Establishing the European Network for
In Situ Conservation and Sustainable Use
of Plant Genetic Resources

ISSN: 2281-2067 (Online)

http://www.farmerspride.eu

Landraces

Issue 5, January 2020

Farmer's Pride – EU Horizon 2020 Framework Programme—GA774271

Conserving plant diversity for future generations

Landraces

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Front cover image: 'Arakas for Fava Santorinis'. Photo: courtesy of Santo Wines (Santorini, Greece)

Funded by the Horizon 2020 Framework Programme of the European Union

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Welcome to Issue 5 of *Landraces*.

Thanks to the funding awarded by the European Commission to the project *'Networking, partnerships and tools to enhance in situ conservation of European plant genetic resources'* (short name 'Farmer's Pride') within the Horizon 2020 Framework Programme, we are able to continue the publication of this newsletter.

As in the previous issues, 'Landraces' provides a medium to draw attention to information about the conservation, promotion and use of landraces in different contexts. This issue initially provides information concerning the progress of the 'Farmer's Pride' project with regard to landraces. The project started in November 2017 and the main achievements after two years' work, with specific reference to the conservation of landraces in Europe and the establishment of a network of landrace conservation sites across Europe, are highlighted.

An inspiring paper follows which gives an example from Spain of how to document, share and protect landrace traditional knowledge. Then you will find two articles outlining how landraces may be "reconstructed": in need of variable materials, locally disappeared in the form of true landraces, sustainable (organic) agriculture can take advantage of such materials.

Finally, we present a collection of case study landraces, mostly of neglected and under-utilised crops, reviewing where and how they are cultivated, how they are promoted and marketed, among other issues. They concern the apple (Germany), broccoli (Spain), great-headed garlic (Italy), the common bean (Romania), chicory (Czech Republic), horseradish (Finland) and the climbing herb *Lathyrus clymenum* L. (Greece) and on-farm maintained landraces. These case studies can be used as an evidence-base for developing similar activities for other crops and landraces across Europe.

We hope you will enjoy reading this issue.

Valeria Negri, Lorenzo Raggi and Nigel Maxted

Above: The locals at this vineyard of Asyrtiko landrace in Santorini (Greece) still grow grapes without the use of a vine training system.
Photo: Leonardo Caproni.

Farmer’s Pride: the main achievements for landrace conservation in the first two years

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The Farmer’s Pride project (www.farmerspride.eu) aims to build a permanent collaborative network for the long term *in situ* conservation and sustainable use of Europe’s plant diversity for food, nutrition and economic security throughout the European region. As such, the Network will for the first time address the systematic and comprehensive conservation of crop wild relative and landrace genetic resources diversity in Europe. This paper presents a summary of the activities carried out with regard to landrace diversity thus far, as a means of informing the public.

An analysis of stakeholders

An initial step towards Farmer’s Pride’s general aim was to understand the range of stakeholders involved in/with an actual interest in *in situ*/on-farm conservation and sustainable use of Plant Genetic Resources (PGR) and to help ensure full stakeholder representation in the future Network. To this purpose, an online survey was carried out. To maximize the number of responses across the region, the survey was prepared in 10 different languages. Launched at the beginning of May 2018, it remained open until April 2019. During this time the project partners and Farmer’s Pride Ambassadors (see www.farmerspride.eu/collaborators) disseminated the survey to a wide number of potentially interested stakeholders including: members of the European Cooperative Programme for Plant Genetic Resources (ECPGR), farmers, gardeners, trade associations, seed-saver networks, plant breeding and seed companies, public research and technology institutes, botanic gardens, national parks, agro-NGOs, protected area managers, Government Ministries and other policymakers and national PGR coordinators.

More than 1,000 responses were collected from stakeholders from 35 different countries (Figure 1). Questionnaire respondents were asked to indicate: a) the type of organization they are associated with and/or their individual area(s) of work/interest(s), b) their specific interest(s) in *in situ* conservation of PGR and c) the type(s) of PGR they work with. An analysis of answers received to the three questions is in Figure 2 (a, b and c), while a detailed report on the survey results is reported in the project Deliverable 1.1 (https://more.bham.ac.uk/farmerspride/wp-content/uploads/sites/19/2019/10/D1.1_Identify_in_situ_stakeholders.pdf).

The results exceeded our expectations in terms of the overall number of responses, geographic coverage, breadth of stakeholder organizations represented, and interests of respondents in the *in situ* conservation and sustainable use of PGR. In fact, representatives of all stakeholder groups responded to the survey, including independent farmers, protected area managers, seed companies and policymakers, groups that are usually difficult to reach using this type of survey approach.

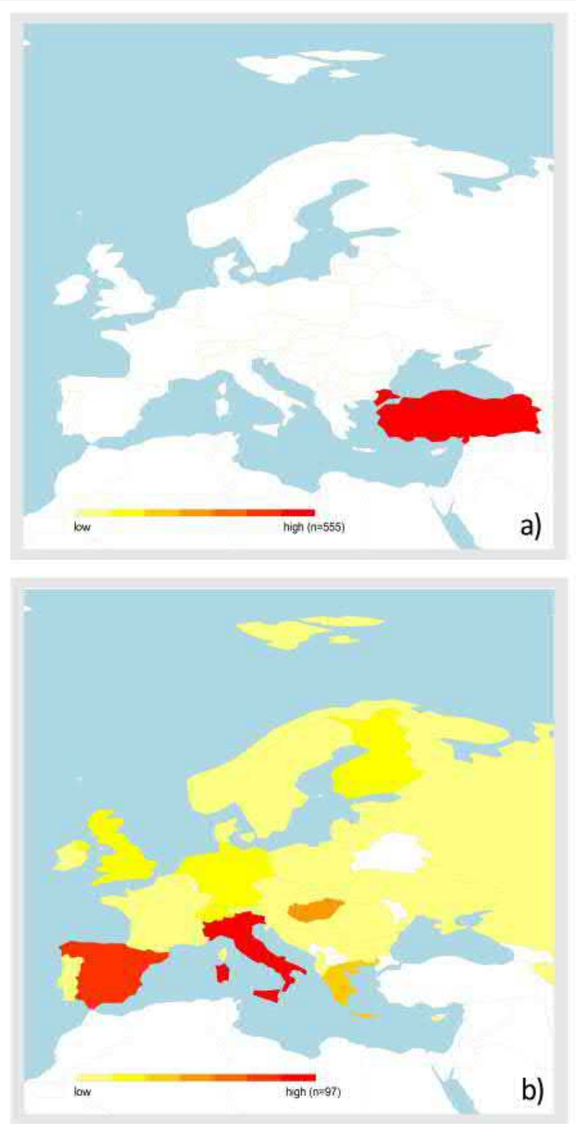

Figure 1. Heatmap of “number of replies by country” based on data from Turkey only (a) and mainland Europe only (b). In the figure colours range from: faint yellow (very low) to dark red (very high) number of replies in relation to the maximum number.

According to the collected data, the majority of respondents are interested in becoming members of the future “European Network for *In situ* Conservation and Sustainable Use of Plant Genetic Resources”. This shows a wide interest in *in situ* conservation and sustainable use of PGR across different sectors of society in Europe; we therefore also have concrete evidence of support for the establishment of the Network and of its possible active maintenance for years to come.

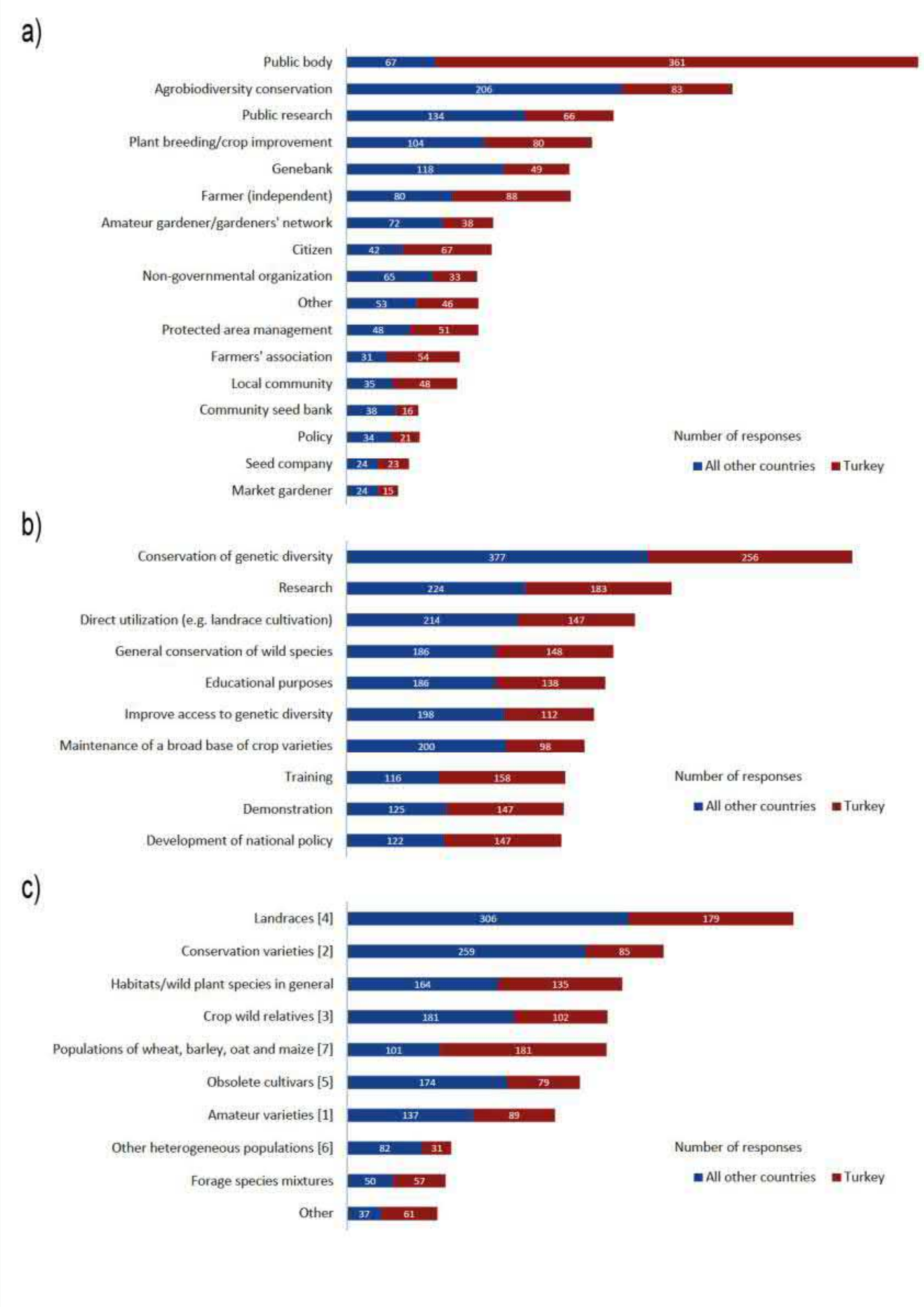

Figure 2. Data from Turkey were analyzed separately due to the very high number of responses received from this country in comparison to the others. **a)** The types of organizations respondents are associated with and/or their individual areas of work/interests (if not associated with an organization). The total number of options selected were 1,139 from 555 respondents (Turkey) and 1,175 from 467 respondents (all other countries). **b)** The main interests of respondents in in situ conservation of PGR. The total number of options selected were 1,534 from 555 respondents (Turkey) and 1,948 from 467 respondents (all other countries). **c)** The types of PGR respondents work with. The total numbers of options selected were 999 from 555 respondents (Turkey) and 1,941 from 467 respondents (all other countries). Definitions: [1] Vegetable varieties with no intrinsic value for commercial production (2009/145/EC – EC, 2009); [2] Varieties which are naturally adapted to the local and regional conditions (Commission Directives 2008/62/EC and 2009/145/EC – EC, 2008, 2009); [3] Wild species related to crops which contain important diversity forcrop enhancement (Maxted et al. 2006); [4] Diverse, locally adapted crop populations which not only contain diversity for crop enhancement, but are also important for local food and economic security (Casañas et al. 2017); [5] Cultivars having no or limited intrinsic value for commercial crop production (ECPGR 2017); [6] Different types of materials purposely developed by farmers, farmers' organizations and/or by breeders, including through participatory plant breeding (ECPGR 2017); [7] As defined by Commission Implementing Decision of 18 March 2014 (EC, 2014).

Building the first European inventory of landraces

Farmer's Pride also aims to produce a detailed inventory of landraces still maintained on-farm in Europe, since no conservation and promotion of use can be carried out without knowing where landraces are and which species they belong to. At the time the project was launched, very little information about on-farm landraces in Europe was available. The exception to this is Italy where on-farm conservation has been well established for a long time, is a widely promoted activity and where an inventory (although incomplete) was already created in a previous EC funded project (see http://vnr.unipg.it/PGRSecure/).

A second step was to collect baseline data of on-farm landraces across Europe (Project Deliverable 1.2). To this purpose, in April 2019 UNIPG prepared a template and circulated it to Project Consortium Members, Farmer's Pride Ambassadors and ECPGR National Coordinators. They were asked to provide the needed information (i.e. genus, species, crop common name, local name, geographical data of location) about the maximum possible number of landraces in their respective countries without recording the farmer names. In order to be inclusive regarding materials to be included in the future network, it was decided to collect information concerning all the different types of materials that are maintained and managed on-farm, following what was proposed in the 'ECPGR Concept for on-farm conservation and management of plant genetic resources for food and agriculture' (ECPGR 2017). As such, information on true landraces, conservation and amateur varieties (Commission Directives 2008/62/EC and 2009/145/EC, EC 2008 and 2009), populations (Commission Implementing Decision of 18 March 2014, EC 2014) and obsolete cultivars (all materials that, in a broad sense, can be referred to as landraces) was collected.

As of December 2019, data have been recorded for over 19,000 European on-farm conserved landraces, a much higher number and more geographically inclusive than initially expected.

Although it was not possible to collect data from all European countries, it is clear that different countries maintain/use a different number of landraces (broad sense) of each crop. As such, it is likely that the same situation exists in all European countries. It is also clear that landraces are maintained on-farm in all European climatic regions (Figure 3). Although still partial, this makes up the first inventory for any continent and will serve the European Commission to better plan conservation activities and policies. This data will also allow the identification of *in situ* hotspots of diversity in Europe (Project Deliverable 1.4) to better focus conservation policy and resources.

European landrace conservation, management and best practices

In order to gain insights that can be used in conservation planning, Farmer's Pride also aims to understand i) 'why' and 'how' landraces are currently maintained and managed on-farm/in-garden (Project Deliverable 2.4), ii) which tools can be used to sustain or promote landrace cultivation. Based on these insights, an online freely available *best practice evidence-based database* will be developed (contributing to Project Deliverable 2.2). Farmer's Pride consortium Partners and Ambassadors were asked to provide detailed information on landraces they knew: their general description and maintenance motivations, how they are cultivated, multiplied and managed across time, the procedures used to add value and market their products and the eventual availability of their seed. To collect this information a descriptive format was agreed and circulated among Farmer's Pride Partners and Ambassadors in May 2019 with the request to fill in information within July 2019.

By December 2019 over 100 case studies of landraces (broad sense) maintained on-farm were collected from 14 European countries. Landrace descriptions covered 49 different crops (including garden, open field and industrial) characterised by different propagation systems (i.e. autogamous and autogamous or vegetatively propagated). Four of these examples are described in this '*Landraces*' issue. From preliminary analyses of the whole collection of case studies, which will be soon available in a user-friendly format in the *best practice evidence-based database* (Project Deliverable 2.2), the following evidences of on-farm/in-garden conservation and management of landraces emerge.

First, there remains a wide interest in growing and using landraces across Europe, as already shown by the inventory results. Reasons for continued landrace cultivation are very diverse: consumers request the typical food of an area, resistance/tolerance to the particular biotic/abiotic constrains of a certain area, preferences of certain families or groups of people for a specific food, use of heterogeneous materials in sustainable agriculture (mostly organic), specific uses (*e.g.* ceremonies of a certain group of people or house roof thatching), simple willingness to increase the biodiversity of an area, love for a family heritage, or existence of specific funds to increase the diversity of a crop in a certain area.

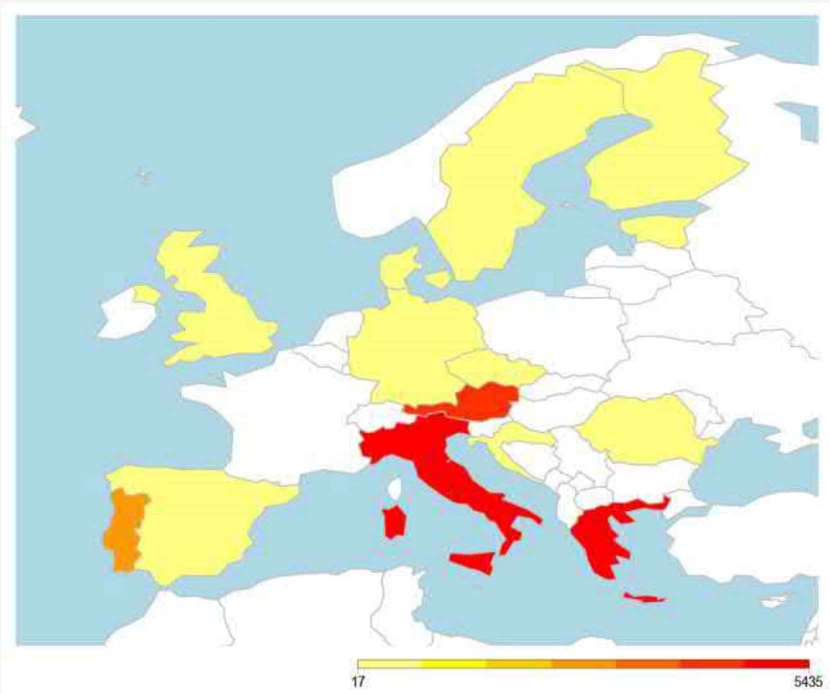

Figure 3. Heatmap of "number of records by country". In the figure, colours range from: faint yellow (very low) to dark red (very high) number of entries in relation to the maximum number.

Table 1. List of species and the relative number of landrace records.

Species	n.	Species	n.	Species	n.	Species	n.
Abelmoschus esculentus	88	*Cornus mas*	4	*Luffa cylindrica*	3	*Ribes plicatus*	1
Allium ampeloprasum	4	*Corylus avellana*	41	*Lupinus albus*	27	*Rorippa nasturtium-aquaticum*	2
Allium ascalonicum	3	*Crataegus azarolus*	10	*Lupinus spp.*	1	*Rosa gallica*	3
Allium cepa	279	*Crataegus laevigata*	1	*Maclura pomifera*	1	*Rubia tinctorum*	5
Allium porrum	42	*Crocus sativus*	1	*Malus baccata*	1	*Rumex rugosus*	1
Allium sativum	274	*Cucumis melo*	574	*Malus domestica*	948	*Salsola soda*	1
Allium schoenoprasum	2	*Cucumis sativus*	145	*Malus pumila*	7	*Salvia officinalis*	1
Amaranthus cruentus	1	*Cucurbita ficifolia*	23	*Malus sylvestris*	3	*Salvia x auriculata*	1
Amaranthus retroflexus	13	*Cucurbita maxima*	231	*Matricaria recutita*	1	*Satureja hortensis*	2
Anethum graveolens	48	*Cucurbita moschata*	231	*Medicago sativa*	47	*Scolymus hispanicus*	1
Apium graveolens	78	*Cucurbita pepo*	451	*Melissa officinalis*	1	*Secale cereale*	669
Arachis hypogaea	10	*Cuminum cyminum*	3	*Mentha pulegium*	2	*Secale multicaule*	111
Arbutus unedo	3	*Cydonia oblonga*	16	*Mentha spicata*	2	*Sesamum indicum*	26
Asparagus acutifolius	1	*Cynara cardunculus*	17	*Mespilus germanica*	5	*Setaria italica*	9
Asparagus officinalis	4	*Cynara scolymus*	56	*Morus alba*	21	*Sinapis alba*	2
Atriplex hortensis	6	*Daucus carota*	32	*Morus nigra*	22	*Sinapis arvensis*	5
Avena nuda	82	*Diospyros kaki*	40	*Nicotiana tabacum*	4	*Sinapis nigra*	5
Avena orientalis	4	*Dipsacus fullonum*	1	*Ocimum basilicum*	69	*Solanum lycopersicum*	838
Avena sativa	117	*Elettaria cardamomum*	5	*Olea europaea*	228	*Solanum melongena*	137
Avena strigosa	43	*Eriobotrya japonica*	25	*Onobrychis viciifolia*	44	*Solanum tuberosum*	179
Beta vulgaris	65	*Eruca sativa*	7	*Opuntia ficus-indica*	9	*Sorbus domestica*	23
Borago officinalis	1	*Eruca vesicaria*	6	*Origanum majorana*	5	*Sorghum bicolor*	51
Brassica juncea	1	*Fagopyrum esculentum*	775	*Origanum vulgare*	17	*Spinacia oleracea*	41
Brassica napobrassica	4	*Ficus carica*	111	*Oryza sativa*	5	*Tanacetum cinerariifolium*	1
Brassica napus	41	*Foeniculum vulgare*	14	*Panicum miliaceum*	20	*Thymus vulgaris*	2
Brassica nigra	7	*Fragraria vesca*	5	*Papaver somniferum*	560	*Trifolium alexandrinum*	1
Brassica oleracea	434	*Gossypium hirsutum*	1	*Petroselinum crispum*	110	*Trifolium hydridum*	1
Brassica rapa	163	*Hedysarum coronarium*	5	*Phaseolus coccineus*	76	*Trifolium pratense*	121
Calendula officinalis	2	*Helianthus annuus*	35	*Phaseolus lunatus*	1	*Trifolium repens*	8
Camelina sativa	110	*Helichrysum italicum*	1	*Phaseolus vulgaris*	1781	*Trifolium squarrosum*	1
Capsicum annuum	446	*Hordeum vulgare*	150	*Phleum pratense*	4	*Trigonella caerulea*	5
Capsicum chinense	5	*Humulus lupulus*	18	*Pimpinella anisum*	9	*Trigonella foenum-graecum*	6
Capsicum frutescens	40	*Hypericum perforatum*	1	*Pistacia vera*	5	*Triticum aestivum*	256
Carthamus tinctorius	1	*Jasminum officinale*	2	*Pisum sativum*	209	*Triticum dicoccum*	95
Castanea sativa	80	*Juglans regia*	27	*Prunus armeniaca*	54	*Triticum monococcum*	233
Ceratonia siliqua	6	*Lablab purpureus*	13	*Prunus avium*	513	*Triticum spelta*	1820
Chaenomeles japonica	1	*Lactuca sativa*	207	*Prunus cerasifera*	2	*Triticum spp.*	11
Cicer arietinum	149	*Lagenaria siceraria*	71	*Prunus cerasus*	28	*Triticum turgidum*	83
Cichorium endivia	8	*Lathyrus cicera*	2	*Prunus domestica*	149	*Vicia ervilia*	16
Cichorium intybus	51	*Lathyrus clymenum*	13	*Prunus dulcis*	68	*Vicia faba*	228
Citrullus lanatus	177	*Lathyrus ochrus*	31	*Prunus persica*	121	*Vicia narbonensis*	1
Citrus limon	7	*Lathyrus sativus*	68	*Punica granatum*	33	*Vicia sativa*	7
Citrus lumia	1	*Lavantula officinalis*	1	*Pyrus communis*	712	*Vigna unguiculata*	270
Citrus medica	1	*Lens culinaris*	151	*Raphanus raphanistrum*	5	*Vitis vinifera*	445
Citrus reticulata	2	*Levisticum officinale*	1	*Raphanus sativus*	36	*Zea mays*	623
Citrus sinensis	18	*Linum usitatissimum*	23	*Rheum rhabarbarum*	21	*Ziziphus jujuba*	6
Coriandrum sativum	89	*Luffa acutangula*	4	*Ribes nigrum*	1	-	

The predominant motivations for continuing the cultivation of certain landraces may also be different from landrace to landrace, and more than one motivation is often recorded. In many of the analysed examples, on-farm conservation of landraces was promoted by numerous activities funded by local, national, and in some cases also international, public or private entities. These supporting entities gave, and in some cases are still giving, scientific and/or financial support for the landrace characterisation (*i.e.* the description of the landrace) and valorisation. Among the means of valorisation of the landrace products, the acquisition of quality marks awarded by the European Union (like the Protected Designation of Origin or the Protected Geographical Indication) and/or of other brands were recorded.

Such brands help increase the commercial value of landrace products, which in turn makes landrace cultivation more attractive for new generations of farmers. These aspects are of great importance to guarantee a long-term conservation through use of landraces (broad sense). In other examples, promotion mainly relied/relies on local fairs, festivals and traditional happenings, demonstrating the profound link between a certain landrace and local culture. Even if product processing has not been specifically analysed in the case study collection, we gathered clear evidences that product processing played a key role in enhancing market extent, product marketability and adding value of some landraces [*e.g.* Orkney Bere (barley), Aglione della Val di Chiana (great-headed garlic) and Mais di Storo (maize)].

As for the on-farm/in-garden management practices that are carried out to multiply plant material, most of the collected evidence demonstrates that farmers (alone or grouped in consortia) are the main actors carrying out multiplication. The same crops, or similar crop groups, are managed using slightly different multiplication strategies and selection methods that may affect the main features of the landraces. However, even if differences in multiplication management of on-farm/in-garden similar crops exist, the analysed set of data allowed us to identify key management elements characterised by different levels of relevance within the diverse identified crop categories. Based on the results of this example collection, common management guidelines for landraces of different crops will be drawn to help new farmers interested in starting on-farm/in-garden conservation of landraces (Project Deliverable 2.4).

Perhaps surprisingly, an initial analysis of the collated examples shows that only a fraction of landraces are registered within the European seed legislation framework (*i.e.* as "conservation varieties" or "amateur varieties") and only few small, local seed companies are involved in their multiplication and commercialisation. In fact, most seed companies have a limited interest in producing and commercialising landrace seed due to its limited market extent and to national or European catalogue registration fees. The involvement of a local seed company in the multiplication process could bring important technical advantages, especially concerning seed quality (*i.e.* guaranteeing germinability, purity and freedom from diseases as required for seed commercialisation). In this context, the registration of landraces in the European catalogue of varieties could be an important means to scale up their conservation, use and market.

It should also be noted that, as from the recorded examples, information on the genetic outcomes of the applied multiplication procedures for landraces is poorly known. It appears that further scientific investigations are needed in this field: availability of such knowledge would help landrace maintainers in sustaining and maximising the level of on-farm/in-garden conserved genetic diversity across time and thus promoting on-farm/in-garden landrace evolution. All the collated examples will populate the *best practice evidence-based database* for on-farm conservation and management, that, although implemented by the Farmer's Pride consortium, will be available on the ECPGR web site. This database will be a useful tool to help farmers to initiate landrace on-farm conservation and for farmers already maintaining and managing landraces to sustain their promotion activities.

How to evaluate the efficiency of a network

On the basis of the examples of Greek, Italian and Swiss networks, of other networks described in Farmer's Pride Milestone 1, and of discussion with involved Partners and Ambassadors, a set of criteria for the evaluation of the efficiency of a network in securing and giving access to landrace diversity was proposed that is going to be published on the Farmer's Pride web site (Milestone 4). This could be a useful tool for monitoring future network functionality.

Acknowledgments

Thanks are due to all the Farmer's Pride Consortium Members, Farmer's Pride Ambassadors and ECPGR national coordinators for providing data and examples of landraces maintained on-farm and all the stakeholders that took part in the online consultation.

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CONECT-e: Documenting, sharing and protecting Spanish traditional knowledge on landraces

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Abstract
The CONECT-e project aims to become an example of how to integrate traditional ecological knowledge, education, science and society in a more democratic and inclusive process of knowledge co-creation and sharing. In order to do that, a wiki-like digital platform (www.conecte.es) was launched in 2017 to document, share and protect Spanish traditional ecological knowledge. The platform has a dedicated section for landraces, which aims to be a dynamic inventory of the Spanish landraces and their associated traditional knowledge. In this article we describe the initiative and highlight some of the main objectives attained and challenges faced.

Introduction
Traditional agroecological knowledge is a particular domain of traditional ecological knowledge (TEK), referring to knowledge of different landraces and agroecological management techniques used in a given landscape and passed through generations of farmers. This knowledge is largely being lost in Europe (Hernández-Morcillo et al. 2014), yet at the same time, Europe is experiencing an increase in the number of people who adopt sustainable agricultural practices, as can be seen, for example, in the growing number of citizens interested in agroecology and landraces preservation (van der Ploeg 2008).

However, the young population interested in agroecology does not always have access to TEK-related information, a gap they often try to fill by looking for this information online. Nevertheless, elders from rural communities, who currently are the main holders of this knowledge, are not interested or do not have access to the information communication technologies (ICT) through which much knowledge is transmitted nowadays. Consequently, they are restricted to transmit their agroecological knowledge mainly to those with whom they have direct interaction (Karahasanović et al. 2009).

The paradox is then that, while traditional agroecological knowledge is being locally lost because oral knowledge transmission in not working, a different sector of the population, who has a demand for this type of knowledge, is not able to access it. Improving the communication flow between the two groups of actors has the potential to not only help to maintain the stock of traditional agroecological knowledge, but also to generate new knowledge, that would emerge from adapting traditional practices to the resurgent agroecological initiatives in Europe.

Given the potential sociocultural differences and geographical separation between the two groups, the challenge lays in achieving effective communication between them. In this context, the CONECT-e project emerges. Its objectives, challenges and achievements are described below.

CONECT-e: Merging tradition and ITCs through citizen science The CONECT-e project (*Compartiendo el CONocimiento ECológico Tradicional*, www.conecte.es) aims to address the communication gap described above in an innovative way: applying new ICT tools and citizen science to document traditional plant uses and management practices, in order to make them widely available to society. To do so, in 2017 CONECT-e launched a wiki-like citizen-science digital platform. This platform is open to the general public, so anyone can provide new information and consult information entered by other people. Users can provide their own knowledge or act as citizen researchers, interviewing knowledgeable people and entering information in the digital platform. CONECT-e allows different levels of participation: consult, contribute and edit content provided by others. Editors are scientists or experienced citizen scientists who validate the information added to the platform.

To enhance participation, a complementary educative programme has been developed to work with students from rural agricultural technical schools. The programme consisted of several workshops that took place during the 2016-2017 school year. The objective has been to disseminate the importance of TEK in agroecology and promote TEK exchange between generations at a local scale. By working on the intergenerational transmission of knowledge between youngsters and elders, the project has bridged the communication and technological gap currently faced by traditional knowledge holders.

The project is a collaborative initiative built by a multidisciplinary team from five universities and research centres (Universitat Autònoma de Barcelona, Universidad Autónoma de Madrid, Universitat de Barcelona, Institut Botànic de Barcelona and Instituto Madrileño de Investigación y Desarrollo Rural, Agrario y Alimentario) and the Spanish Seed Network (Red de semillas Resembrando e Intercambiando, RdS). The academic team is part of a wider team (including researchers from 29 institutions) devoted to the documentation of TEK in Spain through the Spanish Inventory of Traditional Knowledge related to Biodiversity.

Figure 1. Landraces sheets on CONECT-e's front page.

The RdS is a non-profit, decentralised organization created in 1999 with the aim of encouraging the sowing and exchange of landraces (www.redsemillas.info). The RdS brings together more than 20 regional and local seed networks from all over Spain, forming a very diverse, dynamic, and geographically dispersed group of stakeholders.

A digital inventory of Spanish landraces

CONECT-e has a section dedicated to landraces, with the goal to create a dynamic inventory of landraces and associated traditional knowledge, with a page dedicated to each landrace, defined by its local name, plant species, and the region where it is cultivated. Users can create a new landrace page in the platform or enter information in the already existing ones. To create a new landrace page the user must confirm that it has been used and cultivated in a certain region for at least 30 years (Calvet-Mir et al. 2018). The platform recommends users to share at least one photo of the landrace in order to facilitate the validation of the information. Users can enter information regarding landraces' local names, description (growth habit, life cycle, flavour, etc.), traditional uses and management, and where to find seeds or other propagules (i.e., seed banks, seed networks or farmers). Moreover, the information can be entered in a map where the geographical distribution of the landraces is presented (Figure 2).
The current version of the platform was launched publicly in February 2017. In September 2019, the 668 users have recorded 556 landraces.

Figure 2. Map displaying the municipalities where the bean landrace 'mongeta del ganxet' (*Phaseolus vulgaris* L.) is cultivated.

To date, the information has been accessed 297,000 times and there have been 24,145 information entries, (an entry equals an information input). Regarding the content entered in the platform, the most prevalent species are tomato (*Solanum lycopersicum*), with 73 landraces documented, followed by the common bean (*Phaseolus vulgaris*) with 50 landraces, and the apple tree (*Malus domestica*) with 41 landraces. Crop groups are not documented evenly, since most of the landraces are vegetables and fruit trees, while cereals or fodder species are under-represented. The landraces with more contributions are 'mongeta del ganxet' (*Phaseolus vulgaris*) from Catalonia, and 'bubango' (*Cucurbita pepo*) and 'boniato saucero' (*Ipomoea batatas*) from the Canary Islands.

The information recorded in the platform contributes to the Spanish Inventory of Traditional Knowledge related to Biodiversity, a Spanish Government funded project that is documenting the biocultural heritage of Spain in a series of publications (Pardo de Santayana et al. 2014, 2018 a,b,c; Tardío et al. 2018). This inventory compiles the traditional knowledge of cultivated and wild plants registered in published works. Despite this exhaustive compilation, some thematic and geographical gaps have been detected, with some areas (e.g. Canary and Balearic islands, Catalonia) having received more scholarly attention than others (e.g., the northwest and the southwest and northern plateau). CONECT-e holds the potential to cover the spatial and thematic gaps in the documentation of TEK because citizens from any geographical region can enter information on any domain of knowledge (Calvet-Mir et al. 2018). Furthermore, CONECT-e frees TEK from its territorial boundaries, which eases its sharing and promotes its use among an extended and geographically dispersed community (Reyes-García et al. 2018). Regarding landraces, CONECT-e has the potential to be a source of information for the Spanish government. The official register of varieties in Spain (Oficina Española de Variedades Vegetales) registered 98 landraces from 20 crop species in the last decade, while CONECT-e documented 556 landraces from 88 species in two years (Reyes-García et al. 2018).

This difference can be explained because documenting the existence of a landrace is much simpler and flexible in CONECT-e than in the official register. Moreover, the use of citizen science is a way to include the people that still cultivate and use the landraces – farmers and seed networks – in the documentation process.

Landraces under copyleft license

The CONECT-e team (i.e., the RdS and the researchers involved) are concerned about the risk of misappropriation when disseminating the knowledge related to landraces. To minimize the risk, all the content of the platform is protected under a copyleft license, a way to guarantee non-exclusion by allowing reproduction and exchange of information. Specifically, the license used is the Creative Commons Attribution-ShareAlike 4.0 International License (CC BY-SA 4.0), which requires that any product using original or modified content is protected under the same license, impeding the establishment of copyrights or trademarks over it. This licence ensures the rights and access of the farmers over the knowledge on landraces that they contributed.

The platform has the potential to be a tool in cases of landraces misappropriation. Documenting the existence of these landraces in CONECT-e, specifically the local names and the distribution map, has been used by seed networks and farmers to reclaim landraces as a common good. That was the case of the 'bubango' (*Cucurbita pepo*), a well-known and highly valued landrace from the Canary Islands whose name was appropriated by private companies to mislead consumers and sell hybrids (Panizo and Perdomo 2017). As one of the actions of the campaign to reclaim the use of the name 'bubango' only for the landrace produce, the local seed network registered in CONECT-e a very complete page describing the landrace.

Conclusions

Firstly, CONECT-e contributes to the documentation, sharing and protection of traditional agroecological knowledge in two innovative ways. First, CONECT-e helps complement information in national databases and fosters the exchange of landrace information among an extended community of potential users that are not necessarily physically linked, as is normally the case with traditional knowledge (Reyes-García et al. 2018). In that sense, CONECT-e contributes to raising societal awareness about the value of traditional agroecological knowledge sharing it with the larger society.

Secondly, CONECT-e also protects traditional agroecological knowledge posted in the platform from misappropriation using a copyleft license which guarantees that landraces' names and knowledge remain in the public domain. The landrace section in CONECT-e creates a dynamic inventory of landraces and associated traditional knowledge, which – at the same time – helps complement national databases and can be useful to contest issues related to the misappropriation and enclosure of landraces knowledge.

Acknowledgements

We thank the IECTB, IECTBA and CONECT-e teams for their work. Research leading to this article has received funding from the Spanish government through 1) a grant of the Spanish Economy and Competitiveness ministry (CSO2014-59704-P), 2) three grants of the Spanish Agriculture, Fishery, Food and Environment ministry (TEC0004583, TEC0003351, TEC0003909) and 3) one grant from Fundación Biodiversidad. This work contributes to the 'María de Maeztu Unit of Excellence' (MdM-2015-0552).

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Reconstructing a common bean landrace for sustainable agriculture

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Use and conservation of agrobiodiversity are widely recognised as essential elements to sustain future food production and food security (Esquinas-Alcázar 1993). Currently, contemporary agriculture uses only a little portion of the potentially available diversity; this is true for many major crops, where the relatively low number of varieties are bred to perform best under optimal agronomic conditions, usually characterised by good nutrient availability, low pest and disease pressure and near-absence of weeds.

However, in marginal areas, where difficult conditions can limit the advantages brought by the use of the latest agronomical techniques, modern homogeneous varieties may not always perform well. The same is true when modern varieties are used under low-input or organic management systems where such materials may not have those traits that can positively affect yield and yield stability. Actually, it is generally recognised that poor yield stability is among the major limitations of organic or low-input farming due to limited availability of purposely bred varieties and/ or of products for weeds, pests and diseases management; poor yield stability can negatively affect both income generation for farmers and prices of the final products on the market. So, how can we cope with that?

Presently there are different strategies that can be applied to overcome such disadvantages especially in annual crops. A possible strategy is to increase the biological diversity within a certain cultivated crop; the idea being that genetic and morpho-phenological diversity are theoretically expected to contribute increasing resilience and yield stability over time and across different environmental conditions (Tilman 1999; Raggi et al. 2017). A brief description of an experiment carried out on barley at the University of Perugia is reported in the following article of this Landraces issue.

When considering self-pollinating species, basically two different techniques can be applied to increase the within population diversity. The first procedure consists of creating mixtures of existing uniform cultivars; interestingly, such materials demonstrated improved abilities to buffer soil variation, different levels of weed pressures and also the ability to contain fungal and virus disease diffusion. The second approach relies on the creation of segregating populations in which a number of certain diverse founder genotypes are crossed with each other rather than physically mixed. In this case the idea is to generate a population of recombinant individuals that is left to evolve in different environmental conditions, especially where locally adapted varieties are needed, without applying any active selection. In the long-term (i.e. after many generations), this approach should theoretically guarantee that frequencies of adapted 'types' would increase without creating a uniform population. Such populations – called Cross-Composite Populations (CCPs) – can be considered 'modern reconstructed landraces'. Such procedures have been recently and successfully applied to different cereal species including wheat and barley (Thépot et al. 2015; Raggi et al. 2016, 2017).The use of CCPs in organic and low-input farming systems has generated a certain interest especially in cereals. In particular, it has been demonstrated that such populations can produce very positive results in terms of yield stability (Raggi et al. 2017).

As the matter became quite interesting, because of some positive scientific evidences, the Department of Agricultural Food and Environmental Science (DSA3) of the University of Perugia (Italy) in collaboration with the Research Centre for Cereal and Industrial Crops (CREA-CI, Bologna, Italy) started developing a common bean CCP in 2016 (Figure 1).

Figure 1. A tunnel located at the experimental station of CREA (Anzola dell'Emilia, Bologna, Italy) in which the crosses were carried out. Photo: Leonardo Caproni.

The development of a common bean CCP would represent: i) a scientific tool in experimental evolutionary studies aimed at understanding allele frequency dynamics across time and space for this species, ii) a useful resource to be directly used for production under organic and low-input conditions and iii) a dynamic reservoir diversity for this crop based on locally adapted materials in a readily exploitable form (possibly used in breeding programmes).

The common bean CCP is currently under development; its creation has been based on the cross of five diverse common bean pure lines (founder genotypes); each of them has been developed starting from bushy landraces of different origins that have been selected within a panel of 67 diverse bushy lines that are part of the 'common bean panel of diversity' held by DSA3 (Caproni et al. 2019).

Notably, as this material is being mainly developed for direct use and breeding purposes, we only focused on founder lines characterised by small plant size; this would allow a convenient use for relatively dense cultivation under open-field conditions also allowing mechanical harvest. Hopefully, the common bean CCP will be available by the end of 2020, when the first CCP generation will be delivered.

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Reconstructing a barley landrace for sustainable agriculture

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Although rich in landraces of several crops, a few landraces of barley are still present in Italy and barley cultivation mainly relies on the use of modern cultivars (pure lines). With the aim of serving the request of variable materials for low input and organic systems and building up experimental material for short-term evolution studies, in the early 1990s we started an Evolutionary Breeding programme for barley.

Initially, different Parental Populations (PPs) showing good agronomic performances under low input conditions in Central Italy (Negri and Petti 1995) and, at the same time, high genetic diversity were selected. In 1997, the selected PPs were intercrossed to produce a Composite Cross Population (CCP). The CCP (named AUT DBA) was then multiplied for nine successive years under low input management system without any artificial selection (Raggi et al. 2016a; 2016b).

In 2010, a line mixture named MIX48 was developed (Figures 1 and 2) by mixing an equal number of seeds harvested from 48 individual plants from the AUT DBA characterised by high grain yield, low lodging and high diversity for all other morpho-phenological traits considered (i.e. days to heading, plant height, kernel and hectoliter weight). As such, MIX48 selection was aimed at increasing the agronomic performances of the original CCP, while maintaining a high level of morpho-phenological diversity and a favorable combination of traits relevant for organic and low-input agriculture (Raggi et al. 2017). This population, composed of both distic and polystic types, was proved to be highly productive and stable under organic and low-input conditions (Raggi et al. 2017).

Following the COMMISSION IMPLEMENTING DECISION of 18 March 2014 on the organization of a temporary experiment providing for certain derogations for the marketing of populations of the plant species wheat, barley, oats and maize pursuant to Council Directive 66/402/EEC (notified under document C(2014) 1681), the University of Perugia registered the population MIX48 and started its commercialisation.

In 2019, over 2 tonnes of MIX48 seed were sold by the Department to farmers involved in organic or conventional agriculture. Some of them, in connection with a local brewery, are testing MIX48 suitability in producing a local beer. At the same time, malting and brewing quality of MIX48 is being tested at the University of Perugia where the first research institute on beer in Italy, the Italian Brewing Research Centre (CERB, http://www.cerb.unipg.it/english.html), is operative. Preliminary results of such experiments encourage the spreading of cultivation as well as the selection of a new mixture made of distic lines.

Figure 1. MIX48 barley population in the field at the experimental station of the University of Perugia, Sant'Andrea d'Agliano, (Perugia, Italy).

	STAGE 1	
from 1990/91 to 1994/95	Identification of PPs that performed well in LI	
1995/96	Manual cross of different PPs	
	STAGE 2	
1996/97	Harvested F1 grown separately	
1997/98	Harvested F2 bulked to produce the AUT DBA population	
	STAGE 3, natural selection	
	Selection product	Selection method
from 1998/99 to 2006/07	**AUT DBA**	**Multiplication under LI**
	STAGE 4, artificial selection	
	Selection product	Selection method
2007/08	***mix100*** selected from AUT DBA	Visual evaluation of 3000 plants for traits relevant in OA and LI systems
2008/09	***mix80*** selected from *mix100*	Evaluation of 100 individual plants for traits related to yield
2009/10	***mix48* and pure lines** selected from *mix80*	Evaluation of 80 lines (dense stand) for: heading time, plant height, lodging, yield and yield related traits
from 2010/11 to 2013/14	**Identification of high yielding and stable EBP materials**	Multi-environmental trials (dense stand) in Central Italy different locations

Figure 2. Schematic representation of the Evolutionary Breeding Programme carried out by the DSA3 (University of Perugia) for the selection of mix48 population (from Raggi et al. 2017).

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Apple delights past and future: old apple varieties and their conservation in Germany

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This article tells the old story of the apple's ancestry and its long way to Europe. It recounts some of its turbulent changes in taste and nutritional value, and gives an outlook into some recent breeding developments. Finally, it exemplifies the case of apple landrace conservation in Germany today.

A short history of apple cultivation

Presumed to have been the famous 'forbidden fruit' of the Garden of Eden, the apple has been depicted on many paintings illustrating the account of Adam and Eve from the Bible. Botanically, apples belong to the family of Rosacea, just the same as roses, pears, cherries and strawberries.

Malus domestica, Latin for the domesticated apple, has got several wild relatives occurring in nature, like *Malus pumila* or *Malus communis*. Plant scientists hold that the genetic ancestor of all the apples we eat today, *Malus sieversii*, grows in central Asia somewhere between China and Kazakhstan. There, it evolved for several million years within its mountain homeland, before it spread to other parts of the world. The history of apple cultivation presumably goes back 6,000 years, when traders carried the apple from central Asia to Europe.
Today, its general availability, affordable price and flavour make it the most often consumed fruit in the world.

There are more than 70,000 varieties of apples, with over 20,000 cultivated varieties. (Figure 1) While our modern apple cultivars are usually quite big, red, sweet and of round shape, their wild relatives are nothing alike. They can sometimes be found in the woods, bearing tiny, green, and extremely sour fruit (Figure 2). Henry David Thoreau, an American poet and naturalist, insisted that he much preferred the wild apple ('of spirited flavour') to the civilised versions. But even he admitted that the occasional bite was 'sour enough to set a squirrel's teeth on edge and make a jay scream.'

From sour to sweet – why the acidity matters

Why were apples intended to be sour in nature? The answer lies in the chemical composition of apples. The substances responsible for their acidity are malic acid, phosphoric acid and ascorbic acid. Even the cultivated fruits have an unpleasant acidity when they are not fully ripe. During the ripening process, the acidity steadily decreases and the sweetness of the fruit increases. This acidity in the early stages of growth prevents wild animals from eating it, thus preventing the releasing of yet unripe seeds.

The ratio between the acids and sugars contained in the growing fruit mainly determines the time of harvest. But even at the point of harvest, apples still contain a certain amount of acids. This time, they have another benefit. Acids are responsible for the conservation of the fruit during storage and transportation. Good storage quality was especially relevant during wintertime in the past, for a lack of other fresh fruits or refrigerators. Transportability is more important in nowadays' globalized world. You can observe the same phenomenon of conservation through acids in the food industry. Many canned products, for instance, contain acids to maintain durability.

Figure 1. From left to right: Pirol, Collina, Delcorf, Gravensteiner, Prinz Albrecht, McIntosh, Champion and Boskoop, different apple varieties growing on a farm in Northern Germany. Photos: Naomi Bosch.

Figure 2. A wild apple found in a forest in Croatia.
Photo: Naomi Bosch.

Why are today's apples sweeter?

Though apple cultivars of the past were of course never as sour as their wild relatives, they still contained a healthy acidity to improve their storing traits. In times before fridges and storehouses, this was ever more important. It helped secure stocks of healthy fruits even during winter. While the sweetness of a fruit used to signal 'edibility' to our ancestors, we have developed an overly sweet tooth in recent times. This was also helped by the emergence of cheap sugar production technologies in the 20th century, and so a change in 'taste' occurred in the western societies. These developments called for sweeter fruit varieties as well.

Since plant breeders breed varieties that are consumed and accepted by the population, our supermarkets are now filled with sugary tasting apple varieties, depleted of much of their former taste and features (Figure 3). Along with this loss of taste diversity comes a loss of precious, healthy substances. Among these lost substances is the above-mentioned ascorbic acid. This acid is also known as vitamin C – an essential nutrient to humans that helps maintain the immune system, functions as an antioxidant and is involved in the repair of tissue, among others. Older apple varieties generally contain larger concentrations of vitamin C compared to modern breeds.

Multi-talent flavonoid

Another 'lost' substance in modern apple cultivars are flavonoids. For humans, flavonoids have anti-inflammatory and anti-bacterial effects and help reduce the risk of cancer (González 2012) and cardiovascular diseases (Higdon 2009). In plants, flavonoids have the role of protecting plants from stresses, like drought, frost and UV-light, and are responsible for the colour and aroma of many fruits. (Samanta 2011) On the other hand, flavonoids also cause apples to turn brown after being cut and exposed to oxygen. Since brown apple-juice, for instance, wouldn't be quite as saleable and accepted by customers, plant-breeders have been breeding apple varieties with a lower flavonoid content. But that inevitably goes along with the compromise of apples being less nutritious nowadays.

A change of perspective

Plant-breeders are constantly in a tug-of-war of interests: higher nutritional value of the plants and fruits they are breeding, or higher yield? Good storage qualities and transportability or appealing sweetness and colour of fruits? One has to bear in mind that breeding new varieties is a costly undertaking. The whole process until a new variety can be put on the market takes 10-15 years and is connected with many uncertainties. Ultimately, the varieties produced will have to be accepted by the wider public and the farmers.

From the perspective of the farmer setting up an apple plantation, he has to make sure that his produce can be sold throughout the whole 20-30 years his trees will bear fruit. In his decision on which varieties to choose for his plantation, he will have to consider the trees' resistance to pests, their yield, their performance under stresses like drought or frost, the timing of the harvest, the quality of the fruits (whether destined for the juicing industry, baby food or consumption) and their acceptance by those who will ultimately buy and consume them. For instance, fruits from older apple cultivars are often not a standard size (too small, too big) and vary greatly in yield from one year to another (so-called alternation).

Flavour, scent and genetic diversity

These are some reasons for which older, local apple cultivars have been pushed from the market. The modern varieties that have replaced them are regrettably of less nutritional and aromaleptic value. Along with this, many locally adapted cultivars have disappeared not only from supermarket shelves, but from our landscape as well. This narrowing variety deprives us of some excellent aroma and extraordinary beauty.

Figure 3. Modern sweet apple varieties compensate their bad storing capacity through a thicker peel. Photo: Maria Lindsey Multimedia Creator.

Figure 4. Farmer markets sometimes offer old apple landraces to their customers. Photo: Erik Scheel.

But genetic diversity (i.e. the diversity of plant varieties cultivated, and the genes contained in them) is also important for breeding in general. Its basis is and remains the naturally occurring diversity of species and varieties. Plant-breeders of the future will want to breed cultivars that are robust and resistant to plant diseases (as many older cultivars still are), well-adapted to their local environment, as well as to a changing global climate. For this, they will have to use the existing genetic diversity.

Of the existing 20,000 apple varieties, only four cover 70% of the European market! And most modern apple varieties have their genetic ancestry in just three cultivars (Golden Delicious, Cox Orange and Jonathan). This narrowing genetic diversity is a problem. To do something about it, we will need to look into the past, as well as into the future. Rediscover some old apple varieties, and you will realize that they are necessary for maintaining future breeding work, too. Only recently, *Nature* published an interesting paper on that topic (Wang 2018). The research discusses the role of *Malus sieversii,* the domestic apple's ancestor from Asia, in breeding apple varieties with a higher flavonoid content. Australia's agricultural department is also currently leading research into breeding flavonoid-rich apples again.

Apple landrace conservation in Germany

In Germany, just like in the rest of Europe, the knowledge of old landraces has dramatically declined. Supermarkets, as the main provider of food for the general public, offer a very limited variety of apples. But in recent times, the protection not only of the local landraces, but of the traditional landscape of orchard meadows as a whole has gained more attention. The care or re-establishment of these traditional orchards is encouraged through financial help either from private initiatives or the state, depending on the region. This is seen as a way of conserving apple landraces as well, since it is often landraces that are planted here.

As for the consumers, increasing awareness of the benefits of old apple varieties can be observed, especially among people with an apple-allergy. Farmers markets, notably the organic sellers, sometimes have apple landraces in stock (Figure 4). For organic apple growers, old landraces are potentially of higher interest because they necessitate less pesticide input. Still, the conservation of old apple landraces is largely in the hands of private, hobbyist apple growers, as well as direct marketers with a suitable clientele. While many landraces are in danger of extinction and live on only in small private orchards, the case of Seestermüher Zitronenapfel landrace is an interesting exception to this.

Seestermüher Zitronenapfel

Seestermüher Zitronenapfel is named after its place of origin, the Seestermüher marshlands at the Lower Elbe in Schleswig-Holstein (Northern Germany). Here, it was found as a chance seedling around 1930. Other names include Goldgelbe Renette or Kohlapfel. The attribute 'Zitronenapfel' (meaning 'lemon apple') is probably due to the apple's yellow colour (Figure 5).

The fruits of this landrace are relatively large, ellipsoid in form, with a distinctive olive-coloured rust-coating around the stalk. The peel is matt, first green in colour and then turns green-yellow to bright yellow (Figure 6). The pulp is white, aromatic, of a sweet acidity and very juicy (often, even the core is filled with juice). The tree grows erectly and remains relatively small. In contrast to many other older apple varieties, Seestermüher Zitronenapfel is not affected by strong alternation. Apple varieties with alternation have substantial yields only every two years. But Seestermüher gives high, regular yields: between 40 and 50 tonnes per hectare in good years. Harvest of this cultivar takes place from mid-September. Being a winter variety, Seestermüher can be stored and eaten until January. But due to its acidity, it is not widely distributed for direct consumption. Rather, it is used in the juicing industry, given its excellent juicing properties. Additionally, it is a robust landrace, not very prone to plant diseases.

Figure 5. A young tree of Seestermüher Zitronenapfel with fruits. Photo: Wikimedia Commons.

The tree is triploid, therefore it depends on pollination from other varieties. Seestermüher Zitronenapfel is regionally threatened with extinction. Therefore, it was elected the 'Orchard meadow variety of the year' in Hamburg in 2007 to give it more attention in the public. Surprisingly, in Mecklenburg-Vorpommern, the neighbouring district to Schleswig-Holstein and Hamburg, it has been widely distributed since the 1980s.

Along with the varieties Remo and Rewena, it is the most significant apple variety for the processing industry in Mecklenburg -Vorpommern. Besides for the industrial juicing companies, a local niche market exists for pure 'Seestermüher Zitronenapfel juice' produced by a local company in Rostock, Mecklenburg-Vorpommern.

Notably, the farms cultivating Seestermüher can be found in Ludwigslust-Parchim, Rostock and Vorpommern-Greifswald. Due to the humid climate and wet soils in this region (similar to the area of its origin), Seestermüher grows excellently here. Lately, it is even being considered as a parent in a participatory organic fruit breeding programme in Northern Germany (Wolter 2018). Given the fact that Seestermüher is a locally-adapted landrace and not prone to plant diseases such as apple scab and canker, its genetic material has excellent predispositions for being used in (organic) fruit breeding.

To conclude, Seestermüher Zitronenapfel is an important landrace for the local apple processing industry and a valuable genetic resource. It is well established here and is not expected to decrease in cultivation in this region, contrary to its neighbouring region of origin where it is still in danger of extinction.

Even though this is a very positive and encouraging example of how a landrace can be conserved and implemented in farms on a larger scale, many other apple landraces are not in such a favourable position. Further efforts need to be made to maintain genetic resources of the many apple landraces and to preserve the diversity of agricultural landscapes.

Acknowledgment: I want to thank Dr. Rolf Hornig and Gundula Unger for kindly providing me with information about Seestermüher Zitronenapfel and its cultivation in Mecklenburg-Vorpommern.

Figure 6. Seestermüher Zitronenapfel fruits. Photo: Wikimedia Commons.

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Bróquil (*Brassica oleracea* var. *italica*) landraces in the Aragón region (Northeastern Spain)

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Bróquil is a traditional winter cole crop typical in the Northeast of Spain, mainly in Huesca province. It is locally produced for its organoleptic traits, with a peculiar taste. It is grown in family orchards for auto-consumption, but also in small farms for local markets. Bróquil edible parts are a mix of young leaves and inflorescences or heads. Plants show many axillary sprouts formed by a group of leaves with a central inflorescence of variable size.

Under the name of bróquil, two different types of plants are cultivated by farmers in our region: the 'green bróquil' type (locally known as 'bróquil verde') and the 'headed bróquil' type (or 'bróquil pellado'). Figure 1 shows an example of both typologies. Many sprouts, born from axillary buds of older leaves, form the green bróquil plants. A group of young leaves surrounding a small curd ,when the floral stage arrives, forms each sprout. Nevertheless, curd size is bigger in headed bróquil type and curds predominate over leaves. Color heads are yellow, from pale to yellow green. It seems that both bróquil types are ontogenetically younger than broccoli inflorescences, remembering cauliflower. Marketable maturity arrives when curds start to appear and form together with the leaves, a compact plant structure.

Taxonomy

Bróquil belongs to Brassicaceae family, previously known as Cruciferae, specifically to the *Brassica oleracea* L. species. *B. oleracea* L. is an important species that probably originated in the eastern Mediterranean area (Babula et al. 2007), although this point is controversial. From the East, it dispersed towards the North and the South of Europe originating a heterogeneous group, considering both morphological characters and culinary uses. As Ciancaleoni et al. (2014) pointed out, the extreme plasticity of the species, the possibility of wide crossing with many other species belonging to the same genus, as well as to Brassica-related genera and human selection during domestication have differentiated a large number of cultivated forms. In that way, the species include cabbage, broccoli, cauliflower, kale, brussels sprouts, collard greens, savoy or kohlrabi, in addition to several traditional forms locally known, as bróquil, and also all the oriental forms not common in our continent.

Taxonomically, each *B. oleracea* form belongs to a specific botanical group. In the absence of more detailed studies, bróquil belongs to *B. oleracea* L. italica group whose main member is broccoli. According to the main hypothesis, this group evolved from wild progenitors in the eastern part of the Mediterranean (Harberd 1976), where the first crops were probably domesticated, although others also suggest southern Italy as the domestication area (Maggioni et al. 2010).

A wide range of sprouting coloured headed broccolis exist in southern Italy, Sicily and small Italian islands, which would indicate this area as the main centre of diversity. Many different landraces are cultivated in both large fields and home gardens and are highly appreciated for their organoleptic traits by local people (Branca 2008). Gray (1993) summarized several forms of Italic group grown for fresh markets in that area. It includes purple sprouting broccoli, purple cape broccoli, white sprouting broccoli, purple Sicilian broccoli, calabrese or black broccoli. Calabrese type originates the actually worldwide known broccoli. White sprouting broccoli is described as 'overwintering, branched, white spears. Distinct early and late maturing forms of which the late type more strictly within the Botrytis group'. This description fits bróquil morphology, although general appearance of the plants and the spears development in bróquil looks different from white sprouting broccoli. Probably commercial relations between territories of historical Aragón kingdom contributed to the arrival of white sprouting broccoli seeds to actual Spanish territories, where the species continued to evolve.

Agronomic practices

Bróquil production involves traditional agronomic practices common to other cole crops such as cabbage, cauliflower or broccoli, usually cultivated at the same orchards. Bróquil is a cool-season vegetable. Seeds are sown in 200 cell plug trays, and young plants are then transplanted into the open field. The sowing season begins in the last week of June and is continuous up to August in order to transplant the young plants from the last week of July to the first week of September. It is a rustic plant well adapted to different type of soils. Land is prepared by ploughing. Previously, cow or sheep organic manures should be spread in the field. Then, the land should be levelled and conditioned before transplanting. Fertilisation rates follow other *B. oleracea* vegetable crop recommendations. Mineral fertiliser applications are usually split into pre-plant and one post-plant application. Total nutrient amounts depend on the soil properties, manure input, or previous crop species. Cropping area pH is commonly alkaline. A ridges and furrow type of layout is used for the crop. Typical plant spacing is single row with 60-80cm between rows and 45-70cm between plants in the row.

The most common irrigation system is by surface flooding, although drip irrigation is also frequent where technology is in place. Irrigation at the time of transplanting is essential. A steady supply of moisture is necessary for good growth and development. The interval between two irrigations depends upon climate, soil, plant growth and seasonal rainfall. In dry fall seasons, irrigation at an interval of 10-15 days is enough.

Many diseases and insects common to other cole crops also attack bróquil. The most common bróquil pest in the traditional growing area of Huesca are caterpillars, aphids, and whitefly. Lepidoptera cause very important damage. *Pieris rapae* and *Pieris brassicae* caterpillars devour leaves in only a few days. Also *Mamestra brassicae* and *Plutella xilostella* could attack the crop. Aphids as *Brevicoryne brassicae* and the Hemiptera *Aleyrodes proletella* may infest plants and spoil productions. Farmers tend to use conventional authorised chemicals to control pests, but biological products such as *Bacillus thuringiensis*, insecticidal soap, or pyrethrum are also frequently applied. Diseases are not important for this crop, although *Sclerotinia sclerotiorum* may sporadically affect some plants.

Bróquil cultivation takes place mainly on family orchards for on-farm consumption and only a few farmers produce for local markets. Bróquil harvesting is carried out dependent on the maturity of the sprouts. Plant material sow differences in days-to-harvest ranged from 190 to 220 days in our region. The green bróquil cycle is shorter than for headed bróquil, although this fact is dependent of plant material genetic properties. This vegetable is related to Christmas-time because is at that moment when first plants reach the local markets. Harvesting period prolongs to February. Increasing day-length induces flowering and then heads extend, harden, and depreciates production. Farmers cut the whole plant that achieves an average weight of four kilos at commercial maturity. External leaves are eliminated before they are sent to the market and only 10% of plant weight will be the raw ingredient to cook. No data of yield per hectare is known.

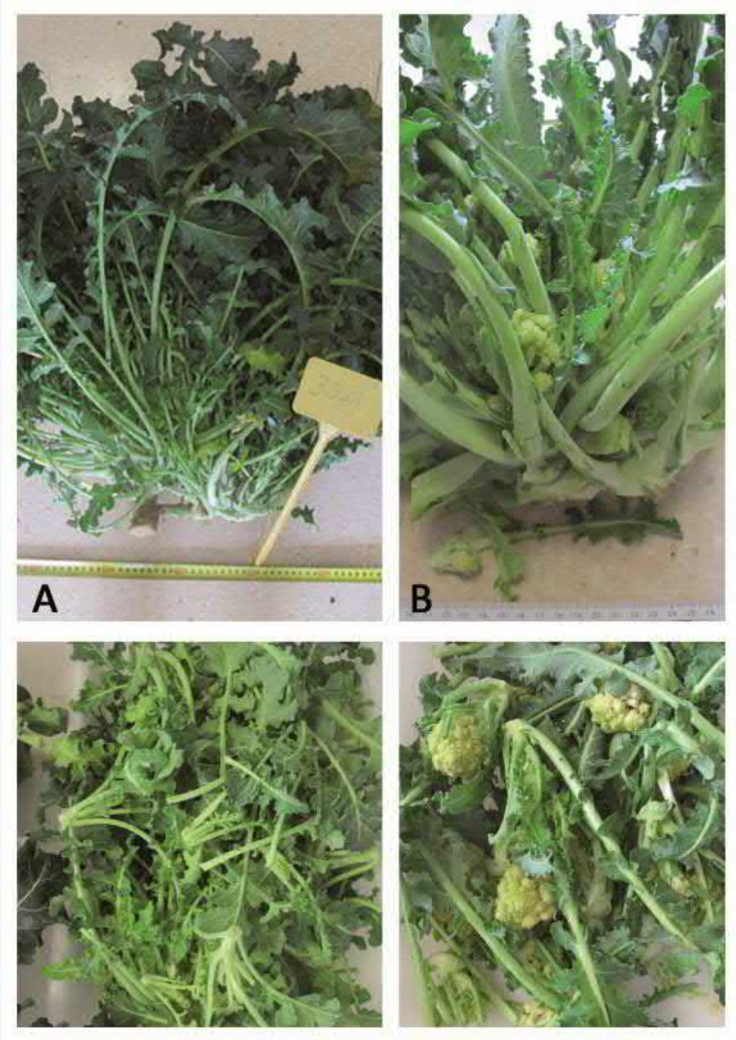

Figure 1. Bróquil landrace types. A: green bróquil and B: Headed bróquil.

Plant material and biodiversity

Nowadays, cultivated bróquil plant material comes from two nurseries located in Huesca, the capital of the province (Figure 2). Both nurseries produce only five varieties of seedlings, two green bróquil and three headed bróquil. Nursery owners multiply and maintain their own varieties year by year. Bearing in mind the *B. oleracea* open pollination behavior, this task has a big risk of losing landrace identity. In order to avoid crosspollination between different landraces or other brassica groups, nursery farmers multiply only one of them by year and they produce it in remote farms. No commercial bred material exists.

These landraces are kept in the Spanish vegetable genebank of Zaragoza (BGHZ in Spanish) where seeds are maintained in dryers and freezers. BGHZ was founded in 1981 and holds a collection of 17,425 accessions belonging to more than 300 vegetable species, mainly of Spanish landraces or farmers' varieties, but also crop wild relatives and neglected and underutilised species. Information about stored accessions is available in the Spanish National Inventory and EURISCO databases (FAO code: ESP027).

Figure 2. Local producers in Huesca. A: Oliván nursery; B: Barbereta nursery; C: Bróquil field; D: Marketing their own produce.

Table 1. Bróquil accessions stored in the Vegetable Genebank of CITA (BGHZ-CITA) in Spain (FAO code ESP027).

Genebank code	Bróquil landrace type	Origin		
		Locality	Province	Country
BGHZ2636	Headed / pellado	Huesca	Huesca	Spain
BGHZ2637	Headed / pellado	Huesca	Huesca	Spain
BGHZ2638	Green / *verde*	Huesca	Huesca	Spain
BGHZ3021	Green / *verde*	Barbastro	Huesca	Spain
BGHZ4057	Green / *verde*	Calatayud	Zaragoza	Spain
BGHZ6685	Headed / *pellado*	Binéfar	Huesca	Spain
BGHZ6686	Green / *verde*	Azlor	Huesca	Spain
BGHZ6687	Headed / *pellado*	Ayera	Huesca	Spain
BGHZ6688	Green / *verde*	Barbastro	Huesca	Spain
3,975	Headed / *pellado*	Barbastro	Huesca	Spain
4,548	Headed / *pellado*	Barbastro	Huesca	Spain
4,678	Headed / *pellado*	Huesca	Huesca	Spain
5,007	Headed / *pellado*	Huesca	Huesca	Spain
5,008	Green / *verde*	Huesca	Huesca	Spain
HU004	Green / *verde*	Ayera	Huesca	Spain
HU009	Green / *verde*	Arbaniés	Huesca	Spain
HU028	Headed / *pellado*	San Juan de Plan	Huesca	Spain

This genebank preserves a collection of 17 accessions of bróquil, mainly from Huesca province (Table 1). These accessions are being studied considering both agronomic and quality characteristics, in order to select for specific desirable traits to develop improved varieties of bróquil (Montaner et al. 2018) (Figure 3).

Figure 3. Experimental assay of bróquil. A and B: shaded house; B and C: field; D and E: sampling and laboratory analysis.

Ethnobotany of bróquil

Bróquil was deep-rooted in popular gastronomy, being usually grown during the 50th years in a lot of local orchards for self-consumption (Figure 4). The slaughtering of the pig used to take place at the same time as bróquil harvest dates, so it was very common to consume pig meat together with bróquil. In the 1960s, the first hybrid cauliflowers arrived, with different growing cycles, covering longer periods of time. In the 1980s, they started to grow broccoli, later romanescu, and recently bimi and kale.

These new varieties were very well accepted by farmers for their productivity, culinary characteristics, easy handling in the kitchen, taste, good acceptance by young people. All these factors had a share in displacing bróquil landraces as the predominant winter vegetable in the local area.

Figure 4. Traditional food preparation of bróquil with potato (A, B and C).

Today broquil is only grown by a few elderly local growers, who have grown bróquil since the dawn of time and know its excellent properties.

A local project has recently been initiated in order to promote bróquil among the people that no longer know this product, although it was very well known in the not too distant past.

Acknowledgements
The authors wish to recognise the farmers who donated the seeds to the genebank and those who are still growing their local varieties, enthusiastically collaborating for the recognition of this crop. The authors are also grateful to the Aragon Govern and the programme FEDER Aragón (2014-2020) for funding the PROVESOS group (Ref. A11_17R) and the Spanish National Institute of INIA for funding the vegetable genebank project RFP2015-00012-00-00. The grant obtained in the XXI Premios Félix de Azara 2019 (Diputación Provincial de Huesca) will enhance the promotion and the *in situ* conservation of bróquil genetic resources.

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‘Aglione della Val di Chiana’, a white gentle giant

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Introduction

Allium ampeloprasum L. is a species-complex that includes different types (i.e. cytotypes) commonly distributed across the countries surrounding the Mediterranean basin, spanning from North Africa, Southwest Asia to the South of England (Hanelt 1990,). It is commonly recognised that *Allium ampeloprasum* species-complex is composed of four genepools: wild leek, European leek cultivars (*A. ampeloprasum* var. *porrum* (L.) J. Gay), Egyptian kurrat (*A. ampeloprasum* var. *kurrat* (L.) Shweinf.) and great-headed garlic (*A. ampeloprasum* var. *holmense* (Mill) Asch. et Graebn) (Kik et al. 1997). The latter is characterised by large cloves and an oversized bulb when compared to common garlic. The great-headed garlic, also known as ’elephant garlic’, is propagated vegetatively; in fact its large flower heads are usually seedless (Guenaoui et al. 2013).

‘Aglione della Val di Chiana’ landrace

Already famous at the time of Pliny the Elder, mentioned by Dante in the Divine Comedy, drawn by Leonardo da Vinci (Figure 1), the Val di Chiana has always been a sort of swamp until Grand Duke Peter Leopold of Lorraine began the drainage. Therefore, this territory that belongs to the provinces of Siena, Arezzo (Tuscany) and Perugia (Umbria) was marshy until the 30s of the 20th century.

At the end of the 90s only few elderly farmers cultivated ‘Aglione della Val di Chiana’ (*Allium ampeloprasum* var. *holmense* (Mill) Asch. et Graebn.), a giant garlic. Many historical documents report the use of ‘Aglione’ in Italy since the beginning of the 16th century: it risked extinction, remaining for a long time only in family gardens.

Figure 1: Map of Val di Chiana, Leonardo da Vinci. 1503-1504. Windsor Castle, Royal Library, n. 12278 r.

Nowadays, circa 60 farmers that actively cultivate the landrace producing Aglione are grouped in two local associations: i) ‘Associazione per la promozione e la tutela dell’Aglione della Val di Chiana’ and ii) ‘Aglione di ValdiChiana’. Generally, due to its production cost, the cultivation is carried out on small surfaces (maximum 3 ha). Farmers cultivating ’Aglione della Val di Chiana’ do not generally exchange propagation materials except in some cases (e.g. cultivation failure due to unexpected environmental factors), when exchange can occur. Plants of ‘Aglione della Val di Chiana’ are not able, as other garlics (Guenaoui et al. 2013), to produce seeds; thus, the vegetative propagation by cloves is the only way to reproduce the plant. However, it is noteworthy that a farmer affirms that plants are (rarely) able to produce viable seed. Each farmer selects the biggest cloves (of about 60 g) as propagation material for the following season (Figure 2) .

From a first molecular screening (Terzaroli 2015), there was little genetic diversity within the landrace. This is reasonable considering that the cultivated material originated from plants conserved and cultivated by very few farmers and the fact that vegetative propagation produces clonal plants (Figliuolo and Di Stefano 2007). Currently, no *ex situ* backup has been carried out for ‘Aglione della Val di Chiana’, in fact cloves are not easy to store and they must be renewed every year in order to maintain a high viability. ‘Aglione della Val di Chiana’ is similar to garlic throughout its vegetative cycle, but its bulbs are much bigger (up to 1.5 kg of fresh weight) and characterised by a softer taste: this is probably due to the lack of allicin and other sulphur compounds in Aglione (currently studies are in progress at the University of Pisa). The tunic of the bulb is ivory white, while the bulbils skin is thick and yellow.

Within the cultivation area, cloves are generally sown between the 15th of September and the 15th of December in rows spaced 40-70 cm apart; within rows plants are spaced 25-40 cm. In order to keep the bulb as big as possible, in April flower shoots are manually removed; within the traditional area of production flower shoots are also used in some culinary preparations. Before and after flower shoot removal, weeds are removed manually or mechanically while fertiliser is generally applied before the sowing. The harvest is traditionally carried out manually by digging up the bulbs on Saint John’s day (June 24th) (Figure 3), but some farmers also use mechanical harvesters.

Valorisation and market

Nowadays, the Italian Ministry of Agriculture and Forestry has recognised this landrace as ‘Prodotto Agroalimentare Tipico’ (PAT, literally Typical Food Product). The PAT recognition is based on evidence that demonstrates the use of a landrace (or a processed foodstuff) in a certain area for at least 25 years. In recent years, ‘Aglione della Val di Chiana’ also caught the interest of the ‘Slow Food’ foundation that included it in ‘the Ark of Taste’, a group of products grown in small areas and with a high risk of erosion. Regione Toscana, within the EU’s Rural Development Plan 2014-2020, funded an historical research and morpho-phenological and genetic characterisation of the landrace in order to include it on the ‘Regional register of landraces’ of Tuscany Region. This activity is foreseen in the implementation of the Tuscany Region Law (n. 64/2004) which is aimed at safeguarding and promoting the cultivation of local genetic resources.

After the harvest, the bulbs are dried in fresh shaded rooms for at least two weeks, in which a drastic drop in weight (around 30%) occurs. However, it is also common to cook using bulbs that have not reached full maturity (i.e. before their usual harvest time): concerning this way of utilisation, it is not possible to place such material on the market. In recent years, the market of ‘Aglione della Val di Chiana’ has been quickly growing both locally and nationally.

Figure 2: Umbrella inflorescence produced starting from April-May. Photo: Niccolò Terzaroli.

Figure 3: A plant of ‘Aglione della Val di Chiana’, one month before ripening. Photo: Niccolò Terzaroli.

The landrace is commercialised as a row product (i.e. bulbs and cloves) or also as processed products such as ready-to-use sauces, creams and jams; many local restaurants use it for the preparation of a typical main course called ‘Pici all’Aglione’ (Figure 4) and as a substitute for common garlic.

The interest in this landrace also caught the attention of other European and non-European markets: it has recently been exported to the USA and Japan.

In addition to its culinary value, ‘Aglione della Val di Chiana’ is sustainable from an economic, social and environmental point of view: it is a low impact crop, which requires few fertiliser and phytosanitary treatments, ensuring a good income for the rural community.

Figure 4: ‘Pici all'Aglione’, a typical dish of Siena province.

Acknowledgments
Thanks are due to Matteo Finocchi for some of the information reported here.

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Common bean landraces (*Phaseolus vulgaris* L.) in the Maramures area

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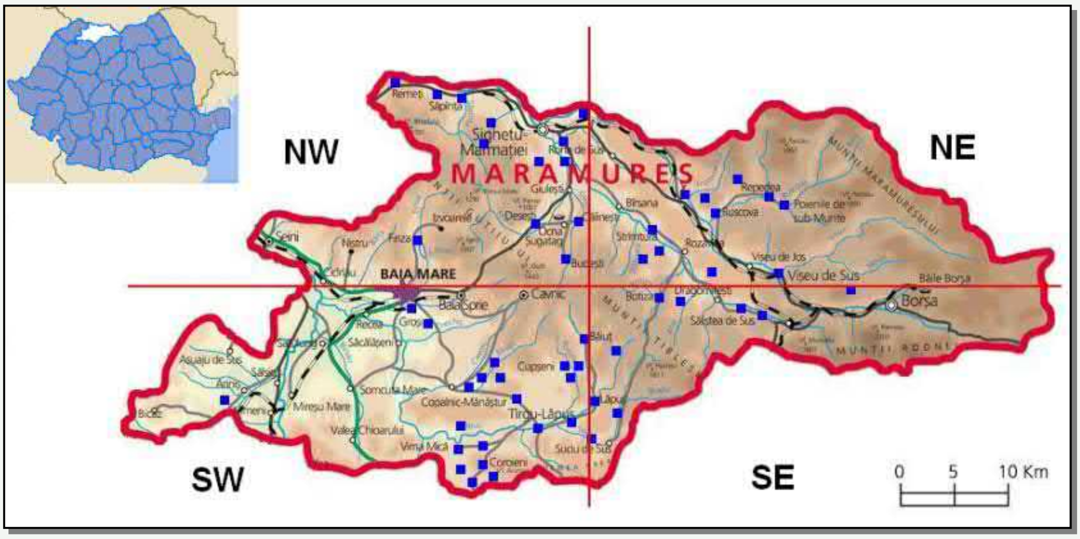

Figure 1. Surveyed villages across the Maramures area.

Placed in the northern part of Romania, Maramures County covers an area of 6 304 km², and half of its population live in rural zones. The present inventory is the result of surveying 55 villages spread on the whole surface of the county, including different ecological zones (Figure 1). In each of those 55 villages under study a number of 5 to 8 households were visited and certain data were recorded by filling out a questionnaire with codified answers, in order to save time and to get as much standardised information as possible. To get maximum efficiency from our interviews, the farmers were approached in an open and friendly way using regional words and explaining to them who we were and the reason of the visit.

The common bean represents the most important crop in the Maramures area, being used as food by rich and poor families. In all explored sites exclusively landraces were in cultivation. In total, 258 bean landraces were found at different study villages, grouped in 4 categories based on their geographic position (North-East, North-West, South-East, and South-West) see Table 1. The material was collected from farmers' fields, home gardens and farm stores.

Table 1. Number of bean varieties (*P. vulgaris* L.) collected from the surveyed villages

Geographic area	Number of villages	Number of bean landraces identified
North-West	13	64
North-East	11	42
South-West	22	85
South-East	9	67

It is remarkable that the diversity (the number of the grown landraces) is not uniformly distributed throughout the region. The first place is occupied by the Firiza area with 23 different varieties, followed by the Botiza area (21 varieties), while in the other 14 localities (Mocira, Baiut, Basesti, Coroieni, Costiui, Desesti, Lespedea de Jos, Stramtura, Suciu de Jos, Rogoz, Teceul Mic, Vadul Izei, Valenii Lapusului, and Viseul de Sus) a single form of *P. vulgaris* was found.

Based on the phenotypic assessment of all collected samples, a number of 67 distinct types was identified. They fall down into 8 colour categories, as shown in Figure 2.

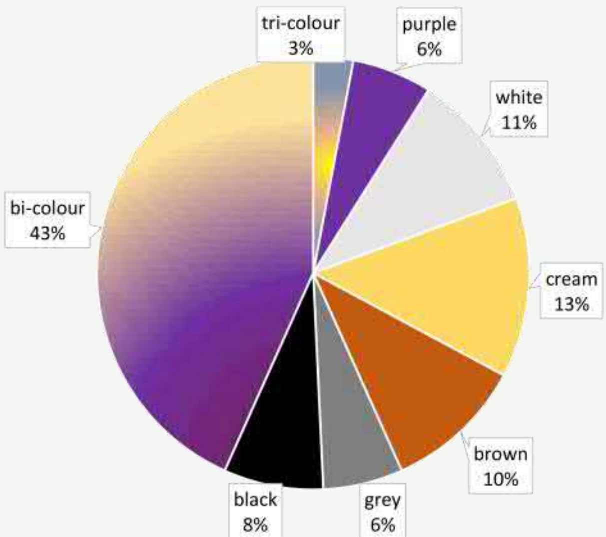

Figure 2. Number/percent of distinct bean landraces (*P. vulgaris* L.), according to their colour.

The gathered material contains both bush (17%) and climbing (83%) types showing the highest morphological variability expressed in seed colour, seed pattern, seed shape and seed size.

As a general rule, small seeded forms are grown for green or dry pod consumption, and types with large seeds are preferred for fresh and dry grain uses.

Regarding the spreading area it was found that bi-colour types, followed by those brown and white, are sown in large fields by many families, while types with black, grey and purple seeds are preferred by few farmers. A white type, characterised by large kidney seeds, is very common in the area most however, sow a pinto type landrace with oval shape and medium or large sized grains, which is appreciated for its gastronomic qualities.

Underlining that local name for bean landraces can not be used as a proxy indicator to discriminate between different varieties, some original names are listed in Table 2. An interesting aspect related to the local farmers' names given to different varieties of *P. vulgaris* L. is that people name them 'mazare', which means 'pea' while *Pisum sativum* is not grown at all, being almost unknown in the area.

The inventory of distinct landraces found in the Maramures region classified according to their colour, pattern, shape, and size, including the number of populations for each bean type is given in the Figures 3 and 4.

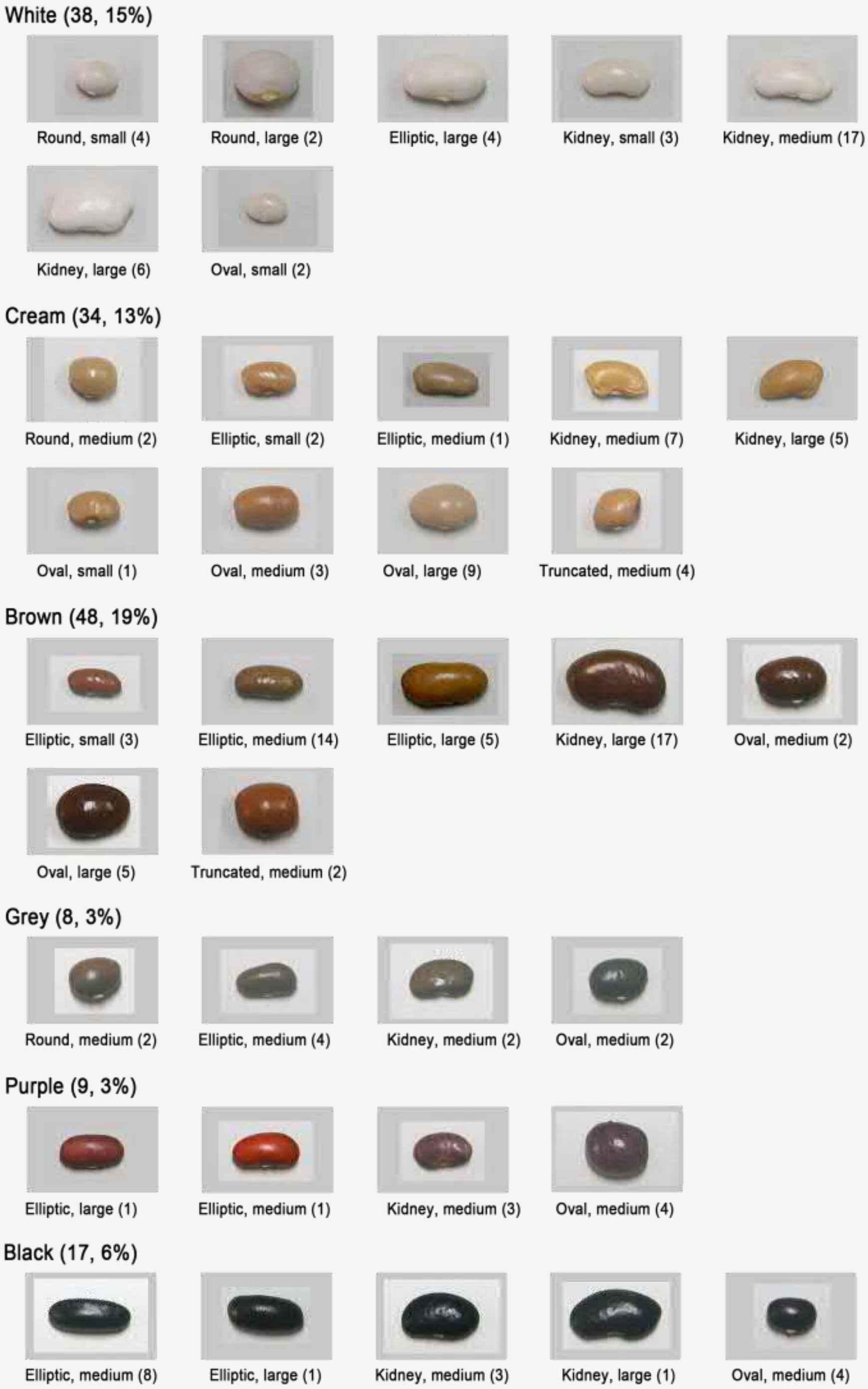

Figure 3. Common bean (*P. vulgaris* L.); classification by colour, shape and size in the Maramures area. For each colour group, absolute (n) and relative (%) number of landraces is reported. For subclasses (shape, size) the number of landraces is also reported.

Table 2. Local names for *P. vulgaris* L. across study community

Local name	n of landraces	Local name	n of landraces
Mazare uscata	28	Mazare de ruda grasa	1
Mazare urcatoare	33	Mazare de ruda	140
Mazare pitica	10	Mazare de pastai	11
Mazare de tirs	1	Mazare alba	2
Mazare de tufa	1	Mazare	7
Mazare grasa urcatoare	1	Fasole alba de ruda	2
Mazare grasa	14	Fasole de ruda	5
Mazare de ruda pestrita	1	Fasole	1

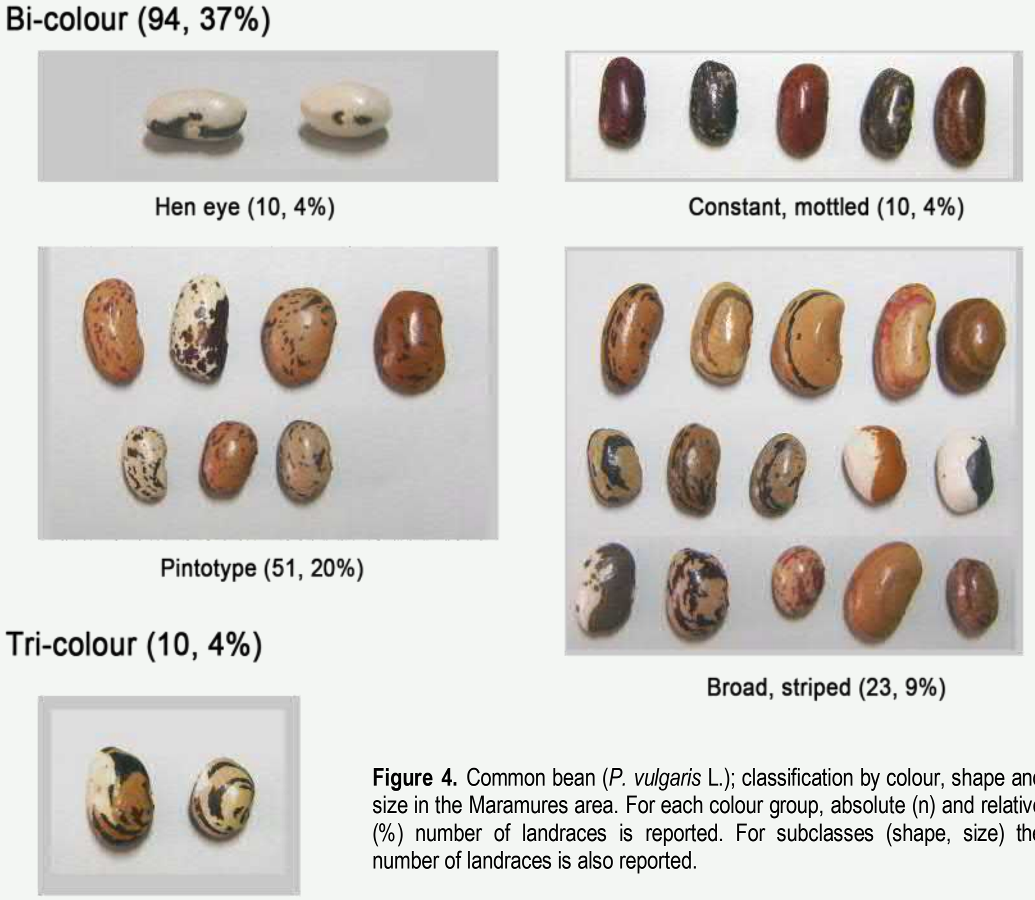

Figure 4. Common bean (*P. vulgaris* L.); classification by colour, shape and size in the Maramures area. For each colour group, absolute (n) and relative (%) number of landraces is reported. For subclasses (shape, size) the number of landraces is also reported.

Conclusions

The study revealed the following remarks:

1. Maramures County is an extremely important area for on-farm and in-garden management of landraces, particularly common bean landraces.
2. On-farm conservation activities are not sustained by the formal sector, besides the National Genebank in Suceava which acts as a reliable source of seeds in different species, including *Phaseolus vulgaris*, for individuals willing to maintain the traditional varieties.
3. Farmers did not adopt in cultivation modern cultivars, and specific names connected to the local population are not used, while the vernacular name 'mazăre is found over the Maramures'.

The area is dominated by the pinto type landraces, and brown and white landraces are placed at second and third place, respectively.

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The Silesian chicory landrace ´Slezská´

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The crop: chicory (*Cichorium intybus* L. var. *sativus*)

The chicory (*Cichorium intybus* L. var. *sativus*) is a biennial species, belonging to the *Asteraceae* family. The wild species commonly grows along roads, on fields, pastures and secondary habitats, from lowlands to foothills. It is widely distributed across Europe, North Africa, and Iran, until the Baikal Lake in the Eastern part of Russia (Botany.cz 2019) Secondary distribution is in East Asia, South America, South Africa and on New Zealand. The chicory is used as vegetable (var. *foliosus*), medicinal plant and for production of coffee substitute (var. *sativus*).

The chicory is valuable vegetable due to its chemical composition. Roots can contain up to 20% of storage polysaccharide inulin – composed of fructose derivatives – and fructans that are important as sweetener for diabetics. Inulin is used as an energy reserve by some plants (Van den Ende et al. 2011), and also plays different roles in the regulation of osmotic pressure, sink strength, and resistance to cold and drought (Valluru and Van den Ende 2008; Livingston et al. 2009). Interestingly, inulin is currently used as an additive to various food products, such as yoghurt and bread (Kip et al. 2006; Morris and Morris 2012, Maroufi et al. 2018). The main active substances for medicinal use are present in latex, mainly terpenic and glycosidic bitters supporting control of appetite, digestion and bile secretion. It also contains tannins, mannitol, rubber, choline, arginine and mineral compounds. The folk medicine decoction is prepared from both the root (*Radix cichorii*) and the green parts (*Herba cichorii*) for blood cleaning, promoting bile secretion and supporting digestion. It was also traditionally used for treating skin inflammations and rashes (Wendys 2019).

The cultivated chicory came to Middle Europe from the Netherlands during blockades of ports by Napoleon (Hruška 1966). Its cultivation on the territory of the Czech Republic was widely extended after 1887, especially in the regions of Hradec Králové, Čáslav, Nový Bydžov and Haná. Before that time the import of dry roots was around 100 to 160 thousand tons for coffee substitute production (Konečný 1997). So far, at a global level, chicory is the only crop that is used for commercial fructan extraction. During the last decade, annual inulin production from chicory roots increased from 1,000 to more than 100,000 tons (Van den Ende et al. 2002).

The landrace ´Slezská´

The Silesian landrace called ´Slezská´ was most likely bred from the cultivar Brunschvick, which has a common ancestor with other cultivated varieties of chicory such as the Magdeburg Canine variety. The breeding took place at a historic Breeding Station in Dobřenice (Hruška 1966). The whole chicory production system in the Silesian region is based on an understanding of the historical heritage, which has in the past ensured the prosperity of local farmers. They were grouped in drying cooperatives, which built monumental brick kilns typical for the area. There were still a few of them before the velvet revolution in 1989. In the 1990s they were closed and the root was dried on the modernised line in the Kratonohry Dryer. It is also property-related with the only current Czech processor of coffee, Kávoviny Pardubice Ltd. The production of the root corresponds to the processing capacity of the factory and the sales of the product. In recent years there has been a great promotion of chicory products in the media. The importance of inulin in human nutrition is indisputable.

The chicory cultivation area after the First World War fluctuated between 5 to 8 thousand hectares with an average yield of about 16 t/ha, with top yields above 20 t/ha. During the Second World War its area fell to the level of around 3-4.5 thousand ha. In the sixties it gradually decreased to an area of 600-1,000 ha and after 1989 it practically disappeared from the fields. For instance, its area was only 14 hectares in the whole country in 1992.

Landrace rescue

The chicory landrace practically disappeared from cultivation in the late eighties, including available seed stocks. It was maintained in the Research Institute of Beet, Semčice, which was partly privatized by a Dutch company and partly abolished after 1989. The enthusiastic Silesian farmer, agronomist Pavel Veselý considered it as an agronomic challenge to rescue the Silesian landrace. He was looking for the chicory seed in the region for a few years. He addressed seed companies until he encountered one old sack for free at Bedihošť Station, a branch of the former Semčice Institute from Joseph King of Hileshog. It became the source to start growing chicory again. Then he received more material. The old chicory breeder Mr. Husek once told him that there was still some seed supply left in his office at the abolished breeding station Dobřenice, belonging also to the Research Institute of Beet, Semčice. He went to the Dobřenice Station, the site was already in desperate condition and abandoned, but he found the seed and took it away, a few patched glass jars of seed. This was the last reserve. It was possible to rescue the material from both sources successfully.

Where it is cultivated

The current place of growing Lhota pod Libčany, East Elbe River basin, is in the centre of the historical distribution of the landrace (Figure 1). In addition, there was a drying company in nearly all the larger villages in the region (Sedlice, Praskačka, Libčany, Kratonohy, Osičky, Černůtky, Bydžovská Lhota, Figure 2).

Figure 1. Chicory ´Slezská´: (A) production field and on farm conservation; (B) detail of the root. Agrodružstvo farm, Lhota pod Libčany, Czech Republic. Photo: Pavel Veselý.

The building of a dryer company in Osičky is shown on the historical postcard (Figure 3). Currently, the building is owned by Agrodružstvo Lhota pod Libčany and it is used for mixing feeding mixtures for animals. From the old technology, only the washing process function is saved in Kratonohy. At present, its cultivation in the Czech Republic has stabilised on an area of 30 ha. It is grown by the farmer Pavel Veselý (farm Agrodružstvo Lhota pod Libčany in the Hradec Králové region) and by another farmer, Mr. Červený in Tetov, near Kladruby nad Labem. However, only the Agrodružstvo Lhota pod Libčany maintains the gene pool of the old regional variety ´Slezská´. It is a characteristic of this Silesian variety that the beet-shaped root allows harvesting by means of self-propelled sugar beet machines. Only minimal adjustments to the machines ensures limited harvest losses. According to the monopoly customer, the dryers Kratonohy, the difference in yield between ´Slezská´ and other modern foreign cultivars are large, but in favour of ´Slezská´. The reason for successfully maintaining this old landrace is especially the fact that it tolerates a lower supply of rainwater in the past period of changing climate.

Landrace management

Chicory is grown in a system similar to sugar beet. It is an excellent nematicidal pre-crop. It is sown in rows 45 cm apart. The aim is to reach about 200 thousand plants per hectare. The seed is regenerated on the farm. The chicory is a biennial plant, it is necessary to select suitable part of fields for seed production for the next year. It is important to verify, there is no wild chicory around, which of course would have a major impact on the gene pool of cultivated chicory.

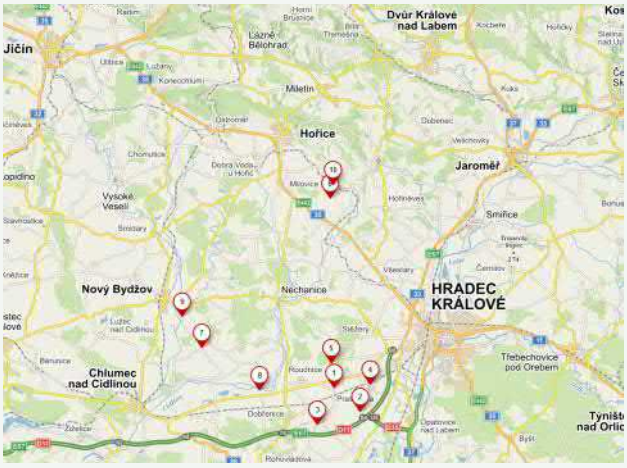

Figure 2. Area of historical dryers of chicory in the Hradec Králové region.

Contemporary winters provide fairly reliable winter resistance and survival of almost all individuals until spring. During the vegetation, the seed regenerating field must be kept manually free of weeds. Unsuitable plant types are also removed. The actual harvesting is done manually. Almost ripened stems cut off, transported under cover to the hall, where they are allowed to dry. Threshing takes place manually by inserting the stems into a harvester. The threshed seed is then precisely cleaned by a specialist seed production company. The returned pure, untreated seed, is then used for sowing next year. Vegetable sowing machines with a vacuum sowing system are used for sowing. The sowing is set to the precise finite distance to minimize manual unity. A sufficient amount of cheap seed also allows rapid over-sowing in cases where sown stands are damaged for some reason (soil crust, hail, frost, etc.).

Landrace market

The crop is industrial and therefore the market is based on agreement with the producer, the Dryer Kratonohy company, depending on market demand. The landrace Slezská is nearly the monopole cultivar source of the coffee substitute reaching up to 80%. The coffee product is of chicory only, or as a mixture of different coffee substitute such as rye. The leading role of ´Slezská´ landrace is a result of good properties and yield in a regular rain-fed agriculture. The resulting chicory coffee is marketed within the whole Czech Republic and Slovakia with occasional export.

Figure 3. A dryer company building in Osičky on a historical postcard.

By maintaining the old Silesian variety ´Slezská´, we hope that we will be able to increase the cultivated area in the event of future demand increases. The complexity of cultivation, and the impossibility of using pesticides, make this crop a family silver that awaits its opportunity.

Products and brand

One of the most prosperous early factories for coffee substitutes from chicory was 'Továrna na cikorii, Josef Balounek' founded in Humburky nr. Nový Bydžov in 1880 (Figure 4a). The factory purchased chicory landrace from farmers in the region. Their product Balounek´s Chicory (Figure 4b) was advertised as a local and Czech product. His advertising campaign also had a special focus for children as he furnished chicory leaflets with fairy tale colouring pictures and some statements ('Dedicates to children' or 'Without Balounek´s chicory there is no good coffee', Figure 4c, d, e). The balloon trademark was always prominently displayed on advertisement plates.

Currently the only end-producer Kávoviny, stock holder co., Pardubice offers a diversity of products based on the chicory landrace ´Slezská´(Figure 5). Some products were awarded a stamp Klasa (high quality, Czech made), some are stamped as gluten-free. These products are sold in Czech and Slovak markets.

- Melta 500 g: the original mixture over 100 years old, mixture of chicory, sugar beet, barley and rye.
- Melta 140 g: the same in bags.
- Vita Melta 75 g: mixture of barley, chicory and rye, Klasa stamp.
- Vitakáva 180 g: mixture of barley, rye and chicory .
- Top Karo 200 g: instant mixture of chicory and Jerusalem artichoke (*Helianthus tuberosus*), gluten-free.
- Kávička 130 g: 30% instant coffee and 70% of Vitakáva.
- Karo 180 g: instant chicory extract 100%.
- Melta TOP 200 g: Instant mixture of barley, rye, Jerusalem artichoke and chicory.

Figure 4. Historical documents of the production and sale of chicory, Material source: Radek Kulich.

Figure 5. Temporary products of coffee mixture substitutes, based on chicory landrace ´Slezská´, Photo: Pavel Bartoš.

The support

The landrace Slezská was not fully lost, because it is also kept in the collection of vegetables in the Dept of Vegetables and Special Crops, Olomouc, CRI, a part of a National Programme. However, the remarkable effort to rescue the landrace within the region of former cultivation by enthusiastic agronomist and farmer Pavel Veselý was highly appreciated by the Czech Board on Plant Genetic Resources (RGZ) and by the National Coordinator. The National Programme for Conservation and Use of Plant Genetic Resources and Agrobiodiversity (https://www.gzr.cz/) understands the rescued system of keeping historical Czech / Silesian chicory with the link to producers as an excellent model case of on farm conservation, which is aimed at safeguarding and promoting the cultivation of local genetic resources. It is marked in the national documentation system GRIN Czech as an alternative conservation.

Acknowledgments

The information on chicory production and on farm conservation was provided by Pavel Veselý, agronomist and proprietor of Agrodružstvo farm, Lhota pod Libčany. He was interviewed by Vojtech Holubec, National coordinator for PGR of the Czech Republic, who also wrote the English text. Pictures of historical artefacts - products, advertisements, invoices etc. were kindly provided by Mr. Radek Kulich from his and his village collection in Humburky. Information on current products of coffee mixtures were provided by Pavel Bartoš, Production director of Kávoviny s.h.co.

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Horseradish in use and preserved in collections in Finland

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Introduction

Horseradish (*Armoracia rusticana* Gaertn., C.A. Meyer et Schreb.) is a perennial plant species belonging to the *Brassicaceae* family. Its genetic diversity centre is in Eastern Europe and the southwestern parts of Russia. Large-leaved horseradish has white to light yellow strong wasabi- and mustard-tasting thick roots, which are used mainly as spice, in pickles, preserved in vinegar as well as a mould preventer, in fish dishes, and sauces and dressings. It can be used as a substitute to the more expensive wasabi. It is used as uncooked small pieces and grated. Leaves are also edible. Although it flowers in early summer it is mainly vegetative propagated, since seed yield is very poor or absent. It is a very vigorous and hardy species being able to grow decades in the same growing site and colonise a larger area. As it is easily propagated from roots, the same clones have probably spread from pieces of roots from garden to garden by people. (e.g. Wedelsbäck Bladh 2014).

Horseradish has a high nutrient and mineral content, which includes dietary fibre, vitamin C, folate, potassium, calcium, magnesium, zinc, and manganese, as well as its organic chemical composition of enzymes and oils, like sinigrin, which is a powerful glucosinolate. It is associated with many health benefits, such as anti-cancer properties, boosting of the immune system, improving digestion, helping with weight loss and lowering blood pressure (Staughton 2019). Horseradish is probably native to western Asia and south eastern Europe and has been grown throughout recorded history. Mentions of it are already made in 'De material medicia libri quinque' written in 100 A.D, in Greek mythology, Pliny's 'Natural History,' and Shakespeare (Alfaro 2019; Wedelsbäck Bladh 2014). Horseradish is produced in all parts of the world. In Europe, the main production takes place in Hungary with production in 1200 ha, but Austria, Germany and Poland also have extensive commercial production of horseradish (Eurostat). USA is the largest producer of horseradish in the world with an area of 1600 ha. Illinois is the main production centre. In China, production has increased during the last years (Wedelsbäck Bladh 2014).

Horseradish in Finland

Horseradish has also been grown in Finland for centuries. Probably during the Middle Ages, it moved along with the networks of the German monastic system to the Nordic Countries for medical use. In the 1600s it was well-known and grown at least in Southwestern Finland. People had taken it to use, proof of which is that it had several local names referring to its strong and special spicy taste. (Kairikko 2006). Since then, horseradish has been commonly grown in home gardens, in the countryside, and used as a spice. Thanks to its vigorous growth, from a small piece of root, it has spread to the same extent in nature as an invasive crop in South and Central Finland (Lampinen & Lahti 2019).

In 2017, the total commercial cultivation area of horseradish was 6.52 ha. Three farms take care of the commercial production. (Finnish Food Authority 2019). Since the 1990s, two farmers have cultivated a landrace horseradish in the municipality of Vehmaa (60°41' N, 021°42 E) in south-eastern Finland (Finland Proper Region). It covers over half of the domestic horseradish production in Finland. In 2018, the leading farm had 3.5 ha of horseradish (earlier years 4.8 ha). Fields are located at 15 m a.s.l. Farmers sell the root crop to wholesale businesses to be sold fresh in retail shops in Finland. The leading farm has developed a special seasonal product of horseradish sauce for local markets. The limited time and marketing resources restrict its large-scale product development. The stronger taste, i.e. higher content of glucosinalites, has proved to be a competitive edge over imported horseradish (Farmer interview 2019). According to the local parish register, the landrace horseradish was brought to the Vehmaa area in the 17th century by an armour-bearer of a career soldier (a knight). It was taken for cultivation in home gardens in the area. (Farmer interview 2019). Its morphological (Wedelsbäck Bladh et al. 2019) and genetic (finger printing) characterisations have been carried out (Wedelsbäck Bladh et al 2014) and glucosinolates content has been evaluated (Wedelsbäck Bladh et al. 2013) and compared to other Nordic horseradish clones preserved in genebanks.

Horseradish cultivation method

If horseradish is left to grow in the garden, it grows numerous side roots making it difficult to dig up, and roots remain thin. The commercial horseradish cultivation in arable land differs significantly from growing it in a garden for home consumption. In May, part of a some years-old horseradish field is ploughed with a special ploughshare. The plough cuts horseradish roots and the most suitable ones, called side roots, are handpicked for new planting. Good root for planting is 1-1.5 cm thick and 20-30 cm long. The top of the root is carved slanting before planting. Planting is performed manually, setting roots to the bottom of the furrow made by a planter (Farmer interview 2019).

Roots are manually dug up in summer with a special hoe, side roots are removed from the strongest root. Roots are planted in the field again to grow. Farmers call this method fattening horseradish. The first fattened horseradish roots are dug up at the end of September in order to get sufficient roots to the market before the main crop. The harvest time continues until frost arrival in November and continues again in spring (Farmer interview 2019). Notwithstanding horseradish vegetative multiplication in home gardens and in field cultivation differs significantly, as described above, clones remain genetically stable. The availability of a skilled labour force, imported cheaper horseradish and wholesale business contracts have caused troubles to farmers (Farmer interview 2019).

However, the stronger taste (higher content of glucosinolates) has proved to be a competitive edge over imported horseradish.

Future prospects

Commercial farmers are not paid any extra support for cultivating landrace horseradish in Finland. If it provides economic value for farmers in the future it will remain in cultivation and use. However, farmers constantly seek more suitable horseradish clones for commercial cultivation, and this may endanger the continuity of its cultivation and use.

Consumers lack knowledge on its added values as a landrace. The commercially cultivated horseradish clone is safely preserved. In 2002 the Finnish National Genetic Resources Programme accepted it for long-term preservation at the central clonal collection located in Luke (GBK Luke Piikkiö, accession FIN67) (Sesto 2019) among two other landrace horseradish clones. They all have unique genetic (Wedelsbäck Bladh et al. 2014) and morphological (Wedelsbäck Bladh et al 2019) characteristics and have differences in glucosinolates content (Wedelsbäck Bladh et al 2013). In 2019, the preservation of five Finnish landrace horseradish clones were strengthened when they were accepted to the national backup preservation in the backup collection site (*in situ*) for vegetables located in an open-air museum operated by the Museum Centre of Turku in Turku City (60° 27' N, 22° 16' E) in south-eastern Finland. The commercially cultivated landrace horseradish clone with centuries's long cultivation history in Vehmaa area was one of the clones (Figure 1).

Acknowledgements

Data produced in the project Farmer's Pride - Networking, partnerships and tools to enhance *in situ* conservation of European plant genetic resources' under the Horizon 2020 Framework Programme, [GA no. 774271].

Figure 1. Thick roots of 'Piparjuuri Vehmaa' processed for a retail shop. In the top right of the photo in a glass jar, horseradish's thin roots grown in a home garden.
Photo: Maarit Heinonen, Luke.

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The *in situ* conservation of 'Arakas' (*Lathyrus clymenum* L.) in Thera island throughout the centuries

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An overview of the *in situ* conservation and use of Lathyrus clymenum L. in Thera and nearby smaller islands from the ancient years 'til today is given. Specific information is provided about the landrace 'Arakas for Fava Santorinis', the environment and the cultivation techniques and the efforts that have been made for its support and promotion to the market.

The crop

The Spanish vetchling (*Lathyrus clymenum* L.) is an annual species, belonging to the Fabaceae family. It is a Mediterranean grain crop of restricted distribution, still grown today in several Aegean islands such as Thera (Santorini), Anafi and Karpathos (Sarpaki and Jones 1990). Like other legumes, seeds are protein-rich and highly nutritious. *L. clymenum* is known as a fodder crop, as well as a staple food. Wild and weedy forms of *L. clymenum* are widely distributed in the western and central parts of the Mediterranean basin, from west Turkey to the Iberian Peninsula, and from Cyrenaica to Morocco (Zohary et al. 2012). Relative to other legumes finds of *L. clymenum* are rather rare. The earliest and largest find came from ca. 4850-4550 cal BP Early Bronze Age II levels of Yenibademli Höyük in the Gökçeada island, Turkey (Oybak-Donmez 2005). Seeds of *L. clymenum* have been discovered in a storage room in ca. 3900-3700 cal BP Middle Bronze Age IIA Tel Nami, a coastal site in Israel, suggesting the transport of this pulse from the Aegean basin into the Levant by maritime traders (Kislev 1993). Large quantities of charred seeds of *L. clymenum*, placed in storage jars, were discovered in Akrotiri, Thera Island, in a house destroyed by the volcanic eruption that devastated this island in ca. 3578 cal BP (Sarpaki and Jones 1990). These authors also reported seeds of this pulse among plant remains retrieved from Late Minoan II Knossos, Crete, and contemporary Phylakopi, Melos. These finds establish *L. clymenum* as a local, Aegean, Bronze Age domestic plant, which survives today only as a relic (Zohary et al. 2012).

All *Lathyrus* species (such as *Lathyrus cicera* L., *Lathyrus ochrus* (L.) DC. and *Lathyrus sativus* L.) are cultivated nowadays as food and feed. *L. clymenum* is an important legume in the Mediterranean diet, not only because of its taste, but also for its nutrients that contribute to a healthy diet. Its cultivation focuses on the production of dry grains 'Fava' (in Greek language). However, the production and consumption of fresh grain and fresh pods by local people is common too. Another meaning of 'Fava' corresponds to a traditional Greek dish that is in the form of thick slurry and is made from dried, peeled and crushed cotyledons of species of the Fabaceae family. In different places of Greece fava can be produced from faba bean (*Vicia faba* L.) locally called 'kouki', from pea (*Pisum sativus* L.) locally called 'arakas' and from various *Lathyrus* spp. (*L. sativus* L., *L. ochrus* (L.) DC.). For the production of 'Fava Santorinis', only the seeds of the species *L. clymenum* with the traditional name 'arakas' are used.

L. clymenum is a predominantly self-pollinating plant, but significant levels of cross-pollination can occur. In the genus *Lathyrus,* the cultivated species are preferably autogamous (Ben Brahum et al. 2001) with several flowers being receptive to insect-mediated pollen transfer into their raceme. This results into the so -called 'geintonogamous selfing' (Richards 1997).

The Landrace 'Arakas for Fava Santorinis'

L. clymenum, locally called 'Arakas' (Figure 1), is a landrace with historical origin, distinct identity, specific adaptability and it is closely connected with the traditional cultivation system on Santorini Island where it has been cultivated exclusively and continuously for more than 3.500 years, while elsewhere it was known only as a wild plant. The archaeobotanical data supports the theory of local origin and its continuity through culture and subsistence practices (Valamoti and Kotsakis 2007) and indicate that *Lathyrus* has been continuously cultivated in the Aegean region up to the present, supporting the traditional farming and the low input rain-fed cultivation system for hundreds of years.
The dried legumes of 'Arakas' make 'Fava Santorinis' a famous agricultural product of Santorini Island. The seeds are used to prepare a Greek dish also called 'fava'.

Where and how it is cultivated

'Arakas for Fava Santorinis' is traditionally cultivated in Thera (Santorini) island (Figure 2) and other nearby smaller islands like Thirasia, Palia and Nea Kameni, Aspro, Christiana and Askania (Region of South Aegean, Regional Unit of Thera Island, Greece).

Figure 1. 'Arakas for Fava Santorinis', dried seed sample. Photo: Parthenopi Ralli, Hellenic Agricultural Organization-DEMETER.

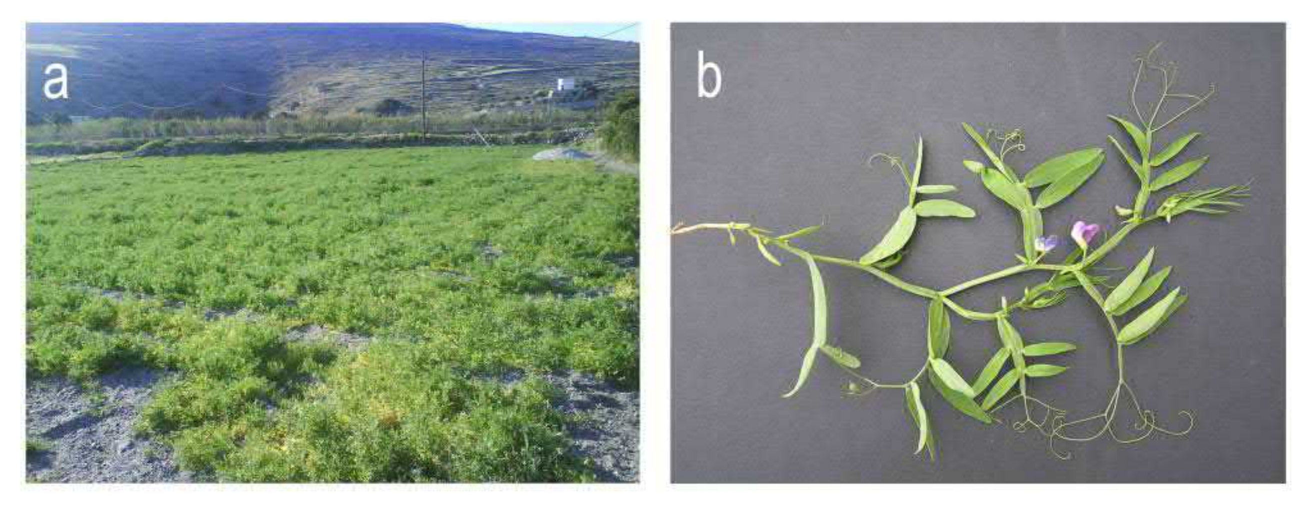

Figure 2. 'Arakas for Fava Santorinis' (*Lathyrus clymenum* L.) **a.** cultivation on the volcanic soil of Thera island; **b.** Plant at flowering stage. Photo: courtesy of the Hellenic Agricultural Organization-DEMETER.

The common characteristics of these islands, that are considered being responsible for Favas' quality, are the volcanic soil (which makes up nearly all of Santorini and consists of tertiary deposits of Thera soil, pumice and lava) and the very specific dry and warm microclimate. More generally, the soil has a fine structure and lacks the basic minerals K and N; it is extremely poor in organic matter and in water capacity which is minimal to non-existent. The average annual temperature is 17.5˚ C, the days of sunshine throughout the year are 202, the conditions are dry, the total annual rainfall is 370 mm, the northern winds are strong (meltemia), the percentage of relative humidity is high (average annual humidity is 71%) and the frost is absent. Thus, the plants are under conditions of water stress, and this, together with the alkaline soil, gives the product special characteristics (EU 2010).

The landrace is maintained by few farmers in small, separate fields in Santorini and the neighbouring islands, in the region of South Aegean (Greece), as part of the local tradition. In 1840 'Arakas' was ranked fourth in the island's agricultural products after the wine, barley and cotton. However, lately the landrace suffered genetic erosion and was subsequently threatened by extinction from field cultivation; in fact, it was only cultivated by a few elderly farmers. It marginally survived at a small scale (on about 1.5-1.8 ha in the whole island), by a limited number of farmers, as part of their agricultural tradition. Currently, however, the number of farmers still cultivating 'Arakas for Fava Santorinis' has increased, possibly after the obtainment of the European Protected Designation of Origin (PDO) brand. The farmers are part of the Union of Santorini Cooperatives–Santo Wines and through the Cooperative they manage to earn a better price and a promotion of their products.

The landrace is sown in December, flowers in April, ripens and dries pods, locally called 'louvia', in late May and early June. The prostrate plant growth habit protects the plant from the strong winds of the area across the growing season. Each leaf consists of three pairs of leaflets and tendrils, the flowers are white or purple (Figure 2b), the shape of the pods is broad linear with slight restrictions of pods between the seeds, the shape of the seeds is square or rhomboid and the colour is brown-grey, the diameter about 2 mm. The cotyledon colour (after removing the seed coat) is yellow (Guide for the identification of cultivated landraces, 2007). Seed composition is characterised by a particularly high percentage of proteins (20%) and carbohydrate content (60%). The processing of the harvested plants includes the basic stages of threshing (Figure 3), sifting and cleaning the seeds. Then the seeds are placed in appropriate areas to reduce their relative humidity to 13% and after 2-3 months the seeds are smashed and peeled. The traditional method of its production, which includes ripening in caves and drying under the sun, and the physicochemical characteristics of fava itself make it easy to cook (shorter boiling time is required) and ultimately add to the cooked Fava of Santorini and other dishes in which it is used, unique organoleptic characteristics, such as velvety texture and slightly sweet taste. It is used as an appetiser, main or side dish. Undoubtedly, even today, it plays an important role in the gastronomic identity of the island and in the Mediterranean diet as well.

Only when weather conditions are good, farmers on the island can reap about 800 kg of 'Arakas' seeds per hectare. 'Arakas for Fava Santorinis' is well-adapted to the volcanic ash of the Santorini island, but it has a low productivity, in fact it is a vulnerable crop: strong winds that blow away its flowers and/or severe drought can reduce or destroy the yield. Its production is thus limited, making it an expensive crop for farmers and consumers. Its cost is four to five times higher than the 'Fava' produced from faba beans or from peas.

In recent years, the landrace has faced intense cultivation problems due to unstable yields and degradation of plant development suggesting a change in allelic frequency in an undesirable direction (Ranalli and Cubero 1997). The landrace is discriminated from other Greek and foreign *Lathyrus* landraces and commercial cultivars by morphological traits and molecular markers (Ganopoulos et al. 2012, Koutsika-Sotiriou et al. 2010, Madesis et al. 2010, Traka-Mavrona et al. 2015). The phylogenetic analysis confirmed that the landrace 'Fava' of Santorini is genetically far from other commercial *Lathyrus* varieties and that it is a different and unique variety. This fact makes the product important for its future utilisation mainly by farmers, who could use these new locally-adapted populations under low-input or organic farming systems; in fact this landrace has low requirements for irrigation and fertilisation (Traka-Mavrona et al. 2015).

Figure 3. 'Arakas for Fava Santorinis', traditional threshing of the harvested plants. Photo: Ioannis Argyros.

The market

Up to now it has had a rich, local niche market due to the limited production. Hence, several strategies are in place to increase the production and the promotion of the product to other European and non-European markets; for example the Union of Santorini Cooperatives launched an e-shop in which it is possible to buy 'Arakas for Fava Santorinis'. Most of the farmers sell the products through the Union of Santorini Cooperatives or other private companies who are responsible for the packing and the labelling.

The value

The unique ecosystem that was created by the volcanic explosions on Santorini, the volcanic ash, the barren, sandy soil, and the resilience of the plant to poor drainage lands, humidity created by the sea, drought, heavy winds and its adaptability to the volcanic soil of the island make it a resource with an important agronomic and commercial value and optimal organoleptic qualities. In 2010, 'Fava Santorinis' was registered into the European Catalogue of Protected Designation of Origin (PDO) products (EC No: EL-PDO-0005-0520-09.01.2006) following the COUNCIL REGULATION (EC) No 510/2006 on the protection of geographical indications and designations of origin for agricultural products and foodstuffs.

The PDO 'Fava Santorinis' offers high income to growers since it is four to five times more expensive than regular 'Fava' coming from faba beans (*Vicia faba*) or from peas (*Pisum sativum*) also locally called 'arakas'. Furthermore, other cultivated Fabaceae such as *V. faba* var. *major* Harz. (cultivated for food) and *V. faba* var. *minuta* (Hort. ex Alef.) Mansf. (cultivated for feed) also called Fava, frequently could mislead consumers. The same is true for other *Lathyrus* spp. For this reason, in 2012, the School of Agriculture of the Aristotle University of Thessaloniki and the Institute of Agrobiotechnology of the Centre of Research and Technology Hellas suggested a method using HRM (High Resolution Melting), coupled with universal chloroplast DNA barcoding regions (Bar-HRM), in order to distinguish legume species (four *Lathyrus*, two *Vicia* and two *Pisum* species which could potentially be used as adulterants in 'Fava Santorinis' commercial products) and, moreover, to authenticate 'Fava Santorinis' commercial PDO products (Ganopoulos et al. 2012).

Support

Currently, subsidies are given from the Hellenic Ministry of Rural Development and Food under a special scheme to support farmers who cultivate 'Arakas for Fava' on the areas of 'Small Aegean Islands' and in particular to sustain its cultivation in Santorini and Thirasia. Technical support is given by the agronomists of the Cooperative. In the past, several initiatives have been carried out in attempt to conserve and evaluate this landrace.

A few years ago, in the framework of a national project the Hellenic Agricultural Organization-DEMETER (Institute of Plant Breeding and Genetic Resources), the Aristotle University of Thessaloniki (School of Agriculture) and the Union of Santorini Cooperatives, with the support of the Region of South Aegean, aimed at improving this landrace through the study of the existing variability, and an intra-landrace pedigree, combined with analytical selection scheme. In addition, morpho-phenological and molecular characterisation activities were carried out to precisely describe the landrace (Koutsika-Sotiriou et al. 2010; Traka-Mavrona et al. 2015). The role of the Union of Santorini Cooperatives-Santo Wines (https://santowines.gr/en/) is very important too. It was founded in 1947. Today, it consists of the largest organizations of the island, representing all the farmers and counting 1.200 active members. Santo Wines is committed to safeguarding the traditional local cultivation, producing highest quality Protected Designation of Origin (PDO) Santorini wines and products as well as promoting sustainable agriculture development. The agricultural production and the cultivated land for 'arakas' and 'tomataki' (i.e. small tomato), and the number of young members of the Union has increased in recent years.

Accessions of 'Arakas for Fava Santorinis' are kept, under long term storage conditions in the Genebank of the Institute of Plant Breeding and Genetic Resources of the Hellenic Agricultural Organization-DEMETER and in the Union of Santorini's Cooperatives-Santowines. Provisions set by the Ministry of Rural Development and Food, the high quality of the product, the increased interest of the consumers of the landrace value and a renewed interest in agriculture gives hope for on-farm conservation in future.

Acknowledgments

We want to thank Dr M. Koutsika-Sotiriou (former Professor) from the Aristotle University of Thessaloniki, Dr E. Traka-Mavrona (former Researcher) from the Hellenic Agricultural Organization-DEMETER, Mr M. Dimopoulos and Mr M. Kafouros from the Union of Santorini Cooperatives-Santo Wines for their contribution to the landrace's conservation and improvement.

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https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:034:0003:0007:EL:PDF

https://santowines.gr/en/

Landraces resources

Farmer's Pride network (http://www.farmerspride.eu/)

https://www.birmingham.ac.uk/index.aspx
https://www.froesamlerne.dk/
https://www.nordgen.org/en/
https://www.ipk-gatersleben.de/
https://www.wur.nl/en/wageningen-university.htm
https://www.plantlife.org.uk/uk
https://www.urjc.es/
http://map.seedmap.org/solutions/conservation/on-farm/prospecierara/
http://www.upv.es/index-en.html
https://www.arche-noah.at/
https://www.bioversityinternational.org/
https://www.eurosite.org/
https://www.gfar.net/organizations/ministry-food-agriculture-and-livestock-general-directorate-agricultural-research-and
https://www.euroseeds.eu/
https://www.luke.fi/en/
https://biokutatas.hu/
https://www.unipg.it/en/
http://www.elgo.gr/index.php/el/
http://www.iniav.pt/

In situ conservation networks

http://www.ecpgr.cgiar.org/working-groups/on-farm-conservation/
http://www.ecpgr.cgiar.org/working-groups/wild-species-conservation/

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