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Community seedbanks in Europe: their role between *ex situ* and on-farm conservation

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Abstract: This article enlightens the role of community seedbanks (CSBs) in Europe within the plant genetic resources for food and agriculture community and their role in the conservation and sustainable use of agrobiodiversity in complementarity with the *ex situ* management system. For more than 40 years, CSBs around the world have emerged as part of the so-called informal seed system to counteract the loss of locally adapted varieties through the development of collective seed systems. Most of the studies and articles refer to experiences from the Global South, whereas a comprehensive analysis of the impact and role of CSBs on seed systems in industrialized countries is still missing. This paper provides three case studies describing the community seed banking experience of different European organizations: Pro Specie Rara (Switzerland), Arche Noah (Austria) and Rete Semi Rurali (Italy). These organizations exemplify the diversity among European CSBs and their efforts to engage with genebanks and the formal seed system.

Keywords: community seedbanks, agrobiodiversity, participatory plant breeding, on-farm conservation, seed networks

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Introduction

This article describes the role of community seedbanks (CSBs) in Europe in the plant genetic resources for food and agriculture (PGRFA) community and their contribution to the conservation and sustainable use of agrobiodiversity in complementarity with the *ex situ* management system. Recently, two EU Horizon projects (DYNAVERSITY: www.dynaversity.eu and Farmers' Pride: https://more.bham.ac.uk/farmerspride/) have worked on this complementarity promoting the emergence of a European network of actors involved in PGRFA conservation and use. Both projects have involved CSBs in their activities and developed manuals and guidelines for the management of CSBs in connection with public genebanks. But what are the main differences between CSBs and genebanks?

If the complementarity between *ex situ* and on-farm conservation of PGRFA has been accepted by the scientific community in the last 20 years, less attention has been given to investigating the role of CSBs in relation to these two systems. Only a few scholars have studied such collective endeavours (Vernooy *et al*, 2015) while national seed policies hardly include CSBs among the relevant institutions for conservation and sustainable use of PGRFA. A quantitative study on the impact of CSBs and civil society organizations (CSOs) in the European conservation system of PGRFA is still lacking. Many questions about their role can be addressed. How can they act as an intermediate between genebanks and farmers/gardeners? How can they increase the awareness of citizens on biodiversity conservation? How can they work with public research centres to support participatory plant breeding programmes? How can they diversify European seed systems and, subsequently, food systems?

It becomes important to better understand the functions as well as the practical and collective actions of CSBs, based on concrete experiences. This article aims to fill this gap, presenting three case studies from Italy, Switzerland and Austria, based on the

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personal experiences of the authors, who work with the three organizations, and on the results of surveys and workshops organized within the framework of four EU-funded research projects – DIVERSIFOOD (https://diversifood.eu/), DYNAVERSITY, Farmers' Pride and PRO-GRACE (https://www.grace-ri.eu/pro-grace).

Genebanks and CSBs should not be considered as competitors but as complementary actors, each having specific objectives, targets and rules as summarized in Table 1 (Bartha *et al*, 2021). Perhaps the most relevant difference is that genebanks are committed to the long-term conservation of PGRFA and to granting facilitated access to a wide range of users, while CSBs aim at short-term conservation and easy availability of seed for the aims of the community managing the CSB. This complementarity means that together, they can contribute to creating inclusive and integrated conservation strategies at national and regional levels.

Community seedbanks in Europe

For more than 40 years, CSBs around the world have emerged as part of the so-called informal seed system to counteract the loss of locally adapted varieties through the development of collective seed systems (Vernooy *et al*, 2015). Most of the studies and articles on the subject refer to experiences from the Global South. However, a comprehensive analysis of the impact and role of CSBs on seed systems in industrialized countries is still missing.

In 2017, within the framework of the European project DIVERSIFOOD, a group of seed networks including Arche Noah, Rete Semi Rurali (RSR), ProSpecieRara (PSR), Réseau Semences Paysannes (RSP) and Red de Semillas (RdS) organized a regional survey on CSBs in Europe, to start understanding their distinctive features. The results of the survey, briefly presented in this paper, showed the great diversity of initiatives in terms of age, size and internal structures. Differences emerged also in their approaches to PGRFA management, with some leaning towards a more 'dynamic management' approach. Since 2005, the number of CSBs in Europe seems to be rapidly growing, at least in some regions (Koller and Bocci, 2018).

The first CSBs in Europe were established in Northern and Central European countries (Austria, Denmark, Germany, the Netherlands, Sweden, Switzerland, United Kingdom), mainly by seed saver organizations and managed by gardeners. The US-based Seed Savers Exchange inspired the birth of many of these organizations. The UK Garden Organic's Heritage Seed Library, known at the time as Henry Doubleday Research Association, was founded in 1975. ProSpecieRara (Switzerland) was founded in 1982 and Arche Noah (Austria) in 1990. Since then, other organizations have sprung up in European countries, with an accelerated increase occurring since the mid-2000s, especially in France and Spain. The DIVERSIFOOD survey was able to map only a few experiences from south-eastern Europe.

The survey revealed that there is not one type of CSB that fits all. This diversity is related to the fact that CSBs in Europe have followed two different pathways. In the older CBSs in Europe, mainly from central and northern Europe, private gardeners had a key role, following the example of the seed savers in Australia and the USA. On the contrary, in southern Europe small farmers played a major role, adapting the experiences of social movements in the Global South, where CSBs emerged to provide seeds to farmers in marginal areas or after conflict. However, most experiences converge around the key ideas of diversity, conservation, exchange, community and sovereignty. Regardless of the crop, most of the accessions they conserve are landraces, farmers' varieties, old commercial varieties (open-pollinated varieties) or breeding populations.

What is important to note is that many initiatives have moved from just conservation to more dynamic approaches, where participatory and decentralized plant breeding plays an increasing role. This change was achieved through dedicated training activities for all the members of the CSBs, which raised awareness of breeding for diversity and local adaptation. Many CSBs have also been able to create strong links with citizens, often using public campaigns focused on the importance of plant and seed diversity, and protecting local varieties. Through these activities, they have promoted more diversified, sustainable and resilient food systems that are better suited to face climate challenges.

The main obstacles raised by the participants to the survey have been the lack of financial resources and an enabling legal environment. In fact, seed and food policies have often promoted uniform and formal seed systems, through regulations on seed marketing. For example, the interpretation of seed exchanged by farmers varies across countries in Europe: some countries allow it, while others consider it as commercialization following the rules of seed marketing. Only recently more diversity entered this picture with the concept of Conservation Varieties (EU Commission directives 62/2008 (EU, 2008), 145/2009 (EU, 2009) and 60/2010 (EU, 2010)), even if its impact is still questioned (Didonna *et al*, 2024). Networking and cooperation as well as mutual support and social learning have been indicated as strategies to overcome these barriers.

Within this large and diversified movement of seed conservation, sharing and breeding, the idea of creating a European umbrella organization emerged as members of different CSBs started connecting through European meetings. In 2005, European seed networks organized the first European meeting – 'Let's Liberate Diversity' – in Poitiers, France. After that meeting, RSP, RSR and RdS started the process of formalizing a regional-wide organization which would group the different associations involved in seed saving, on-farm conservation and agrobiodiversity management. After seven years of negotiations and meetings, the European Coordination Let's Liberate Diversity (ECLLD) was formally registered in 2012 as a non-profit organization in Belgium, and as of

Table 1. The main conceptual framework of community seedbanks (CSBs) and genebanks (Bartha *et al*, 2021).

	Genebank	Community seedbank
Organizational structure	Public Institution	From single-person initiatives to community-based organizations (association, foundation, network without legal status, etc.).
	Centralized structure	Partly decentralized (network structure)
Actors	Employees (scientists, practitioners), occasionally farmers and breeders (if project available)	Network member volunteers (gardeners, farmers, horticulturists, etc.), employees (scientists, practitioners).
Funding structure	State, public–private partnerships (PPP), projects	Private (members, sponsors, foundations, etc.), public (European, state, region, municipality), commercial activities, non-profit organizations (NPO)
Communication strategy; Know-how transfer	Towards scientific and breeder community. Case by case policymakers too. Specific and science-focused communication. Specific communication to farmers.	Broad public (sponsors, donors), practitioners (farmers, gardeners, horticulturists), governmental decision-makers and politicians. Integrative and comprehensive communication.
Quality management for plant genetic resources	Aiming at a common and internationally agreed certification system based on protocols and standardized procedures. Monitoring only internal genebank activities.	Aiming at quality systems that are best adapted to the needs and actual situation (financial and structural) of the CSB. Monitoring is based on the control of the whole network.
Choice of plant material	Based on national breeding programmes, genebank managers' interest, national agrobiodiversity strategy (if existent). Only recently international coordination and sharing of responsibilities (e.g. AEGIS, A European Genebank Integrated System).	Based on CSB strategy developed by network members based on public or founder's interests as well as financial and network capacity. Often local, national or regional focus.
Breeding	Providing PGR for breeders for targeted breeding activities mostly for resistance. Aiming at specific and homogenous varieties. Varieties adapted to industrial agriculture.	Evolutionary breeding mostly aims for tolerance. Varieties with a less homogenous calibration spectrum. Aiming at varieties that keep their adaptation capacity to different agricultural systems.
Governance	Public mission based on national and international law/agreements/protocols	Based on common agreed values, shared visions and missions and agreed statutes and bylaws. Social aspects are key.
	Hierarchic, top-down	From hierarchic to democratic structures, bottom-up
	Bound to governmental obligations	Civil society organizations, representing the interests of the community
Access to materials	Mainly through the easy standard material transfer agreement (SMTA) and the rules of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)	It could vary from one CSB to another. There are CSBs fully compliant with ITPGRA, others that have specific mutually agreed terms
Type of materials	Mainly old varieties and landraces in the public domain. Some conserve also breeding lines or commercial varieties with dedicated access rules	From old varieties and landraces in the public domain to new heterogeneous materials bred through participatory breeding programmes

2024, it brings together 22 organizations from 21 countries, encompassing over 170 national organizations. ECLLD is dedicated to promoting the dynamic management of cultivated biodiversity and farmer-led seed systems across Europe and aims to bring diversity back into our food systems. By connecting CSBs, researchers, civil society groups, seed savers, and farmers, ECLLD operates through three core focus areas: policy, community seedbanks, and communities. As a platform for policy engagement, ECLLD supports capacity-building initiatives and fosters exchanges among its members to enhance their advocacy efforts toward policies and regulations that promote and sustain agrobiodiversity. In the area of CSBs, ECLLD empowers local groups by facilitating knowledge sharing, supporting exchanges on practices, and the integration of participatory plant breeding (see as reference the three Technical Manuals on CSBs, Galluzzi *et al* (2021c,b,a) https://liberatediversity.org/knowledge/readings/). Finally, through its work on communities, ECLLD fosters peer-to-peer learning, enabling stakeholders to share practices, exchange experiences, innovate, build connections and collectively

drive action on cultivated diversity. Events like the Let's Liberate Diversity and Let's Cultivate Diversity forums, are central to these community-building efforts (for further details visit www.liberatediversity.org).

Three case studies

Our case studies describe the CSB experience of three different European organizations which are ECLLD members: Pro Specie Rara (PSR, Switzerland), Arche Noah (Austria) and Rete Semi Rurali (RSR, Italy). They were chosen since they exemplify the diversity among European CSBs and are well connected to their respective national systems for PGRFA conservation. Moreover, the three organizations have all made efforts, although in different ways, to engage with the so-called formal seed systems, with activities such as seed marketing, registration of local varieties/populations, characterization of the accessions conserved and traceability of the work of the CSBs through dedicated databases.

For each organization, we will describe the history, turning points, PGRFA managing system, the networks they are involved in and their perspectives. A brief summary of the main characteristics of the three organizations is presented in Table 2. They have different members (single persons in the case of PSR and Arche Noah, and other organizations for RSR), activities (PSR is working also on animal breeds), facilities and access rules. PSR and RSR have integrated the easy standard material transfer agreement (SMTA) of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) for providing accessions for research and breeding, meanwhile Arche Noah has its own access rules with an obligatory compliance check: if companies or organizations work with GMOs or patents, they are excluded from seed access.

Rete Semi Rurali

History

Rete Semi Rurali (RSR) is the Italian seed network, an umbrella non-profit association grouping organizations involved in the sustainable use of agrobiodiversity, within an agroecological framework. RSR was set up in 2007 by seven founders; in 2024 it consisted of 36 profit and non-profit members. RSR's mission is to diversify our food systems, starting from seeds and varieties. Its projects are directed primarily towards increasing diversity in agricultural systems, starting with the management of diversified seed systems in organic farming. RSR's strategy aims to recognize the role of farmers and other actors in breeding and seed production and enable a legal framework for the dynamic management of agrobiodiversity (Bocci and Galluzzi, 2015). RSR activities cover four different work areas:

1. Action research: this area supports the diversification of agricultural systems, by promoting a different model of agricultural research which brings research back to farmers' fields (decentralization) and involves different food system actors (participation).
2. Community seedbanking: this area supports diversified seed systems by promoting CSB development at a local level (see Figure 1).
3. Communities: working on seeds means working with the communities that grow them, process and consume their products. RSR works to build and support vibrant communities in which food system actors interact with each other, being aware of their complexity and diversity.
4. Policies: to promote changes in agricultural systems, it is necessary to build a political, legal, economic and social environment that makes these possible. RSR is active in fostering this enabling environment at local, regional, national and European levels.

In 2013, after the ECLLD meeting Let's Cultivate Diversity in Tuscany, RSR started to create its own CSB dedicated to different cereal species. Subsequently, the CSB expanded its structures and functions, engaging new members, opening hubs in new regions, establishing field trials for different crops, and engaging the communities in the evaluation of varieties and sensory analysis of the products (Petitti *et al*, 2022). Great emphasis was placed on participatory approaches to bottom-up seed system innovation, focused on the development and dissemination of dynamic crop populations and their management within organic farming systems (De Santis *et al*, 2022). The concept of Community Biodiversity Management (DeBoeuf *et al*, 2013) was adopted, believing in its great potential for change and adaptation, and for making agricultural systems the places where site-specific innovation takes place.

Each year, RSR's CSB organizes two seed distribution campaigns, one for winter and one for spring crops, through which a catalogue of landraces and populations is released and from which farmers or gardeners can ask for small seed samples. RSR has developed a dedicated material transfer agreement to trace the exchange of the materials and keep track of the flows from the CSB. The samples distributed are small, but generally larger than the ones of formal genebanks. For more uniform varieties, RSR provides around 200 or 300gr and for populations up to 2kg, to avoid reducing the diversity by sampling a small amount of seeds.

In 2019, RSR inaugurated its new headquarters, called the House of Agrobiodiversity, a multifunctional space, which includes the first agrobiodiversity library in Italy, a fully operational seedbank and a training centre. In 2022 RSR launched DIVERSITAS – the Digital Ecosystem of RSR. It collects and manages all the accessions in the CSB and the data from the experimental fields. DIVERSITAS is designed to track the flow of seeds in and out of the CSB.

Turning points

From 2010–2019, thanks to EU projects SOLIBAM (www.solibam.eu) and DIVERSIFOOD, RSR moved from

Table 2. Main features of Rete Semi Rurali, ProSpecieRara and Arche Noah

	Rete Semi Rurali	**ProSpecieRara**	**Arche Noah**
Date of founding	2007	1982	1990
Website	https://rsr.bio	www.prospecierara.ch	www.arche-noah.at
Legal structure	Non-profit organization; Umbrella org.	Foundation	Association
Board, staff	5 board members, 2 employees, 15 consultants	7 board members, 35 employees	9 board members, 57 employees (approx. 39 full-time equivalents)
Members	35 entities (profit and non-profit)	13,000 donors and 4,400 active seed savers and rare-breed holders. Farmers, breeders, gardeners, researchers, etc.	10,000 members + 7,000 extra donors
Mission	Diversification of farming and seed systems	Maintain and promote the genetic and cultural diversity of plants and animals.	Conservation and development of crop diversity in regional and Europe-wide networks and advocacy for an enabling policy framework
Main collections	3,487 accessions. Crops: soft and durum wheat, barley, rye, oat, other cereals, rice, maize, tomato, sunflower, soybean, chickpea, bean and lupine.	5,600 cultivated plants and 32 rare breeds	5,500 seed accessions and 550 fruit cultivars
Main activities	Central seed storage (climatic chamber and freezer). Database: DIVERSITAS.	Central seed storage (climatic chamber and freezer), tuber storage facility (climatic chamber), nursery and greenhouse and tunnel. Webpage for seed and breeds exchange. Database for dynamic on-farm management	Central seed storage (climatic chamber and freezer), one visitor's garden and one multiplication garden incl. tunnels. Online shop and shop in the visitor's garden. Internal and external database.
Main network activities	Seed saving, knowledge exchange, courses, markets, collection holders, data collection, breeding	Seed saving, knowledge exchange, courses, markets, collection holders, data collection,	Seed saving and regular multiplication incl. data collection, educational programme with approx. 50 courses per year, political campaigning, participatory vegetable breeding networks, Arche Noah Diversity Farms
Main projects (2024 status)	Implementing the ITPGRFA in Italy, ECPGR EVA Network, 5 Horizon Europe projects	72 different projects; Label for PSR products; Horizon 2020 projects; Projects within the frame of the national action plan for PGRFA	No patent on seeds-campaign, Participatory vegetable breeding, Fruit Monitoring Austria, Supporting community biodiversity management in South-Eastern Europe via Small-Scale Grants. Online seed savers index

the mere preservation of local varieties and landraces to actively breeding for diversity, developing evolutionary populations of soft and durum wheat (*Triticum aestivum* L. and *T. turgidum* subsp. *durum* (Desf.) Husn.), and barley (*Hordeum vulgare* L.). This work on participatory and decentralized plant breeding, and in particular on evolutionary populations, was done in collaboration with Dr Salvatore Ceccarelli, a breeder who worked at the International Center for Agricultural Research in the Dry Areas (ICARDA), one of the SOLIBAM partners, and then directly with RSR. ICARDA's evolutionary populations of soft and durum wheat and barley were evaluated and tested in different and contrasting farming environments (Bocci *et al*, 2020; Ceccarelli and Grando, 2020). This move from agrobiodiversity conservation to breeding for diversity was the first important turning point in the history of RSR. Over time, the work on wheat and barley was expanded to other crops: rice (*Oryza sativa* L.), tomato (*Solanum lycopersicum* L.), oat (*Avena sativa* L.), lupin (*Lupinus*

Figure 1. Community seedbank at Rete Semi Rurali

albus L.), sunflower (*Helianthus annuus* L.) and recently other legumes, following the increasing interest among farmers in crop populations for organic farming systems.

In the beginning, the populations remained within RSR's network and were exchanged during the seed campaigns, since marketing this kind of seed was not legally possible. In 2014, a second relevant turning point occurred: thanks to the lobbying done by SOLIBAM partners, mainly the Organic Research Centre (UK), Fibl (Switzerland), Itab (France) and RSR, the European Commission opened the space for marketing the seeds of these populations by an experimental derogation (EU Commission implementing decision 150/2014 (EU, 2014)). Using this derogation, RSR supported farmers to engage in the process of seed production, multiplication and marketing of the populations they were growing and adapting, by registering as small seed companies. In 2017, the first soft wheat population was officially certified by public authorities and two farmers (one in Tuscany and one in Sicily) started marketing its seeds. At the same time, RSR developed its label for the seed packages using and adapting the open-source pledge promoted by the Open Source Seed Initiative in the US (https://osseeds.org).

The last relevant turning point was the approval of the new EU regulation 848/2018 (EU, 2018) on organic production and labelling of organic products that entered into application in January 2022. This regulation created a new varietal category, the Organic Heterogeneous Material (OHM), which took up the concept of populations contained in the Decision of 2014. Since then, RSR has worked to support the implementation of OHM in Italy, notifying one rice, one sunflower and one soft wheat OHM.

Collaboration with institutions

Since its foundation, RSR has collaborated with the Ministry of Agriculture, being one of three partners of the national programme for the implementation of the ITPGRFA. This programme involves 29 research facilities of the Council for Agricultural Research and Agricultural Economics Analysis (CREA), the Institute of Plant Genetics of the National Research Council (CNR) in Bari and RSR. Thanks to the programme, RSR supports its CSB as well as the Italian delegation within the ITPGRFA framework on negotiations related to the sustainable use of agricultural biodiversity and Farmers' Rights.

Thanks to the above national programme and its involvement in Horizon projects, RSR has developed dedicated agreements with a range of European organizations, including one with the CNR genebank in Bari for the multiplication and regeneration of some of the accessions conserved there. Other agreements on participatory and decentralized plant breeding have been signed with the Universities of Florence, Bari, Turin, Milano Bicocca, Viterbo and the Sant'Anna

School of Advanced Studies in Pisa. The aim of these agreements is to place RSR as an intermediary organization between the public research system and farmers.

Networks

RSR is a member of several Italian alliances and networks including Azione TerrAE, the Coalition for Agroecological Transition (https://azioneterrae.com). This coalition is made up of 7 international cooperation associations (ACRA, CISV, COSPE, DEAFAL, LVIA, Mani Tese, Terra Nuova) and two Italian and European civil society networks (RSR and Agroecology Europe), engaged in experimentation, promotion, training and dissemination of different aspects of agroecology, involving both research and farmers' organizations. Azione TerrAE plays a crucial role in the promotion of agroecology in Italy and West Africa, while the role of RSR is to strengthen the link between good farming practices and seed systems, putting the development of diversified seed systems at the core of activities of the Coalition. At the national level, RSR has also been involved in the campaign *Cambiamo Agricoltura*, which unites over 70 organizations actively engaged in the negotiations of the Common Agricultural Policy (CAP).

At the European level, RSR is a full member of the European Consortium for Organic Plant Breeding (ECO-PB, https://www.eco-pb.org/), which aims at facilitating knowledge exchange and supporting breeding programmes for organic farming. As mentioned, RSR is one of the founding associations of the European Coordination Let's Liberate Diversity.

At the international level, RSR is a member of the Global Coalition of Open Source Seed Initiatives (GOSSI, https://www.opensourceseeds.org/en/gossi), an international coalition of organizations, individuals (farmers, seed keepers, plant breeders, activists) working to ensure that seeds can be freely used and shared in perpetuity.

RSR contributes actively to the debate and negotiations on the European regulatory framework and is involved within the ITPGRFA in the development of policies on the sustainable use of PGRFA and Farmers' Rights.

Perspectives

RSR has become a complex, inclusive and dynamic network dealing with local field experimentations as well as international processes. It aims to maintain a fruitful dialogue among practitioners, researchers and policymakers. Its work demonstrates that we must enlarge the vision of agrobiodiversity, focusing not only on mere conservation but on innovation and breeding for diversity, i.e. delivering new varieties that are sufficiently diverse (rather than narrowly responding to the standard criteria of distinctness, uniformity and stability (DUS) of modern varieties) to be able to adapt to climate change and low-input farming systems. The belief in the importance of diversifying seed, farming and food systems is the reason why RSR has recently moved towards projects and research activities that involve not only seed diversification and breeding but also intercropping, rotations and soil microbiome. These will be the challenges for RSR in the coming years. Regarding the CSB and its database DIVERSITAS, the next steps will be the possibility of implementing the ITPGRFA easy SMTA directly from its website for the accessions distributed from the CSB and the digital object identifier (DOI) for some of the conserved accessions.

ProSpecieRara

History

PSR was founded in 1982 in St. Gallen (Switzerland) and its first activities were related to safeguarding rare breeds. In 1985, collecting activities for fruits, field crops and vegetables started. In 1988, the first employee was hired with a fixed salary. Around the same time, the network of seed savers was established and the seedbank (called 'seed library') was founded. Very successful TV broadcasts and some national exhibitions about rare breeds and fruit varieties organized by PSR and its partners and volunteers helped to raise awareness among the broader public. In the 1990s, the first private foundations started funding the projects of PSR and private donors supported the organization as well as many volunteers who helped to propagate seeds as seed savers. In addition, many breeders joined the different breeding associations created by PSR to coordinate the conservation of the different endangered breeds. After 15 years of existence, PSR encountered about 2,000 donors, 250 seed savers and over 2,000 breeders organized in 15 different breeding associations.

Turning points

The first important turning point for PSR's activities was the ratification of the Convention of Biological Diversity by Switzerland in 1995, followed by the development of the National Plan of Action for the Conservation of Plant Genetic Resources for Food and Agriculture (NAP-PGRFA) in 1998. The Department of Agriculture decided to create the Swiss Commission for the Conservation of Cultivated Plants (SKEK/CPC) in which PSR became a leading member of the governing body to implement the NAP-PGRFA. This mandate was and still is accompanied by some funds (3.2 million CHF per year). At the time, the Commission developed a conservation strategy with conservation standards for various crops and a national database that relates to the European Search Catalogue for Plant Genetic Resources (EURISCO). PSR's own database has an interface with the national database to transfer and exchange passport and characterization data. Today about 15% of the turnover of PSR is covered by these public funds.

A second important turning point was the collaboration with COOP, the biggest supermarket chain in Switzerland. Together with this impactful partner, PSR participated in one of the biggest national exhibitions called EXPO02, which attracted millions of people over

six months. The interest of the visitors in the topic was so big that COOP decided to fix the collaboration through a contract. This collaboration has lasted until today.

Accordingly, PSR's focus shifted more and more from pure conservation towards the sustainable use and development of PGRFA. PSR developed a label for the promotion of traditional and endangered varieties to keep or reintroduce them in the value chain. Aside from the COOP outlet, farmers and horticulturists who are part of the PSR conservation network use this label for their own marketing activities, helping them showcase the added value of their products to consumers. In 2023, PSR's database revealed that about 600 people use the PSR label and surveys reported that around 30% of the Swiss population know this label.

Another important turning point in the Swiss PGRFA conservation activities occurred when the Government implemented article 147a in the agriculture law (SR 910_1 Art. 147a LwG):

"*The Confederation may promote the conservation and sustainable use of genetic resources. It may manage genebanks and conservation collections or have them managed and support measures such as in situ conservation, in particular with financial contributions.*"

Under this provision, PSR and other stakeholders in this field could apply for funding for activities going beyond pure conservation such as on-farm development and improvement of PGRFA.

Thanks to the development of a suitable legal framework (e.g. the national long-term strategy for PGRFA and its accompanying measures) as well as through adequate funding opportunities, PSR was able to grow further, engaging new stakeholders for on-farm management of PGRFA. Today governmental financial support constitutes only about 20% of their total turnover but is still crucial because it guarantees the financing of conservation activities that depend on a long-term financing source (e.g. on-farm fruit and berry collections).

Development and monitoring

ProSpecieRara went on to develop its network of seed savers (for vegetable species) and collection holders (for fruits and berries). Today, 400 seed savers maintain 1,208 vegetable varieties, 270 people care for 1,012 ornamentals, 1,000 people host 2,436 fruit and 422 berries varieties all over the country. The PSR staff is responsible for managing the network and monitoring conservation activities. For seeds, this work is facilitated by the central seed library, located in Wildegg (AG) and consisting of a climatized room with 2,000 accessions stored as seeds. This repository functions as a backup of the *in situ* collection, with seed savers regularly sending back a reference seed lot of the variety/accession they maintain and regenerate. The reference lots are sown in PSR's different demonstration gardens, where quality and varietal identity are verified. All the exchanges between the seed savers and PSR are registered in a specific database for on-farm conservation and can be traced back. Every year, the 1,653 label holders (i.e. registered and validated seed savers) receive a request to fill in a checklist to describe the status of the genetic resources they are maintaining. This checklist is provided by PSR on its portal (https://www.prospecierara.ch/it.html). Based on the results of this monitoring activity, PSR delivers a report about the status of each of the 5,600 accessions maintained by the people of the network. This report also allows the seed library manager to establish how many seed lots are in the genebank and their storage time. The manager will also know how many seed savers are maintaining the accession, how many are marketing seeds, fresh and processed products and how many of them are offering seeds on the variety finder portal of PSR. By compiling all this information, that is facilitated by the database, the manager can judge the conservation status of an accession and decide if an accession is endangered and must be propagated quickly or not. In addition, different training courses are organized for beginners and advanced seed savers to improve their knowledge and skills.

Sustainable use

Over time, PSR's activities shifted more and more from pure conservation to sustainable use of PGRFA and the development and improvement of varieties, e.g. for niche markets and with niche varieties. The shift of PSR's activities towards sustainable use was backed by a national law (SR 916.151.1 Art. 2.4 - 2.7, 27, 29) for the marketing of seeds brought into force in 2010: besides registered and certified varieties, a new category called 'niche varieties' was created to include varieties that don't fulfil the DUS criteria. The government considered that certain varieties could be very interesting for niche markets or small-scale farmers or private gardeners (see Figure 2).

Allowing to register these varieties and being able to place them on the market would enrich the diversity of vegetables and field crops in the fields and on consumers' tables. This positive legal environment led to breeding activities to improve landraces, minor or 'opportunity' crops, or develop populations, with the support of government and private (e.g. COOP) funds.

Some of the breeding activities included participatory methods and, in some cases, citizen participation when a broader range of information about plant growth and development in different agricultural and horticultural contexts had to be collected and compiled. While often breeding activities take the form of mass selection to advance a population variety, in some cases, cross-breeding is the only way to make a variety fit for on-farm utilization (see Table 3).

Further development as a CSB

In the future, open-pollinated crops will become even more important for alternative, independent, locally adapted and innovative agricultural systems, a grass-roots alternative to hybrids that are more and more taking over intensive and industrial agricultural production of food (IPES-Food, 2016). On the other hand, citizens

Figure 2. Carrot variety 'Gniff' from Ticino from Pro Specie Rara collections being commercialized

Table 3. Cross-breeding activities initiated by ProSpecieRara (PSR) for new niche varieties

Species	Varieties	Origin	Breeding
Daucus carota	'Gniffola'	Landrace 'Gniff' x 'Purple Haze'	Sativa Rheinau, 2012–ongoing
Solanum lycopersicum	'Cuore di Bue'	'Cuore di Bue' x resistant varieties against *Cladosporium* sp.	Sativa Rheinau, 2012–ongoing
Brassica rapa subsp. *rapa*	'Albedo Viola' (rejected name) 'Guringa'	Several old varieties of PSR, the Swiss Genebank and from commerce landrace 'Bosco Gurin' x several varieties of the same type	Sativa Rheinau, 2016–2024
Allium cepa	'Piri'	Old variety 'Birnenförmige' x ('Yankee F1' x ('Rijnsburger' x 'Yankee F1'))	Sativa Rheinau, 2012–2022
Tragopogon porrifolius	Salsify populations	11 salsify lines from PSR, the Swiss Genebank and from commerce	PSR & Sativa Rheinau together with PSR network (participatory breeding), 2024–ongoing
Cucurbita pepo var. *cylindrica*	Striped zucchini	Old variety 'De Gênes Striée Vert-Jaune' x other striped zucchini	Sativa Rheinau, 2024–ongoing

are increasingly interested in agroecological food production systems that foster biodiversity, protect the environment and provide healthy food for them. This is one of the reasons why urban farming and gardening movements are popping up all over the country in and around cities. Well-educated young people are applying new and better-adapted farming systems to local conditions. Several community-supported agriculture systems around cities like Geneva, Basel or Zurich have contacted PSR to get access to bigger amounts of seeds to be able to start their trials on a bigger scale and select those varieties that fit best to their local and specific needs and establish production plots for the marketing of produce. For PSR this development causes different challenges: first, quantities of seeds requested are greater than those normally distributed for purely experimental purposes; second, these new actors require training in order to acquire the ability to produce and regenerate their own seed each year. Finally, these users demand more detailed information about the PGRFA stored in PSR's seed library. To face these challenges, PSR is considering a series of new developments. To produce and distribute greater quantities of seed to growers, it could become a small seed company or start collaborating with local seed companies. In general, PSR would like to act as a knowledge hub or be part of a knowledge platform that provides

information to growers and helps them to make decisions tailored to the specific environmental and/or economic and social conditions they operate in – a kind of one-stop shop for farmers.

Networks

Since the early 2000s, PSR has entered several partnerships with research institutions, whether within the framework of the NAP-PGRFA for the inventory, description and conservation of PGRFA, or within the framework of production and distribution with COOP. An important factor in the success of many of these collaborations was the clear definition of partners' roles. The typical collaboration between PSR and research institutions covers three steps along the continuum from conservation to the sustainable use of PGRFA:

1. Conservation: *ex situ*, i.e. *in vitro* and genebank conservation by research institutions (e.g. Agroscope) linked with the *in situ* and on-farm conservation by PSR and its partners. The research institutions use their scientific expertise to carry out *ex situ* conservation measures. On the other hand, PSR has an interest in testing PGRFA in on-farm conditions to possibly promote them among farmers, while network partners can use their PGRFA collections as sources of material for the multiplication and commercialization of seeds.
2. Evaluation: genetic and morphological characterization by research institutions (e.g. Agroscope) linked with the quality assessment, value description (e.g. cultural history, or market value), and determination of the utilization potential by PSR. While research institutions provide the expertise and technical infrastructure for characterization, PSR and its network can evaluate the PGRFA in terms of their socio-economic impact.
3. Environmental adaptation for agricultural use: selection of PGRFA, breeding activities and marketing activities by PSR and partners linked with agronomic evaluation and case studies by research institutions with a strong link to farmers (e.g. Fibl). PSR initiates breeding activities to recover the varieties and bring them to the market. The 'ProSpecieRara' label provides a tool to enhance the product's credibility with consumers. On the other hand, it is important for farmers to know the expected quality and quantity of the PGRFA available before accepting it for large-scale cultivation on their farms. Research organizations advise farmers about the agronomic and quality features of the PGRFA available through PSR enabling them to make informed choices depending on their context and needs.

Perspectives

PSR is dedicated to further developing the plant and animal genetic resources it maintains in its broad network. As this example shows, there are strong incentives for collaboration between CSBs, research institutions and genebanks. There is a great need for research on the characterization and evaluation of PGRFA, and the role of research institutions and genebanks is undeniable. At the same time, PSR experience shows that successful promotion of PGRFA is only possible with many dedicated actors, which come together in the CSB network. This collaboration will not only enable better integration of PGRFA into society through innovative agroecological farming systems but will also return a wealth of real-world data and experiences about PGRFA to the research institutions.

Arche Noah

History

The development of Arche Noah can be divided into four phases:

1. Pioneer phase. Emerging from predecessor organizations, Arche Noah was founded in 1990 by farmers and gardeners who had formed a network among crop collectors and seed savers. Early on, the organization issued a *Seeds Handbook* (not published, for members only) to stimulate the exchange of seed and other plant reproductive materials and began compiling a collection of rare and endangered varieties. The 1990s were a time of rapid growth of the collection, stimulated by collecting missions (Austria, Croatia, Romania) but also by research into commercial open-pollinated and heirloom varieties. Eventually, in 1994, the organization opened a garden for crop multiplication that was also open to the public for educational purposes. Seed production was organically certified which gave it a unique position among seed savers organizations as well as in the agricultural scene. Arche Noah was a pioneer in the then-emerging Austrian organic farming scene.
2. Differentiation phase. Around 2000, the organization had become well-known and grew to 6,000 members. The annual plant market attracted many visitors and became a meeting point for the organic gardening community. Arche Noah took up the direct marketing of transplants. To manage risks from commercial activities and to clearly separate commercial from non-profit activities, a company with limited liability was founded. Along with these developments, the number of employees at the organization rose and departments developed, specializing in plant collections (seed archive, fruit collection), gardening, seed savers activities, sales and event management. An early act of policy advocacy was to secure exemptions for unregistered PGRFA under the Austrian National Seed Legislation. This was achieved through persistence, as well as a rare window of opportunity for alternative farming approaches at that time. Since then, the legal exemptions have allowed for marketing small quantities of seeds, making Austria a unique environment for heir-

loom varieties in the EU. Beyond that, Arche Noah advocated for lighter registration procedures for Conservation Varieties. The demand for seeds was growing and it became necessary to open the registration process for plant materials not conforming to industrial standards and feasible for small seed companies. In the educational sector, a series of books was launched, setting off with a handbook about seed gardening (Heistinger, 2013). In 2008, the education programme on organic gardening and crop diversity was expanded, comprising nowadays up to 80 courses per year, training people in seed-saving techniques, crop diversity and gardening skills.

3. Integration phase. In the late 2000s, a bundle of new strategic targets pushed the enlargement of the organization. With the slogan 'Eating up what we want to save', Arche Noah built a wider network with home gardeners and farmers, incentivizing access and marketing of rare varieties in the form of seeds, plantlets and products through different channels (plant markets, Arche Noah shop, farmers markets). The focus shifted from 'home gardeners' to the urban consumer as a new target group. This was accompanied by systematic on-farm research – also within EU projects – to evaluate varieties and their potential uses. The cooperation with the organic seed company Reinsaat led to an ever-increasing demand from consumers and retailers. Since then, Arche Noah has been registering several heirloom varieties in the EU catalogue per year and offering seeds via the Arche Noah webshop.
4. Association phase. As of 2010, the political and international cooperation expanded: Arche Noah hosted several international policy workshops and advocated for seed law issues, in some cases directly in Brussels. In 2015, the cooperation with the campaign 'No patents on seeds' started. At the same time, Arche Noah started to coordinate the Austrian participatory tomato breeding network. The financing structure was expanded thanks to Austrian and European research funds and new fundraising models, first targeted sponsorships for on-farm breeding and multi-location fruit conservation. Since then, the number of employees and supporters of Arche Noah has remained stable, while noticing a shift from association members to sole financial donors.

Multiplying accessions and making accessions available

In comparison to public genebanks, the association focuses more on cooperation with farmers and gardeners in terms of conserving, describing, spreading and further developing PGRFA. The activities of Arche Noah centre on the seed archive and the gardens which are responsible for maintenance, variety descriptions and seed quality testing. Documentation of each variety or accession is supported by a database of text descriptions and photos for each variety or accession, complemented by data about the origin, plant health status, quantity and germination performance of harvested or stored seed lots. Recently, the database was enforced with crop-specific descriptors, mainly based on UPOV and IPGRI standards, but supplemented by more user-related descriptors such as taste, utilization class, yield or lodging.

Distribution of plant material (mainly seeds) is done via various production lines (Table 4). Seed surplus of non-registered varieties from the multiplication garden are offered as 'Treasures from the Seed Archive' in strictly limited quantities in accordance with the Austrian Seed Regulation revised in 2006 (RIS, 2025). Two additional production lines pursue the aim to provide seeds of registered varieties and varieties of non-regulated species on a regular basis to a wider audience, having the Arche Noah webshop and local sale points as main channels, but also serving major retailers such as a supermarket chain. These marketing activities are carried out by the associated company *Vielfalt Erleben*, which is fully owned by the non-profit Arche Noah. Most of the offered varieties are registered in the EU variety catalogue as "varieties with no intrinsic value for commercial crop production but developed for growing under particular conditions" and are multiplied by contracted farmers. The main target group for Arche Noah seeds are amateur gardeners in Austria and neighbouring countries (see Figure 3). Accessibility of rare fruit varieties is limited to a set that is managed by certified organic nurseries cooperating with Arche Noah. Due to plant health restrictions and the complexity of handling planting material (seasonality, storage, shipping), the assortment of available varieties is less dynamic compared to seed crops.

Conserving and managing PGRFA

In Austria, there are approximately 150 active seed savers in the network of Arche Noah, contributing through growing, multiplying and collecting varieties. Some of them manage their private collection of varieties (with or without links to the Arche Noah seed archive), but many engage in coordinated conservation activities of the organization. As 'guardians', they test varieties of the seed archive in their location and collect data. Depending on season, location and personal preferences, they contribute new or confirm previous observations, and thus, add to the wealth of knowledge and perspectives regarding crop diversity. These seed-saver programmes cover both seeds and tubers as well as fruit crops. Seed guardianship can be permanent or temporary (alternating varieties annually). Fruit guardians are designated permanently with a minimum number of ten trees per location. To facilitate the exchange of plant material and contacts among seed savers and the broader public, Arche Noah digitalized the former *Seeds Handbook* to an online private database where seed and fruit tree savers can indicate their varieties via text and photos.

Table 4. Seed marketing lines of Arche Noah (2024 status)

	Line proven for home garden	Rare Vegetables	Treasures from the Seed Archive
Distribution start year	2009	2014	1998
Main target group	Beginner and advanced home gardeners	Advanced home gardeners	Advanced and professional home gardeners
Criteria for taking into the collection	Robust varieties of well-known vegetable crops, with reliable yield and good taste	Lesser-known vegetable crops, underutilized	History, traits, utilization and/or special usage properties
Flexibility	Consistent collection, 1–3 varieties change per year	Consistent collection, 1–3 varieties change per year	Annually or biennially changing collection
Variety registration	Registration usually as ”varieties bred for cultivation under special conditions”	Usually, no registration necessary if species are not listed	No registration necessary subject to restrictions and quantity limit set out in the Austrian Seed Regulation 2006
Number of varieties	53	18	approx. 100
Varieties also sold to retailers	31	12	0 limited quantities due to legal restrictions

Figure 3. Sale of Arche Noah seeds at the annual seed fair in Wien (Austria).

Farmers multiply seeds in larger quantities for Arche Noah's seed sale. Some of them run farms specialized in vegetable seed production, and others are biodiverse farms selling vegetables or other produce. Together with Arche Noah, they carry out maintenance breeding of seed archive materials by positive or negative mass selection and selection of elite plants. The aims are to maintain the phenotype and to maintain or improve plant health and sensory quality. In addition to this partnership for seed multiplication, Arche Noah licences a label to organic farms which produce and sell rare varieties. In 2024, 32 farms registered for this label, the so-called Arche Noah Diversity Farms.

Some of the partner farmers of Arche Noah not only multiply, produce and sell rare varieties, but actively engage in further developing varieties by cross-breeding and selection. In 2010, the working group *Bauernparadeiser*, a participatory breeding group on tomatoes, was founded on the initiative of farmers due to a lack of organically bred tomato varieties to suit the needs of direct marketing. Conventional tomato breeding mainly breeds hybrids which neither can be reproduced on the farm nor adapted to local conditions, and sensory quality is often neglected. Currently, the group consists of 12 organic Austrian farmers, three research institutions and Arche Noah. The goal is the development of tasty and reproducible (open-pollinating) tomato varieties, featuring resistance to plant pathogens, by means of crossing heirloom and modern varieties. The group works, first, on varieties for greenhouse cultivation, resistant to the fungal pathogen *Cladosporium fulvum*, to Tobacco Mosaic Viruses and common root diseases and, second, on varieties for outdoor production, resistant to the fungal pathogens *Phytophthora infestans*, Early Blight (*Alternaria* spp.) and Septoria leaf spot (*Septoria lycopersici*), and less susceptible to fruit cracking. Since 2020, Arche Noah has coordinated participatory screening and breeding activities within other vegetable crops, such as sugar pea and winter radish.

Networks

Apart from previously mentioned partners in the multiplication and marketing of plant material, Arche Noah is a partner in various research projects, being well-connected with national universities and research stations. The latter are permanent partners in screening and breeding activities. There is loose contact with several other vegetable breeders, mainly in Austria and Germany. Further, Arche Noah is an active member of the Balkan Seed Network Association. The organization was founded in 2021 by 16 organizations and institutions active throughout Southeastern Europe. The purpose of the network is to increase the conservation and sustainable use of PGRFA in agriculture. Activities aim at stimulating resilient food systems and establishing a paradigm of collaboration within the wider Balkan region, which has historically been shaped by conflict. The network consists of seed savers, breeders, scientists, farmers, gardeners, associations, organizations, research institutes and educational institutions. In addition, being an active member of the Balkan Seed Network Association, Arche Noah has been supporting seed savers organizations in Southeastern Europe by awarding small-scale grants, provided by foundations.

Perspectives

Arche Noah calls itself 'The Association for Preserving and Developing the Diversity of Cultivated Plants' and cooperation with diverse network partners is extremely relevant. Arche Noah considers both preserving and developing as equally important activities. Regarding conservation, Arche Noah makes increased use of long-term conservation at sub-zero temperatures of accessions, to enhance the capacities to study and distribute the most valuable accessions for use. The participatory breeding activities account for the necessity to let the accessions adapt and improve according to the needs of home gardeners and farmers. Arche Noah does not intend to be a sole breeding organization by any means, but rather a motivator and catalyst for organic breeding in Austria. Since breeding and cultivating diversity also require suitable frameworks, Arche Noah wants to create the appropriate awareness and the political foundations so that the development and marketing of diverse seeds does not only happen in niches but can also be economically successful on a broader scale. Under the prevailing market economy conditions, diversity is a massive business disadvantage. It would therefore be naive to expect private and for-profit companies to do this work. However, since the preservation and further development of diverse seeds represent an indispensable basis for humanity's livelihood, it cannot be left solely to the dynamics of the market. Arche Noah therefore claims that conserving and breeding for diversity should become part of public services and corresponding programmes should largely be publicly financed.

Conclusions

The three cases presented here show that CSBs in Europe can maintain and manage thousands of varieties, landraces and populations within broad networks of different actors such as private gardeners, farmers and horticulturists. They operate in diverse, decentralized agricultural and climatic environments. Their activities can be framed as Community Biodiversity Management, and they focus not only on mere conservation but also on the dynamic management of PGRFA. This allows evolutionary and adaptive processes to happen. All the described CSBs are well connected to the local/regional communities they are operating in. Because they provide facilitated access to PGRFA, mostly open-pollinated varieties free of intellectual property rights, they are an excellent partner for agricultural movements that advocate for the enhancement of diversity in farming systems. They can be an excellent partner for researchers too, because they can act as bridges between scientific and tacit knowledge and help scale up interesting and crucial ideas for the future of our seed and food system.

Moreover, CSBs can play an important and complementary role with regard to the *ex situ* system. In fact, they can be considered as an intermediary between farmers and the genebanks, receiving small samples from the banks and multiplying them before distributing them to farmers. Propagation activities of the CSBs, in collaboration with their networks, offer the opportunity to provide a larger quantity of seeds to the final users. Very often the small quantities of seed coming from genebanks are considered as an obstacle by farmers, who do not necessarily know that providing larger quantities is not the mandate of these institutions. The multiplication and regeneration done by CSBs can provide useful information about the agronomic value of PGRFA, which leads to a better understanding and knowledge of the variety or landrace itself. These processes, done by the CSB members, operate in very diverse agricultural and horticultural systems, under different climatic conditions and within different social and economic contexts. This opens opportunities to collect site-specific information on how PGRFA perform and could help in coping with climate change and other challenges in the future, providing knowledge that is also useful for future breeding for diversity efforts.

As described by the three case studies, the turning points for CSBs are at least partially related to a change in the legal system. These changes allowed RSR to market the seeds of populations, PSR to market the seeds of niche varieties and Arche Noah the ones of conservation varieties. This means that the operativity of such organizations is concretely impacted by the legal and political environment in which they are embedded, and which has historically been conceived to promote DUS varieties while leaving diversity outside of the picture.

As of the time of writing this article, the EU is reforming the rules on seed marketing, with a proposal released by the European Commission in July 2023, voted by the Parliament in April 2024 and revised by the Council during 2025, before the final approval by the Trilogue involving all three bodies. The proposal contains a series of derogations to the conventional system to allow more diversity and actors in the seed sector. For the first time, the concept of "dynamic management of diversity" by farmers is mentioned in a legal text and participatory plant breeding is defined as an activity which develops locally adapted varieties. Moreover, an article is dedicated to the exchange between farmers, with the aim of creating a harmonized rule across Europe with less space for different national interpretations. All these points need to be maintained in the final regulation, if an enabling environment is to be created in Europe. Only in this way the development of CBSs, a relatively new and highly relevant actor in the PGRFA community, can be supported and the space for more diversity be created in our seed and food systems.

Author contributions

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Conflict of interest statement

The authors declare no conflict of interest.

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