing policies that encourage the cultivation and sustainable use of wild food plants can contribute to dietary diversity, conservation of plant biodiversity, and preservation of cultural heritage.
12	An Heuristic Framework for Identifying Multiple Ways of Supporting the Conservation and Use of Traditional Crop Varieties within the Agricultural Production System (2011).	Supports policies that enable access to diverse genetic materials, participatory methods, and benefit sharing to sustain agricultural biodiversity.
13	An inventory of crop wild relatives of the Maltese Islands (2022).	Provides actionable baseline data for conservation planning and prioritization. Stresses the importance of targeted conservation for high-potential or endangered taxa.
14	Assessing the Effectiveness of Projects Supporting On-Farm Conservation of Native Crops: Evidence From the High Andes of South America (2015).	On-farm conservation projects can enhance crop biodiversity while improving rural livelihoods, offering a viable policy tool for sustainable development.
15	Barley Landraces: Ecological Heritage for Edaphic Stress Adaptations and Sustainable Production (2020).	Implementing supportive policies could lead to the development of crop varieties better adapted to edaphic stresses, thereby promoting sustainable production and food security.
16	Beyond Subsistence: The Aggregate Contribution of Campesinos to the Supply and Conservation of Native Maize Across Mexico (2021).	Implementing supportive policies could enhance the conservation of maize genetic diversity, strengthen food security, and improve the livelihoods of smallholder farmers.
17	Beyond Yield: Plant Disease in the Context of Ecosystem Services (2009)	Advocates for conservation-based and integrative plant disease policies that balance productivity and sustainability goals.
18	Biodiversity Conservation and Productivity in Intensive Agricultural Systems (2007).	Shows that biodiversity-friendly practices may enhance long-term productivity, encouraging policies that reconcile conservation with high-yield agriculture.
19	CAP Payments and Spatial Diversity in Cereal Crops: An Analysis of Italian Farms (2016).	Finds that specific CAP measures positively affect crop diversity, which has implications for biodiversity and sustainable farming practices.
20	Challenges in Genetic Resources Policy Making: Some Lessons from Participatory Policy Research with a Special Reference to Ethiopia (2008).	Suggests that participatory approaches improve policy outcomes by aligning conservation strategies with community needs and ecological realities.
21	Challenges of In Situ Conservation of Crop Wild Relatives (2008).	Identifies key policy gaps and proposes strategic integration of CWR conservation into biodiversity strategies at national and international levels.

22	Climate Change Adaptation: A Global Review of Farmers Strategies (2023).	Poorly designed adaptation policies may lead to maladaptation. Emphasizes the role of institutional and policy support for effective farmer-led adaptation.
23	Co-benefits and trade-offs between agriculture and conservation: A case study in Northern Australia (2015).	The study provides insights into how agricultural policies can be designed to achieve co-benefits for conservation, suggesting that recognizing and managing trade-offs is crucial for sustainable development.
24	Comparing Wild and Cultivated Food Plant Richness Between the Arid American and the Mesoamerican Centers of Diversity, as Means to Advance Indigenous Food Sovereignty in the Face of Climate Change (2022).	Incorporating traditional knowledge and diverse food plant species, including CWRs, into agricultural policies can strengthen Indigenous food sovereignty, enhance food security, and improve adaptation strategies to climate variability.
25	Conservation and Sustainable Use of Crop Wild Relatives (2007).	Supports integration of CWRs into broader conservation agendas and highlights gaps in current legal structures; emphasizes coordination across scales.
26	Conserving Agrobiodiversity amid Global Change, Migration, and Nontraditional Livelihood Networks: The Dynamic Uses of Cultural Landscape Knowledge (2014).	Recommends adaptive policies that consider the social and spatial complexity of rural-urban migration and its effects on conservation.
27	Conserving Wild Arabica Coffee: Emerging Threats and Opportunities (2017).	Promotes community-based conservation and policies mitigating forest loss and climate risks to conserve wild coffee populations.
28	Contribution of Wheat Diversity to Total Factor Productivity in China (2002).	Reinforces the importance of maintaining crop genetic diversity as a foundation for sustainable productivity gains in agriculture.
29	Critical Review of the Increasing Complexity of Access and Benefit-Sharing Policies of Genetic Resources for Genebank Curators and Plant Breeders–A Public and Private Sector Perspective (2023).	Expanding the ITPGRFA to cover all plant genetic resources and implementing standardized agreements could enhance plant breeding efforts and contribute to global food security.
30	Crop and Income Diversification for Rural Adaptation: Insights from Ugandan Panel Data (2022).	Implementing policies that promote moderate crop diversification alongside income diversification can improve farmers' welfare and reduce vulnerability to climate shocks.
31	Crop Biodiversity Repercussions of Subsidized Organic Farming (2013).	Challenges assumptions about organic farming and biodiversity; calls for refined CAP policies to better support crop genetic diversity.
32	Crop Biodiversity, Productivity and Production Risk: Panel Data Micro-Evidence from Ethiopia (2012).	Indicates that biodiversity-supportive policies can promote sustainable agriculture by improving productivity and fostering in situ conservation.

33	Crop Biodiversity, Risk Management, and the Implications of Agricultural Assistance (2005).	Policies designed to reduce revenue risk may unintentionally discourage biodiversity-conserving behaviors, calling for a better alignment of economic and ecological objectives.
34	Crop species diversity: A key strategy for sustainable food system transformation and climate resilience (2024).	Supportive policies promoting species diversification for food security and biodiversity conservation.
35	Crop Wild Relatives: A Valuable Source of Tolerance to Various Abiotic Stresses (2023).	Advocates for the conservation and utilization of CWRs as a means to enhance crop resilience, aligning with policies promoting agrobiodiversity and sustainable agriculture. Highlights the need for supportive policies that facilitate the incorporation of CWRs into breeding programs to address challenges posed by climate change.
36	Crop-Diversity and Cereal Production under the CAP Reform: Evidence from Italy (2014).	Finds that CAP reforms have led to increased crop diversity and revenue stability for farmers, supporting both environmental and economic goals.
37	Decoding Seed Quality: A Comparative Analysis of Seed Marketing Law in the EU and the United States (2021).	The analysis suggests that the EU's stringent seed certification requirements may hinder the preservation of conservation varieties, whereas the U.S.'s flexible approach could facilitate greater biodiversity.
38	Demystifying the Advanced Interventions of Genetics and Modern Breeding Approaches for Nutritional Security and Sustainability of NUCS (2023).	Advocates for developing strategies and policies to support collection, conservation, and genetic analysis of NUCS. Highlights the importance of involving farmers and community organizations in breeding processes. Emphasizes the need for policies that recognize and promote the economic, cultural, and export potential of NUCS.
39	Diverse Varieties and Diverse Markets: Scale-related Maize "Profitability Crossover" in the Central Mexican Highlands (2013).	Supports differentiated policy frameworks that favor landrace cultivation for smallholders and reflect market diversity.
40	Diversifying Food Systems in the Pursuit of Sustainable Food Production and Healthy Diets (2017)	Promotes policies encouraging crop diversification and sustainable production for improved nutrition and environmental outcomes.
41	Drivers and Constraints of On-Farm Diversity: A Review (2022).	Highlights the necessity for context-specific policies that balance the benefits of diversification and specialization, considering local environmental and socio-economic conditions.
42	Earth Observation Based Multi-Scale Analysis of Crop Diversity in the European Union: First Insights for Agro-Environmental Policies (2024).	Integrating EO-based crop diversity assessments can enhance the effectiveness of policies aimed at promoting agricultural biodiversity and sustainability, including CWR conservation.
43	Evaluating Plant Genetic Diversity Maintained by Local Farmers and Residents (2020).	Proposes policy support for community seed-saving initiatives and farmer participation in agrobiodiversity programs.

44	Ex Situ and In Situ Conservation of Agricultural Biodiversity: Major Advances and Research Needs (2010).	Recommends creation of national action plans for CWRs, integration into sectoral plans, and improved global coordination through platforms such as the CWR Global Portal.
45	Exploring molecular, morphological, and biochemical diversity of Phaeolus vulgaris landraces cultivated in the Aniene Valley (Lazio region, Italy) (2024).	The findings suggest that preserving the genetic diversity of local landraces can enhance agricultural resilience and sustainability, informing policy decisions on biodiversity conservation.
46	Extensive Mediterranean agroecosystems and their linked traditional breeds: Societal demand for the conservation of the Majorcan black pig (2022).	Highlights the importance of integrating public conservation funding with product innovation and premium niche markets to enhance agroecosystem sustainability.
47	Family Farming as a Key Element of the Multifunctional and Territorialized Agrifood Systems as Witnessed in the South Pacific Region of Costa Rica (2022).	Implementing supportive policies could strengthen family farming models, promote sustainable agricultural practices, and contribute to the conservation of biodiversity and cultural heritage in rural landscapes.
48	Farmers' Preferences for Crop Variety Traits: Lessons for On-Farm Conservation and Technology Adoption (2010).	Supports the development of farmer-centered policies for conserving crop diversity and guiding technology adoption in traditional farming systems.
49	Farmers' Adoption of Maize (Zea mays L.) Hybrids and the Persistence of Landraces in Southwest China: Implications for Policy and Breeding (2012).	Supports on-farm conservation and policies that integrate farmers' preferences and traditional knowledge into breeding programs.
50	Food Security and Biodiversity: Can We Have Both? An Agroecological Analysis (2011).	Proposes that agricultural policies supporting agroecological systems can enhance food security and biodiversity simultaneously.
51	Fostering in situ conservation of wild relatives of forage crops (2023).	Implementing bottom-up, auction-based conservation programs can effectively engage landowners in preserving CWRs, suggesting that such market-driven approaches may enhance the sustainability and scalability of conservation efforts.
52	From 'Farm to Fork': Exploring the Potential of Nutrient-Rich and Stress-Resilient Emergent Crops for Sustainable and Healthy Food in the Mediterranean Region in the Face of Climate Change Challenges (2024).	Encourages tailored policies and funding to promote the cultivation and commercialization of emergent crops, contributing to food system sustainability, climate adaptation, and public health.
53	Functional Agrobiodiversity and Agroecosystem Services in Sustainable Wheat Production: A Review (2014).	Suggests that promoting functional agrobiodiversity through appropriate policies can lead to more sustainable and resilient wheat production systems by enhancing agroecosystem services.

54	Getting (ECO)Ready: Does EU Legislation Integrate Up-to-Date Scientific Data for Food Security and Biodiversity Preservation Under Climate Change? (2024).	Implementing real-time monitoring tools and integrating emerging technologies can enhance sustainability, benefiting biodiversity and food security within the EU.
55	Haitian Coffee Agroforestry Systems Harbor Complex Arabica Variety Mixtures and Under-Recognized Genetic Diversity (2024).	Highlights the potential for developing conservation strategies and policies that integrate traditional farming practices to preserve coffee genetic diversity.
56	Homegarden agroforestry systems in achievement of Sustainable Development Goals: A review (2022).	Integrating homegarden systems into policies for food security and agrobiodiversity conservation.
57	How Agricultural Research Systems Shape a Technological Regime That Develops Genetic Engineering but Locks Out Agroecological Innovations (2009).	Suggests the need for inclusive and pluralistic research policies that promote agroecological innovations supportive of biodiversity and sustainability.
58	How has the consistency of the Common Catalogue of varieties of vegetable species changed in the last ten years? (2021).	The increase in hybrid varieties suggests a trend towards homogenization, which may impact agricultural biodiversity. The study implies a need for policies that support the conservation of traditional varieties.
59	How Policies Affect the Use of Plant Genetic Resources: The Experience of the CGIAR (2013).	Demonstrates how restrictive policies may hinder PGRFA distribution and utilization, which could reduce innovation in agricultural research and limit climate resilience.
60	Institutional Support and In Situ Conservation in Mexico: Biases Against Small-Scale Maize Farmers in Post-NAFTA Agricultural Policy (2010).	Calls for policy reforms that support small-scale farmers and recognize their role in conserving agrobiodiversity.
61	Intraspecific Diversity as a Reservoir for Heat-Stress Tolerance in Sweet Potato (2021).	Emphasizes the need for policies that support conservation of crop genetic resources, especially traditional and locally adapted varieties. Suggests integrating heat-tolerant cultivars into breeding and extension programs to support adaptation.
62	Key Factors Affecting Farmers' Choice of Corn Reduction under China's New Agriculture Policy in the 'Liandaowan' Areas, Northeast China (2019).	Findings indicate that existing incentives may be insufficient; improved extension services, economic support, and viable crop alternatives are needed to encourage diversification.
63	Local Organizations Involved in the Conservation of Crop Genetic Resources: Conditions for Their Emergence and Success in Ethiopia and Kenya (2006).	Recommends policies that incentivize community engagement and institutional support to strengthen local genetic resource conservation.

64	Long-term Trends in Functional Crop Diversity Across Swedish Farms (2023).	Emphasizes the need for policies promoting the cultivation of functionally diverse crops to enhance ecosystem services and agricultural sustainability. Suggests that policies should consider functional traits of crops to achieve ecological and agronomic benefits.
65	Maize (Zea mays L.) Management in Yaxcaba, Yucatan, During the Twenty-First Century's First Decade Is Consistent with an Overall Loss of Landrace Diversity in Southeast Mexico (2018).	Highlights the urgent need for conservation strategies aimed at preserving maize landrace diversity in Mexico.
66	Market-based incentives for conserving diversity on farms: The case of rice landraces in Central Tarai, Nepal (2005).	Suggests that market incentives may not be broadly effective unless carefully tailored to specific landraces and integrated with other policy measures.
67	Multiple Livelihood Strategies and High Floristic Diversity Increase the Adaptive Capacity and Resilience of Sri Lankan Farming Enterprises (2020).	Policies should integrate traditional knowledge and practices. Advocates for engaging farmers in the planning of climate-resilient agriculture.
68	Networking Agrobiodiversity Management to Foster Biodiversity-Based Agriculture: A Review (2021).	Calls for policy designs that support social networks among farmers to enable agrobiodiversity exchange and knowledge sharing. Proposes the integration of social-ecological network analysis into policy development.
69	New Services and Roles of Biodiversity in Modern Agroecosystems: A Review (2018).	Supports the development and implementation of biodiversity-inclusive agricultural policies to ensure sustainability and ecosystem service provision.
70	No hay ganancia en la milpa: The Agrarian Question, Food Sovereignty, and the On-Farm Conservation of Agrobiodiversity in the Guatemalan Highlands (2010).	Without supportive policy, market integration may undermine crop diversity. Suggests dual objectives of economic development and biodiversity conservation.
71	Opportunities and Challenges of Indigenous Food Plant Farmers in Integrating into Agri-Food Value Chains in Cape Town (2022).	Advocates for policy reforms to simplify harvest licensing procedures, facilitate access to seeds and cuttings, and promote educational initiatives for consumers and producers.
72	Palaeoecology and GIS Modeling Reveal Historic Grasslands as “Hotspots” of Biodiversity and Plant Genetic Resources (2017).	Emphasizes the importance of conserving ancient, species-rich grasslands as a core strategy for in situ biodiversity conservation and supporting sustainable agroecosystems.
73	Past and Current Dynamics of U.S. Agricultural Land Use and Policy (2020).	Highlights how policy shifts have influenced agricultural specialization and landscape simplification, with implications for ecosystem services and sustainability.
74	Plant Genetic Resources in a Touristic Island: The Case of Lefkada (Ionian Islands, Greece) (2013).	Proposes that landrace conservation can be enhanced through tourism-linked value chains, raising awareness and economic incentives for preservation.

75	Plant Genetic Resources of Lemnos (Greece), an Isolated Island in the Northern Aegean Sea, with Emphasis on Landraces (2012).	Underscores the need for targeted conservation actions and potential integration of traditional knowledge into genetic resource policies.
76	Policy-Oriented versus Market-Induced: Factors Influencing Crop Diversity across China (2021).	Government subsidies can reduce crop diversity, undermining sustainable agricultural practices. Market incentives may support crop substitution and diversity. Policy coordination is essential to balance food security and sustainability.
77	Population and Environmental Correlates of Maize Yields in Mesoamerica: A Test of Boserup's Hypothesis in the Milpa (2015).	Supports the importance of traditional diversified systems for maintaining agrobiodiversity under demographic pressure, indirectly relevant to conservation policy.
78	Possibilities and Reality of On-Farm Conservation (2010).	Highlights on-farm conservation as a viable complement to ex situ strategies; emphasizes the role of multi-sector collaboration in biodiversity preservation.
79	Potential of Underutilized Grain Crops in the Western Mountains of Nepal for Food and Nutrient Security (2023).	Implementing supportive policies could improve the livelihoods of local farmers, promote biodiversity, and address malnutrition and food insecurity in marginalized areas.
80	Progress and Prospects in Harnessing Wild Relatives for Genetic Enhancement of Salt Tolerance in Rice (2024).	Implementing policies promoting the use of wild rice relatives can lead to the development of salt-resilient rice cultivars, improving productivity in salt-affected areas and contributing to global food security.
81	Projecting the Effects of Climate Change on the Distribution of Maize Races and Their Wild Relatives in Mexico (2012).	Demonstrates need for proactive conservation policy under climate change; provides evidence to guide resource prioritization.
82	Reconciling Nature Conservation and Traditional Farming Practices: A Spatially Explicit Framework to Assess the Extent of High Nature Value Farmlands in the European Countryside (2015).	Presents a spatially explicit framework for assessing HNV farmlands, which can enhance the targeting and implementation of agri-environment schemes and inform conservation and rural development policies.
83	Seed exchange networks for agrobiodiversity conservation. A review (2013).	Advocates for policies that support the preservation and sustainable use of traditional crop varieties through the understanding and strengthening of seed exchange networks.
84	Seed Exchange Networks of Native Maize, Beans, and Squash in San Juan Ixtenco and San Luis Huamantla, Tlaxcala, Mexico (2022).	Implementing policies that recognize and bolster informal seed exchange networks can enhance the conservation of native crop varieties and support sustainable agricultural practices.
85	Socio-Ecological and Religious Perspective of Agrobiodiversity Conservation: Issues, Concern and	Encourages policy shifts that support agrobiodiversity and sustainability in mountain agriculture by empowering local knowledge systems.

	Priority for Sustainable Agriculture, Central Himalaya (2012).	
86	Spatial Analyses of Occurrence Data of Crop Wild Relatives (CWR) Taxa as Tools for Selection of Sites for Conservation of Priority CWR in Zambia (2019).	Scientific basis for prioritizing CWR conservation; informs designation of in situ conservation sites and ex situ collection strategies.
87	Sustainability Potential of Marginal Areas for Food, Feed, and Non-Food Production in the Puglia Region, Southern Italy: Part II: A Review (2024).	Implementing supportive policies could enhance the economic role of small-scale farms, promote the use of local crop varieties, and contribute to environmental protection and biodiversity conservation.
88	Temporal and regional shifts of crop species diversity in rainfed and irrigated cropland in Iran (2022).	Encouraging crop diversification can enhance resilience against climate variability and disease outbreaks, contributing to more stable agricultural production systems.
89	The Agricultural Biodiversity Policy Development Process: Exploring Means of Policy Development to Support the On-Farm Management of Crop Genetic Diversity (2009).	The study emphasizes the importance of situation analysis as a tool to identify areas for policy intervention and discusses strategies for locally-tailored policy development and reform. It highlights the need to build on existing policies and programs to support on-farm conservation efforts.
90	The Effectiveness of Access and Benefit Sharing in Costa Rica: Implications for National and International Regimes (2005).	Effective ABS requires clarity in legal frameworks, strong enforcement, and equity in negotiating benefit-sharing to support biodiversity goals.
91	The History and Pedigree of Australian Lentil Cultivars (2024).	Emphasizes the importance of policies that support genetic diversity conservation, international collaboration, and the development of disease-resistant cultivars to ensure sustainable lentil production.
92	The Impacts of Management and Site Conditions on the Phytodiversity of the Upper Montane and Subalpine Belts in the Central Greater Caucasus (2014).	Highlights the role of traditional agro-pastoral practices in conserving plant biodiversity; suggests potential integration in sustainable land-use policy.
93	The Intersection of Food Security and Biodiversity Conservation: A Review (2017).	Highlights the importance of joint strategies that avoid sacrificing biodiversity for productivity and vice versa.
94	The Management of Tree Genetic Resources and the Livelihoods of Rural Communities in the Tropics: Non-Timber Forest Products, Smallholder Agroforestry Practices and Tree Commodity Crops (2014).	Highlights the need for integrated conservation policies and local-level strategies to sustain genetic diversity and rural benefits.

95	The Role of Home Gardens in Promoting Biodiversity and Food Security (2023).	Supporting the role of home gardens can enhance biodiversity conservation and sustainable food systems.
96	The Role of Vegetable Genetic Resources in Nutrition Security and Vegetable Breeding (2020).	Implementing policies that support the conservation and use of vegetable genetic resources can lead to more diverse and resilient agricultural systems, improved nutrition, and strengthened informal seed sectors.
97	The Technical and Economic Effects of Biodiversity Standards on Wheat Production (2024).	Highlights the potential trade-offs between implementing biodiversity standards and maintaining agricultural productivity. Provides evidence-based insights that can guide policymakers in designing and promoting standards that balance environmental benefits with economic viability for farmers.
98	Toward the Next Angiosperm Revolution: Agroecological Food Production as a Driver for Biological Diversity (2023).	Policies encouraging the use of crop wild relatives in breeding and the design of agricultural landscapes that support biodiversity could lead to more resilient and sustainable food systems.
99	Transgenic Crops, Production Risk, and Agrobiodiversity (2016).	Points to potential biodiversity risks from transgenic crop dominance and suggests incorporating biodiversity concerns in biotechnology policies.
100	Understanding farmers' cropping decisions and implications for crop diversity conservation: Insights from Central India (2021).	Conservation efforts should align with farmers' decision-making processes.
101	Wild Food Plants of Bhil and Bhilala Ethnic Community of Western Madhya Pradesh, India – An Implication for Food Security (2025).	Recognizing and incorporating the use of wild food plants can contribute to diversified diets and improved nutrition among indigenous populations, enhancing food security.