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

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Landraces

Issue 4 January 2019

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Conserving plant diversity

for future generations

Landraces

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Nigel Maxted

Layout:
Leonardo Caproni

Front cover image:
Nurturing a tomato landrace in an Italian organic garden
Photo: V. Negri

Correspondence address:
Valeria Negri, Department of Agricultural, Nutritional and Environmental Sciences, University of Perugia, Borgo XX Giugno 74, 06121 Perugia , Italy, e-mail: valeria.negri@unipg.it
Lorenzo Raggi, Department of Agricultural, Nutritional and Environmental Sciences, University of Perugia, Borgo XX Giugno 74, 06121 Perugia , Italy, e-mail: lorenzo.raggi@unipg.it

Funded by the Horizon 2020 Framework Programme of the European Union

Welcome to Issue 4 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 publicise information about the conservation and use of landraces in different contexts. All landrace stakeholders, whether conservationist, breeder, farmer, policy-maker or educator, will benefit from this publication, both by spreading news about their own activities and by learning about other initiatives. The newsletter is aimed at highlighting the importance of landraces as vital agro-ecosystem components, as a resource for food and agriculture and for their cultural values, as well as a critical resource for the improvement of crops. Further it aims to highlight threats to landrace diversity, how the threats may be countered and the benefits to local communities of landrace maintenance made clear.

This issue initially provides information about the aims and objectives of "Farmer's Pride", which started in November 2017, explaining the rationale for the initiation of the project, information on its structure and foreseen achievements with specific reference to the conservation of landraces in Europe and the establishment of a network of landrace conservation sites across Europe.

The issue also presents contributions on specific activities regarding landraces which come from several European countries: Denmark, Finland, Italy, Republic of Macedonia, The Netherlands, Portugal, Spain and United Kingdom.

We hope you will enjoy reading this issue.

Valeria Negri, Lorenzo Raggi and Nigel Maxted

Editorial

Above: Common bean (*Phaseolus vulgaris* L.) landrace diversity in Italy
Photo: L. Caproni

The Farmer's Pride project

Nigel Maxted[1] and Valeria Negri[2]

[1]School of Biosciences, University of Birmingham (United Kingdom); nigel.maxted@dial.pipex.com
[2]Dipartimento di Scienze Agrarie, Alimentari e Ambientali, Università degli Studi di Perugia (Italy)

Farmer's Pride, funded within the HORIZON 2020, Sustainable Food Security (SFS-04-2017), is aimed at establishing in practice the first European Network for *In Situ* Conservation and Sustainable Use of Plant Genetic Resources. Reinforcing links among different stakeholders (Figure 1), its ambition is to bring them together across Europe and coordinate actions to conserve diversity for crop enhancement and adaptation in the future. Its focus is not only on landraces but also on crop wild relatives.

Further information can be obtained from the Project web site http://www.farmerspride.eu/

As a first step towards its final aim, Farmer's Pride launched a stakeholder consultation on a new European network for *in situ* conservation and sustainable use of plant genetic resources. This consultation survey is available at https://ec.europa.eu/eusurvey/runner/FarmersPride2018Stakeholders).

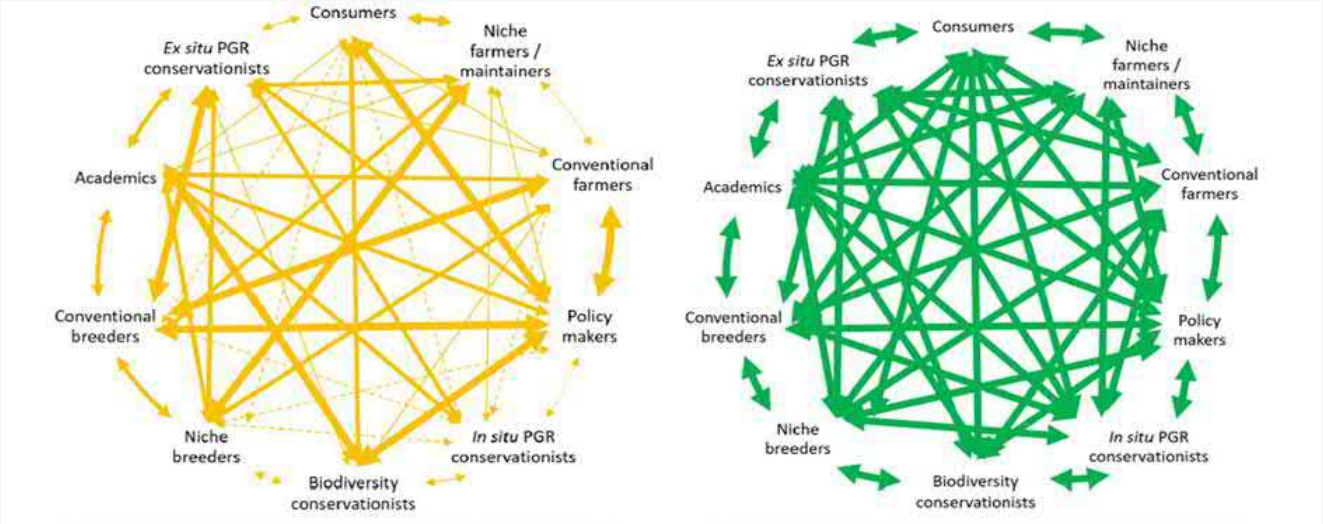

Figure 1. Present relationships among different stakeholders (left), future relationships among different stakeholders (right) as foreseen by the Farmer's Pride project.

The project includes 19 Partners from 15 different European countries, as well from international agencies: University of Birmingham (United Kingdom, Coordinator), Aegean Agricultural Research Institute (Turkey), Arche Noah (Austria), Centre for Genetic Resources (The Netherlands), Danish Seed Savers (Denmark), Hellenic Agricultural Organization – Demeter (Greece), Instituto Nacional de Investigação Agrária e Veterinária (Portugal), Leibniz Institute of Plant Genetics and Crop Plant Research (Germany), Natural Resources Institute (Finland), Pro Specie Rara (Switzerland), Research Institute of Organic Agriculture (Hungary), Universidad Rey Juan Carlos (Spain), Università Degli Studi di Perugia (Italy), Universitat Politècnica de València (Spain), as well as the international Bioversity International, European Seed Association, Eurosite, Nordic Genetic Resource Centre and Plantlife International.

In addition to this large partnership, Farmer's Pride includes Ambassadors from almost all European countries to help the consortium achieve its project objectives across the continent.

It includes five work packages (WPs): WP 1 is aimed at identifying Networking Options, deepening present knowledge on European and extra-European stakeholders and showing exemplary collaboration platforms; WP2 at providing the foundations for individual population management; WP3 at identifying cost-effective conservation strategies and policies; WP4 at designing the future network; and WP5 at disseminating results.

This consultation aims to understand which stakeholders are involved or have an interest in the conservation and sustainable use of plant genetic resources *in situ*. Any person, organization or institution that is a custodian of wild or cultivated populations of plant genetic resources, or that considers conserving plant genetic resources *in situ* to be important, is asked to answer the survey.

The survey is available in several languages (English, Dutch, French, Finnish, German, Greek, Hungarian, Italian, Spanish and Turkish).

We encourage all our readers to complete the survey and help us ensure the all stakeholders involved in *in situ* PGR are represented.

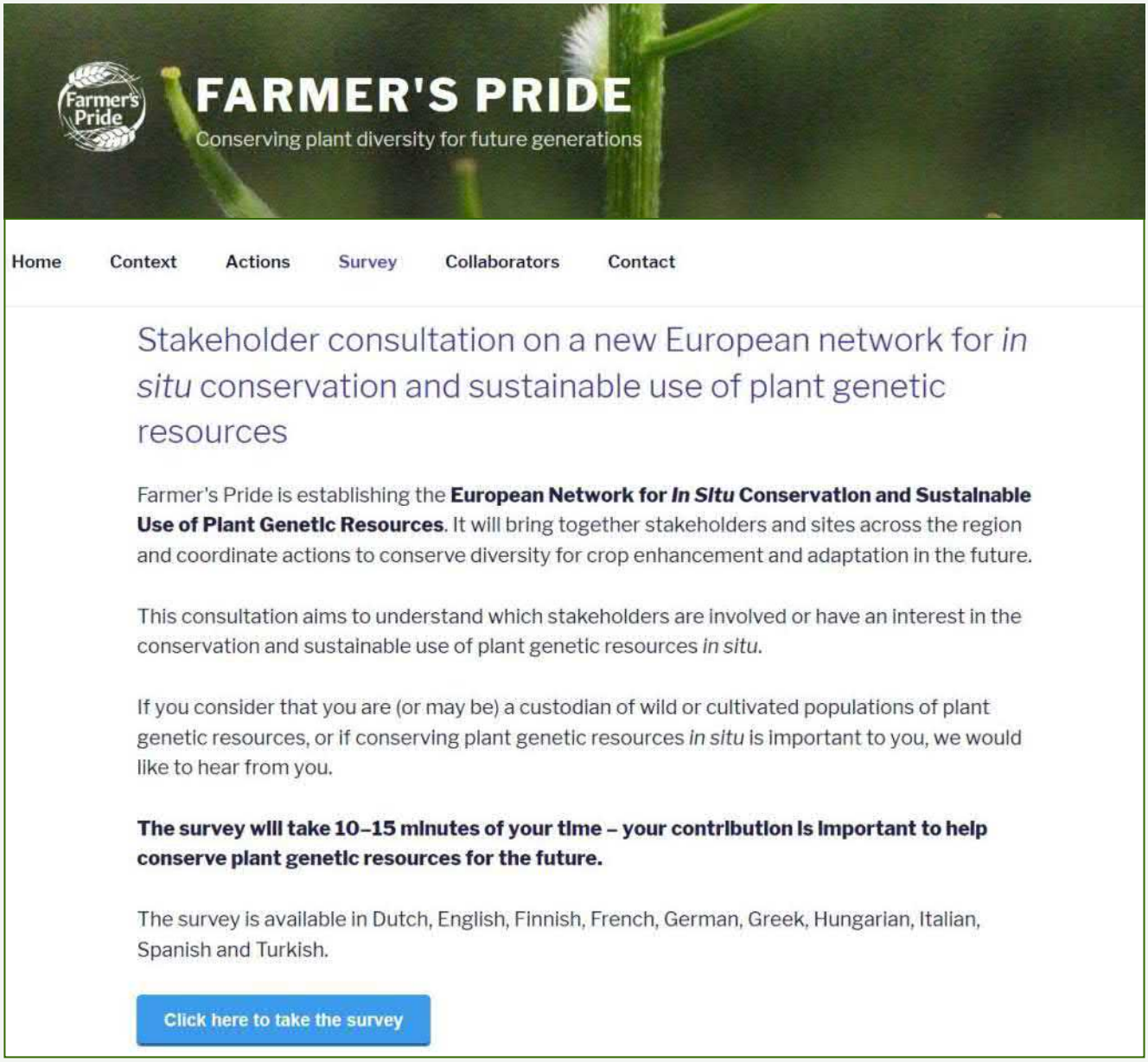

Figure 2. The web page leading to the survey.

The major products of Farmer's Pride will:

- identify the breadth and range of *in situ* (including on-farm and on-garden) conservation sites and stakeholders, and the trait diversity found *in situ*';
- build a self-sustaining network of *in situ* sites/populations and stakeholders involved in PGR conservation and sustainable use through which germplasm flow is significantly improved from source to end user;
- provide a self-sustaining network structure that fully integrates national and regional *in situ* PGR conservation and use in Europe (and even globally);
- enhance the link between *in situ* and *ex situ* conservation to (i) provide a back-up of *in situ* conserved populations and (ii) facilitate breeder/farmer access to the *in situ* conserved resource;
- address the need to link *in situ* PGR conservation to use by promoting (i) improved farmer/gardener access to PGR diversity, (ii) improved breeder access to *in situ* PGR diversity, (iii) integrated *in situ* with *ex situ* conservation, (iv) product value chain enhancement;
- contribute to farming and breeder competitiveness, by (i) maximizing PGR held *in situ*, (ii) promoting its use by policy makers, farmers and breeders in Europe.

Towards the introduction of a Danish asparagus landrace - discovery, collection, multiplication, conservation and access

Gert Poulsen

Danish Seed Savers (Denmark); ngbgpo@gmail.com

In situ conservation and on-farm conservation of crop plants is paradoxically non-existent in the official Danish plant genetic resources (PGR) policy. In the most recent national PGR strategy 2017-2020, *in situ* conservation is mentioned but not practised. Paradoxically, because Danish forestry resources are conserved *in situ* in different eco sites in Denmark and on-farm conservation is practiced in other Nordic countries that Denmark collaborates with in the Nordic Genetic Resources Centre (NordGen).

Danish agriculture has for the last hundred years been very progressive, continuously replacing old varieties with new, and today they grow a very high proportion of certified seed (>90% for cereals), not allowing much space for agro-biodiversity. However, in the Nordic gene bank database - NordGen - there is registered 115 Danish landraces conserved *ex situ* (Table 1) but only a few are maintained on-farm. This indicates an irresponsibly low level of ambitions and visions in the field of on-farm maintenance of plant genetic resources that also applies to the agricultural sector including organic growers.

Table 1. Accession of Danish Landraces stored *ex situ* in NordGen

Cereals	61
Forages	2
Fruits	1
Medicinal and aromatic plants	6
Pulses	22
Potatoes	4
Vegetables	19
TOTAL	115

Despite the hesitant official attitude, the Danish Seed Savers is promoting plant genetic resources conservation on-farm and access to seeds. Danish Seed Savers is an association working for conservation and maintenance of Danish heritage seeds, vegetative material and old varieties that are otherwise threatened by extinction if we do not take care of them. It is an association of enthusiastic people taking care of the germplasm by on-farm maintenance, held either in home gardens or on-farm.

Here I will report on a case with collection, conservation and giving access to an old "Danish Giant" Asparagus (*Asparagus officinalis* L.) "Dansk Kæmpe".

J. A. Dybdahl (1877), lecturer in horticulture at the Royal Agricultural University in Copenhagen, tested existing asparagus 'Connover's Colossal', 'Asparagus d'Argenteuil' and some other varieties, but could not observe difference in any traits. He cited Thompson, London, who tested violet-, white-, green-headed asparagus and "Giant Asparagus" and found them similar.

Goeschke, Leipzig, considered all the old asparagus forms, that were released as varieties named after a town or region known for asparagus cultivation like Darmstädter-, Erfurter-, English- or Dutch- "Giant Asparagus", just were local variants. Giant Asparagus seems to be synonymous with common asparagus.

Figure 1. Asparagus in the collection field 2007. Photo: G. Poulsen.

In spring 2007, I worked on the island of Funen in Denmark, a traditional region for horticultural production, and by chance I came across a local newspaper article, where a local farmer made an appeal to the public. He and his family have grown the asparagus "Danish Giant" for more than sixty years and now he has decided to plough the field, because he did not earn money on it anymore. Immediately, I called him and asked him to wait until autumn, so I could collect ripe seeds to preserve this famous "variety". It is mentioned in old gardening and cook books but was not accessible. It was not in the Nordic Genebank. I located an accession in the Vavilov institute VIR39, but I never got seeds from there (Box 1).

When autumn came, a friend and I went and collected seeds from the big field with more than 500 plants. We collected seeds from 57 mother plants and kept them isolated plant wise. Shortly after the seeds were donated to NordGen for *ex situ* conservation (Figure 2).

DANSK KÆMPE FJELDSTED NGB20405
The accession is stored as bulk. Further, plants are stored as single plants for research and gene bank multiplication. Additionally, an off-type low dense plant with orange berries is stored separately. Further information is available in the NordGen database.

Box 1. Dansk Kæmpe accession in the Vavilov institute

Multiplication of a dioecious and outcrossing species like asparagus is very costly. You must germinate the seed and grow the plantlets in the nursery for one year before transplanting to the field, where plants must grow additionally three more years to be sure that the majority of plants have reached an adult stage and can develop berries and seeds. Consequently, the accession was never multiplied and made available for users. Some members of the Danish Seed Savers offered to do the multiplication which turned into a project to save the landrace.

NordGen germinated the seed in March 2013 and plantlets were distributed in May to seven primary growers in different locations in Denmark, each receiving a minimum of 50 plants, aiming at 20 seed producing plants in each population.

Time passed and in 2017 we received seeds from 73 female plants from 4 growers. The seeds were cleaned and bulked producing 96 grams, which was passed to NordGen for *ex situ* conservation and distribution (Figure 3 and 4). In 2019 we will offer the seeds among Danish Seed Savers and to the public.

Hopefully, this may be a reintroduction of the old asparagus and a step to wake up consumers, farmers and politicians' awareness of the value of plant genetic resources and the importance of *in situ* conservation. Furthermore, "Danish Giant" will be included in the Danish Seed Savers adoption program for on-farm conservation.

Figure 2. In the field collecting berries of old asparagus "Dansk kæmpe" ("Danish Giant") on the central island Funen in Denmark, November 7th 2007. After the collection, the field was cleared and used for another purpose. Photo: G. Poulsen.

Figure 3. Asparagus berries harvested 2017. Photo: G. Poulsen.

Figure 4. Seed of asparagus harvested 2017. Photo: G. Poulsen.

Acknowledgement to Danish Seed Savers growers Niels Olav Crossland, Villy Martinussen, Mie Kongsted Søgaard, Jytte Yde, for producing and supplying the seeds.

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Preserving landrace diversity in national *in situ* and *ex situ* collections: a case of "Rambo" apple in Finland

Maarit Heinonen[1], Lidija Bitz[1] , Annika Möller-Nilsson[2], Ulrika Gräg[3] and Aaja Peura[4]

[1]Natural Resources Institute (Finland); maarit.heinonen@luke.fi
[2]Häme University of Applied Sciences (Finland);
[3]Akademi University Foundation SR (Finland);
[4]English Garden Design (Finland);

Introduction

The Finnish National Plant Genetic Resources Programme is responsible for coordinating the preservation of genetic diversity of cultivated apple trees (*Malus x Domestica* Borkh.) in Finland. Up to date the national clone collection of apple trees contains 138 cultivars and landraces (local varieties) being situated at the Natural Resources Institute Finland (Luke) (Luke, 2018; Heinonen, 2014).

Approximately one third of those cultivars and landraces are in parallel actively preserved *in situ* at public sites, specifically in historic gardens, in Finland—'actively' meaning also being in continuous sustainable use. The official backup clone collection containing also part of the Finnish apple landraces (30) is maintained at the exhibition collection site called Fruticetum (Fruticetum), which is operated by a non-profit organisation. Commercial nurseries are also selling many of those cultivars and landraces within Finland (Heinonen, 2014).

The long-term preserved apple trees consist of both Finnish and foreign cultivars including landraces that have become rare in commercial cultivation nowadays. A set of criteria is used for choosing cultivars to be included into the national collection for long-term preservation. Cultivars from outside of the geographical area of Finland are grouped into 1) foreign landraces having long cultivation history in Finland; 2) cultivars bred in foreign countries having long cultivation history in Finland; 3) foreign landraces with special cultural historic value for Finland (i.e. sites, persons) but marginally cultivated. All selected cultivars were subjected to the genetic analysis with the aim of obtaining their unique fingerprints and accessing their diversity.

This article aims to illustrate the birth and travels of the apple called "Rambo" as an example of a foreign born landrace preserved in the Finnish apple tree collection having personalized historical importance for the country. The "Rambo" apple tree was bred in the USA from seed brought from Sweden during the era when Finland was part of the Swedish empire. It was documented in the 1750s by a Finnish born explorer Pehr Kalm who introduced flora from North America to be potentially useful in Northern Europe under the auspices of the Swedish taxonomist Carl von Linné.

Birth of "Rambo"

During the early 1600s, the Swedish King Gustav II Adolf had ambitious plans to create a Swedish empire similar to the English and Dutch ones. The realization of this idea failed due to the Thirty Years' War (1618-1648), for which all available resources needed to be used. However, in the 1630s Sweden did found a trade station, Kristineskans, in the current Delaware state region in the USA (Ling, 2012.)

During this time petty criminals in Sweden were offered the choice between punishment and working five years for the new Swedish colony in America. In April 1640 the ship *Kalmar Nyckel* arrived in Kristineskans. On board were, besides the petty criminals, also a few voluntary emigrants. One of them was the Swedish farm worker Peter Gunnarsson who was accompanying his younger brother Sven to America (Ling, 2012).

After the mandatory five years of labour, Peter Gunnarsson settled in Kingsessing and soon changed his surname to Rambo. The name Rambo is thought to be a variation of the name Ramberg, a place near Peter's home in Sweden (Ling 2012; Calhoun, 2012). Peter Rambo became an influential man and served under Swedish, Dutch and English governments in Delaware (Calhoun, 2012).

On his new farm, Peter Rambo planted apple seeds he had brought from Sweden. The "Rambo" variety is considered to be originated from these seeds. A noted Finnish born botanist, Pehr Kalm, mentions and describes "Rambo" in a supplement to his book *Travels in North America 1747-51*. The aim of these travels was to gather information on vegetation in North America that exists on the same latitude as Sweden and Finland. Kalm met the grandson of Peter Rambo and documented the story of how his grandfather Peter came to America with a small box of apples and other garden seeds in his pocket (Kalm, 1753; Ling, 2012).

Autumn variety "Rambo"

The morphological and phenological descriptions of "Rambo" were presented in 1903 in the report of the New York Experimental Station (Beach, 1905):

> "It grows a medium size, moderately vigorous trunk and crown. The form is upright spreading and open. The old bark is mentioned to be peculiarly rough. The fruit is medium size and roundish. The skin is thin, mottled with red and striped with carmine. The flesh is greenish white, firm, very crisp, juicy, aromatic and subacid. It is an autumn variety and considered to be an excellent dessert apple. It bears moderate crops every year. It benefits from light, rich soils (sandy or limestone formation) with well-drained subsoil".

"Rambo" is known with several other names as well, for example 'Bread and Cheese', 'Seek-No-Further', 'Gray Romanite', 'Delaware' and 'Fall Romanite' to name a few (Calhoun, 2012).

In the early 1800s “Rambo” was much cultivated in the areas of Delaware, Pennsylvania and New Jersey because it proved to be better adapted to the north or to the mountain regions where the fruit grows smaller, more solid and has better preservability than when grown in warmer regions. It was much less known in western parts of the USA than in the north -east. In the late 1800s it was still very popular in the central regions of the Mississippi Valley (Beach, 1905). In a Virginia nursery catalog dating from 1878 it is said to be one of the best early winter apples for the region (Calhoun, 2012). During the turn of the century its cultivation started to decline when other varieties were introduced. It was recognized to be an apple of excellent quality but in New York it was no longer recommended for planting in commercial orchards after 1905 because new selections become available (Beach, 1905).

In the Report of the New York Agricultural Experiment Station for the year 1903 (Beach, 1905) is the following account of the fruit of ‘Rambo’:

> “When well colored it is rather attractive, the prevailing color being a good bright red which forms a pleasing contrast with the yellow ground color. Very often, however, the red color is not predominant and the fruit is rather dull and not particularly attractive. Often a considerable portion of the fruit does not reach good marketable size, particularly when borne on old trees that are overloaded.”

Although it no longer was thought to be a good commercial variety it is stated in the above-mentioned report that “on account of the agreeable dessert qualities of the fruit it will doubtless continue to be grown to a limited extent for home use” (Beach, 1905).

We dare to state that actually, in the case of “Rambo”, the opposite took place to what Pehr Kalm was sent to explore. It was not that excellent North American landraces were identified at the altitudes similar those in Sweden and Finland in order to be introduced to enrich the flora of northern Europe. It was northern European emigrants who brought sufficiently good landraces to empower North American agriculture of those particular times with their pocket seeds.

Genetic fingerprint of “Rambo”

Cultivated apples mostly have a diploid genome (“two copies of each chromosome” or “two copies of each gene called alleles”) with 2n=34 while some cultivars can also be triploid (“three copies of each chromosome”, 2n=3x=51) or even tetraploid. The genetic database containing fingerprints of apples collected and analyzed in Finland counts over 1000 samples (Genetic apple database, Finland).

This database was established more than a decade ago and is getting larger every year by adding new samples obtained from local cultivars, modern bred cultivars, seedlings and reference cultivars. One of the main uses of this database is to genetically differentiate between samples to ensure that those ones desired for long-term preservation have a unique genetic profile. Samples are arriving from all over the country following repeated calls (Heinonen, 2014) and still today some reference samples are obtained from abroad.

From each apple sample a DNA is isolated and analyzed with the 6 genetic markers being Simple Sequence Repeats (SSRs) also called microsatellites: Ch02c06, COL, Ch04e05, Ch01h02, Ch02c11 and Ch02c09 (Liebhard *et al*., 2002). Variants from each microsatellite marker were scored being presented as a number and this way a numerical fingerprint of each apple sample was created. Alignment of all fingerprints and inter-comparative analysis among them resulted in identification of duplicates after which the duplicates have been removed leaving the set of unique samples behind. “Rambo” always showed to be a unique genotype among a thousand other apples from our database. This was the first genetic indices that we have true to type “Rambo”.

Figure1. Apple “Rambo” - one of the earliest available photo evidence (Beach, 1905).

The unique genetic profile of “Rambo” in respect to e.g. “Discovery” and “Golden Delicious” as obtained by 6 markers are shown in Table 1. Also a dendrogram containing 50 unique apples (5% samples out of 1000 from genetic apple database Finland) was created in order to illustrate the place and up to date uniqueness of “Rambo” (Figure 2). Not only for this but the dendrogram can be exploited to get an insight into possible family relationships between different apples. “Rambo” clustered into the “middle” cluster and e.g. together with the reference foreign cultivars “Discovery” and “Golden Delicious”. “Rambo” clustered also with some newly bred Finnish apples of diverse pedigrees such as “Sandra” and “Vuokko” both of them having one parent that is a Finnish seedborn local cultivar and the other a Canadian.

Furthermore “Rambo” clustered with some other North American apple cultivars. “Norland” (“Rescue” x “Melba”) is a Canadian modern bred cultivar, very winter hardy and therefore suitable for cultivation in Finland. Another Canadian, “Lobo” (“McIntosh” seedling) has been cultivated from late 1920s and is still a popular winter cultivar in Finland (e.g. Meurman, 1943). “Raike” (“Duchess” x “Lobo”) is also bred in Canada, but it has been named and taken into cultivation in Finland. Furthermore, Canadians “Linda” (“Langford Beauty” seedling from late 19th century) and “Quinte” (“Grimson Beauty” x “Red Melba Pate”, 1964) are clustered nearby “Rambo”. Canadian cultivars have been proved to be highly usable in Finnish apple breeding programmes.

Table 1. Genetic fingerprint of "Rambo" as obtained from 6 microsatellite markers including apples "Discovery", "Golden Delicious" and "Grenman".

SSR MARKER NAME / APPLE NAME	Ch02c06	Ch02c06	COL	COL	Ch04e05	Ch04e05	Ch01h02	Ch01h02	Ch01h02	Ch02c11	Ch02c11	Ch02c11	Ch02c09	Ch02c09
Discovery	232	248	231	241	199	203	248	250	-	225	229	-	246	258
Golden Delicious	238	242	221	233	175	175	250	252	-	221	235	-	244	258
Grenman	204	232	231	233	175	212	238	242	-	217	219	-	244	250
RAMBO	232	234	221	235	175	210	205	238	250*	221	233	229*	234	256

*The third allele that is obtained in "Rambo" and not in diploid apples "Discovery", 'Golden Delicious" and "Grenman".

To take an example of "Lobo": it is a parent of e.g. "Sandra" and "Juuso". (E.g. Kinnanen and Antonius 2006.) It is most probably a parent also for "Pirkko". The Swedish lineage of "Rambo" is presented by "Gyllenkrokin Astrakaani" ("Gyllenkrok Astrakan" in Swedish) which is a Swedish local cultivar bred in the 1850s (e.g. Meurman, 1943). In-depth analysis of "Rambo" genetic clustering with other apples from the dendrogram including additional available knowledge is indicating an origin of "Rambo" rather different than Finnish. And this is in accordance what has already been discovered in the old literature about "Rambo". By this example it was nicely demonstrated that with rather low number of markers (6) some of the relationships can be shown, with the support of other known data (historical records and old pomologies).

Moreover microsatellite analysis indicated that "Rambo" might be a triploid apple variety having sometimes 3 different variants at a single marker (diploids cannot have more than two variants - i.e. two copies of each marker) as shown in table. Also earlier this was suspected based on field observations and very vigorous growth of "Rambo". Therefore the analyses of genome size were performed in order to get more exact data about the level of ploidy of "Rambo". The analyses were done by flow cytometry method.

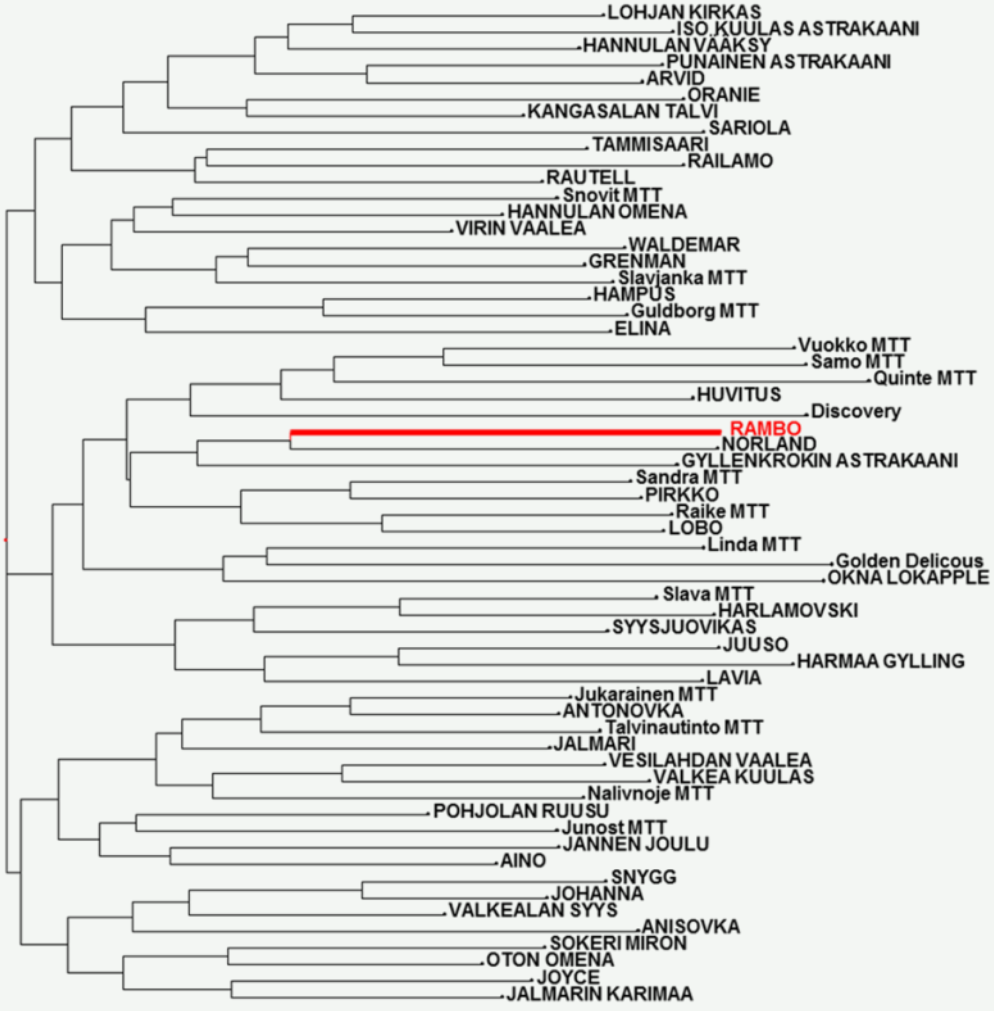

Figure 2. Apple dendrogram generated from the microsatellite data matrix at 6 microsatellites loci for 50 apples using simple matching coefficient of dissimilarity and weighted neighbor-joining method (Bitz Lidija, personal communication, 2018).

Ploidy status was determined by use of an internal standard (*Vinca major* L.) while the Finnish local cultivar ‘‘Eppulainen” was included as a reference triploid cultivar and the Finnish local cultivar “Grenman” as a diploid reference. “Rambo” indeed showed to be a triploid apple cultivar. What is the advantage of having triploid apple cultivars? In recent times it was thought that triploid apple cultivars are characterized with more vigor having also more attractive fruits (larger in size than diploids). Nowadays apple triploids are considered as valuable material to be used for producing aneuploids and thus been used in genetic studies for apple breeding.

“Rambo” trees in Finland

In the early 2000s Herbert Rambo, the chairman of the Swedish Colonial Society, wanted to donate his family’s heritage apple cultivar “Rambo” to Sweden. With the financing of Sweden's royal culture foundation some young trees were safely brought from the USA to Uppsala, Sweden. They were planted at the experimental farm of Sweden's agriculture university in Funbo and Carl von Linne’s farm in Sävja. Furthermore, one young tree was donated to Finland to Åbo Akademi University because the first documentation about “Rambo” was done by one of the Linne’s pupils, Professor Pehr Kalm from the former Åbo University (Turun akatemia) in Finland. In 2008 it was planted in the garden of Kankas manor owned by the Åbo Akademi University Foundation.

“Rambo” was also saved to the clone apple tree collection in Luke for evaluation and fortunately this happened before the young tree died in Kankas manor garden. In summer 2018, the “Rambo” young tree that was grafted from the national clone collection of apple trees was planted back in the manor garden. One safety duplicate was also planted in the nearby former botanic garden of Åbo University established in 17th century as it was there that Professor Pehr Kalm established the cultivation and domestication experiments of the “exotic” American plants he brought from North America in the 1750s.

Museum and other historical gardens are recognized as important actors in gathering, maintaining, using and distributing plant genetic resources in Finland (Pihlman and Heinonen 2015). The advantages are reciprocal: the landraces and historic varieties connected to the historic narration of the site offer platforms for public activities and events; and maintaining landraces and other historic varieties secure *in situ* preservation, serve awareness rinsing and allows sustainable use. The collaboration between the Finnish National Plant Genetic Resources Programme and the Åbo Akademi University Foundation ensures that “Rambo” apple tree will be saved for future generations in Finland.

Acknowledgements

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Fruit landraces in Emilia Romagna (Italy)

Claudio Buscaroli and Daniele Missere

Centro Ricerche Produzioni Vegetali (CRPV), Cesena (Italy); cbuscaroli@crpv.it

At the beginning of the 20th century, many Roman fruit landraces were still grown in Italy. Apples and pears were mostly sold in the markets from the south to central-north. However, these varieties have been replaced by a few modern allochthonous ones grown in intensively managed orchards. As a result, fruit genetic diversity has reduced drastically and thousands of years of tradition has been lost. In many cases, new cultivars had no resistance to some local disease strains and farmers were forced to resort to chemical sprays to maintain production. Nowadays, we find an extreme situation, as in pear cultivation, where one variety provides almost 50% of the Italian pear production (0.7 million tons). The consequences is that farmers increased the use of chemical sprays at 1-2 per week in spring and summer.

In the Middle Age fruit biodiversity was increased by shepherds and pilgrims coming from north Europe to Rome, leaving fruit seeds along the paths. During the renaissance, large fruit tree collections were amassed by the Medici family and new genotypes were introduced and mixed with local races by wind and pests. Fruit trees were cultivated in "piantate", rows with 15 meters between each tree and staked alongside wine grapes.

Around 1880, farmers in Emilia Romagna Region started to make modern peach orchards and cultivation considerably improved and expanded. But now much of this diversity has been lost, even among apple, pear and plum orchards. Many ancient landraces were propagated by farmers until 50 years ago, then many orchard maintainers left for the USA taking their varieties with them. CRPV is attempting to recover this lost diversity and use it in breeding, every year new cultivars are released to farmer organization members and nurseries.

In this context germplasm tree collections have been established and many landraces have been picked up from old orchard and collections of ancient trees. Accessions from these old landraces are used as sources for many traits in crossbreeding. A periodic scion wood exchange is carried out with "farmer keepers", universities and research centers. About 10 years ago some Italian Regions, started to issue, on the bases of CEE guidelines, a framework law (LR n.1/08 in Emilia Romagna) about agricultural biodiversity and to safeguard old landraces at risk of extinction. A procedure was established to register landraces. A commission of experts was established to ensure correct procedures. Farmer variety guardians were identified.

Through the Rural Development Program (RDP) - Integrated biodiversity project 2011-13, the activity of recovery, characterization, conservation and reintroduction (Buscaroli *et al.* 2014) was financed by the administration Provinces. For some important peach, plum and pear landraces, CRPV organized picking up scion from trueness to type trees, propagation in nursery, and distribution of one thousand year-old grafted trees to about one hundred farmers. Activities were promoted as village festivals, where farmers' fruit landraces crop sale was the main attraction (Figure 1). For more successful landraces, "Slow Food" communities have developed recently. In 2014-15 some regional public and private fruit landrace collections were acknowledged by official administration and CRPV accepted responsibility to run evaluation and characterization trials. In 2018 a new ambitious RPD project involving farmer organizations and supermarkets – collaborating to realized landrace product sales – was under development.

Figure 1. Some reintroduced fruit landraces in Emilia Romagna and their area of origin.

Figure 1. a) Massa Lombarda: white flesh peach landrace festival; **b)** Pennabilli: forgotten fruit festival

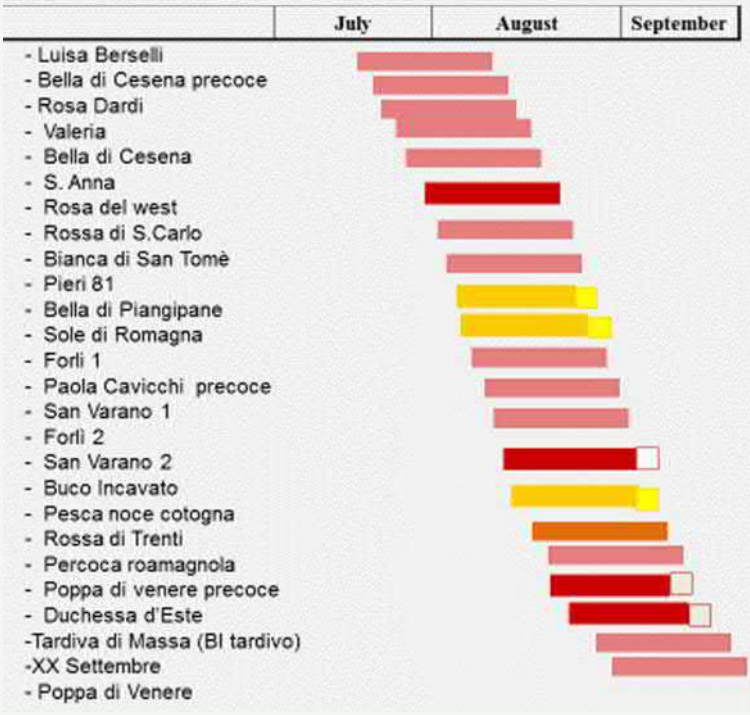

Figure 2. Ripening period of old Italian peach landraces.

Figure 3. "Buco incavato" landrace farmer, C.Bartoli.

Peach Landraces

"Buco incavato"

It is one of most famous and oldest peach population-landrace that history has partially forgotten; yet it is described in detail in some ancient papers. A recent project attempted to revive this precious landrace; the story tells us that in 1865 a farmer was eating peaches at the market while selling fruits and vegetables. He kept the seed of the tastiest variety and sowed it in his farm. In three years the farmer obtained fruits sold at premium price, as nowadays.

Although during the 1930s about 200 hectares were cultivated with this landrace, in the 1950s only ten hectares remained. "Buco incavato" was included in recent trials run by CRPV and showed wide genetic variability and a ripening period from mid-July to mid-August (Figure 2); the variety showed some sensitivity to diseases, but the red fruit color was a strong selling feature for the public (Figure 3 and 4). According to genetic data, this landrace was initially propagated by seed for many generations until farmers learnt grafting. Since a type has been found to be homozygous for 10 molecular markers, this type could be an ancestor of the actual type or the result of a number of self-fertilizing generations of an heterozygous type.

Figure 4. A fruit of "Buco incavato" landrace characterised by its typical suture slit.

"Luisa Berselli"

This white flesh peach is characterized by a long shaped fruit (Figure 5), typical of many old varieties and today missing in a market that prefers rounded shape varieties.
Few farmers in a very restricted area still grown this landrace for early seasonal ripening and its very good taste.
A recent research showed that antioxidant loading capacity of this landrace is significantly higher than those of several modern varieties.

Figure 5. A fruit of "Luisa Berselli" landrace.

"Bella di Cesena"

This white flesh peach (Figure 6) was largely grown from the 1930s to the 1940s in Cesena, that was and still is a very important district for industrial fruit production and processing. The main value is its early ripening, plus its very good flavor and taste. However due to its soft flesh associated with poor shelf-life, this landrace was replace by more firm yellow flesh varieties. Types characterized by different maturity timing (two weeks earlier) were observed. This is probably a mutation chimera, in fact, no molecular fingerprinting differences has been found yet, but only evident phenotypic variations. This type has been recently reintroduced by CRPV .

Figure 6. Fruits of "Bella di Cesena" landrace.

"Poppa di Venere"

This very old landrace was described by Gallesio (1810) and others later. It is characterized by a typical long shape with nipple at the top of the calyx hollow, from which the name is derived. Within the landrace many variations were described, some have been lost, but others still exist and differ in: i) ripening period (from August to the end of September), ii) color and iii) taste (Figure 7).

Figure 7. Fruits of "Poppa di Venere" landrace .

"Forlì 2"

This landrace is probably very old, grown for many centuries in the orchards close to Forlì (Figure 8). It has been reintroduced recently, following its rediscovery. It is resistant to leaf curl and peach rot, so suitable for organic production, with white flesh.

Figure 8. A fruit of "Forlì 2" landrace.

"Tardiva di Massa"

This late white peach can be considered "Buco Incavato" sister because it has been grown over the same historic period. Farmers grew it in order to extend the period of harvest and sell until the end of September. Genetic variations are known as well as ripening period differences (i.e. from first days of September to the end of the month) (Figure 9).

Figure 9. Fruits of "Tardiva di Massa" landrace

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The story of the Macedonian "Black gold" – opium poppy (*Papaver somniferum*)

Sonja Ivanovska and Mirjana Jankulovska

Faculty of Agricultural Sciences and Food, Skopje (Macedonia); s_ivanovska@yahoo.com

History of poppy cultivation

A detailed study on poppy cultivation in Macedonia from a socio-economic aspect was conducted by Jovanovic (2009). The first poppy was planted in Macedonia in 1835 in the vicinity of Shtip, probably introduced from Afyon province of Turkey (Brunetti, 1951) when Macedonia was part of the Ottoman Empire. Farmers quickly adopted this new crop (local name Afion), collecting semi-dried opium from incised unripe capsules. Towards the end of the 19th century, 28% of the Ottoman Empire's total output of opium was cultivated in Macedonia. The first statistical data refers to 70 tons of raw opium produced in the valley of the river Vardar in 1880.

Macedonian poppy had the highest raw morphine content in the world, ranging between 14 to 16%, (by comparison China poppy had 3-5%). Poppy was produced in 40 municipalities, but the highest percentage of morphine was obtained in the area of Kavadarci, Strumica and Veles. In 1927 Macedonia was providing 95% of the production in former Yugoslavia, which was satisfying 43% of the needs of all legal processing factories globally in the period between the two World Wars. In the following years, yields decreased due to unfavorable climate conditions, and increases in pests and diseases. In addition, opium prices dropped significantly in 1930-31, which resulted in a decreased area sown from 14,110 hectares in 1930 to 4,009 hectares in 1932. Consequently, farmers restored their faith in poppy cultivation rather slowly.

The quality of the Macedonian poppy, also known locally as "black gold", was a crucial factor in the founding of the Pharmaceutical Company 'Alkaloid' in 1936 (Alkaloid, 2016). In the post-war period, Macedonia remained the sole Yugoslav republic producing opium poppy. The severe yield loss in 1949, due to bad climate conditions and high prices of other crops, contributed to decreased poppy production which had been retained on approximately 5,000ha in 1955-59 (Kusvie, 1960). Poppy production nearly stopped after Macedonia became independent in 1991, due to various reasons. Several years ago the company Alkaloid initiated organized production of poppy in cooperation with small farmers, providing them with variety Alkaloid 1 seeds and buying the capsules. Finally, the production rose to 180 ha in 2012 and 90 ha in 2016 (SSO, 2017).

The present governmental policy (MAFWE, 2014) is increasing poppy production and breeding support due to the fact that the current production only satisfies 30% of national pharmaceutical requirements, while the rest is covered by import.

The importance of poppy production in Macedonia is illustrated by the image of a poppy flower, a proud synonym for the quality of Macedonian agricultural products, is printed on a 500 Denars bill, while poppy capsules are printed on the coat of arms (Figure 1).

Traditional use of poppy

Historically, unfortunately armed conflicts were common in Macedonia, destroying the value of money and giving opium an opportunity to be a stable "currency". Therefore farmers were keeping opium as a "gold reserve", selling it only in case of need. Common tradition was to save an opium "pie" as a dowry for daughters (Kusvie, 1960). This tradition, which lasted until the 1950s, largely contributed to the preservation of poppy landraces.

Some of the farmers today grow several plants in their gardens just to save the seeds, to prepare pies and cakes and sometimes even to produce a special type of the spice "K'cana sol" (smashed salt). This spice can be prepared in many variants from different ingredients. When it is prepared from poppy, the seeds are baked at 100ºC for 30 minutes until reaching golden color and then are smashed and mixed with salt.

Characteristics of poppy genetic resources

Jovanovic (2009) noted that Macedonian poppy populations in the 1800s probably arose from a cross between white-seeded poppy (*Papaver somniferum* var. *album*) and grey-seeded poppy (*P. somnifeum* var. *griseum*). On the other hand, a CIA record from 1949 states: "In Macedonia two varieties of poppy are cultivated: one with a white flowers and white seeds in a closed pod, the other purple, with black seeds in pods which split when ripe. Both varieties are used in production, but the white has a greater morphine content and is cultivated most." This record also emphasizes that "Kavadar opium" (from the area of Kavadraci) is the best in the world, and that Yugoslav experimental stations created several new poppy varieties, one of which has a morphine content of 21.62%.

Kusvie (1960) described that cultivated poppies in Macedonia had 5-8 capsules per plant, roundish or oval, 2.5-5 cm in diameter and 10-14 stigmatic rays. Seeds varied greatly in color, from grayish white to light brown, which was not considered during the selection of seeds for sowing.

Figure 1. Poppy image on the Macedonian coat of arms and a 500 Denars bill

The varieties were yielding 300-400 kg of seeds on average per hectare, depending on the place and year. This author also noted that the quality of Macedonian opium is characterized with 15.9%-17.2% constant morphine content, 0.9-1.6% codeine, 7-9% narcotine, 0.7-1.7% thebaine and 1.2-3.3% papaverine.

Its most distinguishing trait compared to other opiums was its typical ultra-violet absorption spectrum - mostly attributed to a constant ratio between the thebaine and papaverine content.

According to the ratio between these two alkaloids, Macedonian opium belonged to the papaverine type unlike the majority of the Asian types. The highest morphine content (1.25%) was found in dry capsules grown in the Kavadarci region, while it varied in other regions between 0.47% and 1.05%. It can be concluded that the Kavadarci region has the best climate and soil quality enabling varieties to express their genetic potential. Siljanoski (2001) was analyzing two local Macedonian poppy populations and a landrace:

- White-seeded poppy (white flowers, cream seeds) and Blue -seeded poppy (dark purple flowers, light to dark blue-grey seeds), and the variety "Alkaloid 1". He found 0.53%, 0.67% and 1.80% of morphine content in dry capsules, 510 kg/ha, 632 kg/ha and 566 kg/ha of capsule yield and 680 kg/ha, 904 kg/ha and 864 kg/ha of seed yield, respectively;
- Blue-seeded poppy population (*Papaver somniferum* ssp. *turcicum*) is predominantly grown in Macedonia and is characterized by dark purple flowers (var. violaceum), light to dark grey seeds, 0.4-0.45% morphine, 400-600 kg/ha capsules and 600-800 kg/ha seeds (Boshev, 1996). When cultivated in Macedonia, it had the same content of morphine, but higher contents of the other two alkaloids (1.32%, 0.08% and 0.04% in Australia and 1.36%, 0.20 and 0.43% in Macedonia, respectively);
- "Alkaloid 1" has light purple flowers with dark purple blotches and blue-grey seeds. Its yielding potential is 600 kg/ha of capsules and 700 kg/ha of seeds.

Today "Pioner" is registered as local variety/ecotype along with two other ecotypes: "Arna II" and "Sinosemen opiumski" (Blue-seeded opium), but in reality seeds from these ecotypes are not maintained and are probably lost. In order to create a new improved variety, the Faculty in Skopje initiated a new poppy breeding program in 2010 within the project "Modern perspectives for cultivation and use of poppy in Republic of Macedonia" supported by Alkaloid.

Poppy breeding programs

Macedonian populations were used as genetic resources in the poppy breeding program, which was intensified during the period from 1960-1970. These efforts resulted in a new variety, Pioner (*Papaver somniferum* subsp. *euroasiaticum* var. *caesium*), created by the Faculty of Agriculture in Skopje and registered in the National Variety List in 1982 (Vasilevski, 2008).

It was obtained by crossing Macedonian opium poppy with a variety from Vojvodina cultivated for oil production (Angelov, 1989), but unfortunately it was not widely accepted by farmers. This variety had purple flowers with dark purple blotches, blue-grey seeds, yielding genetic potential for 1300 kg/ha of capsules, 1200 kg/ha of seed and 0.52% of morphine content.

Another breeding program was performed by the company Alkaloid which resulted in a variety ("Alkaloid 1"), registered in the National Variety List in 1996 and again in 2007. The original material for this variety, having high content of morphine and low content of codeine and thebaine, was introduced from Australia in 1979 (Siljanoski, 2001).

Different genotypes, which had been obtained by the Gatersleben genebank, and local populations were used as pre-breeding material (Stefkov *et al.*, 2012; Jankulovska *et al.*, 2012, 2013; Ivanovska *et al.*, 2012, 2016). Significant progress in several breeding lines which were selected from the local populations only has been achieved and analyzed up to 2015. The variability of several characterized traits is presented in Figure 2, 3 and 4.

Table 1. Breeding progress for yielding characteristics from 2012 to 2015

Genotype	Year	Capsule weight (g)	Seed/capsule weight (g)	Morphine content (%)
A/1-1	2012	3.57	3.72	0.84
	2015	4.34	4.83	1.01
A/1-14	2012	4.25	5.36	0.86
	2015	4.93	6.83	0.91
A/6-12	2012	2.25	2.84	0.91
	2015	3.06	4.31	1.12
M/3-9	2012	2.37	4.21	1.13
	2015	2.63	4.56	1.38
M/1-3	2012	2.34	4.15	0.85
	2015	3.76	5.75	0.92
S/5-11	2012	4.25	3.87	0.81
	2015	5.73	4.91	0.93

Figure 2. Variability of the flower color in Macedonian opium poppy breeding lines

Table 2. Contents of specific alkaloids of the improved lines

Genotypes	Morphine %	Oripavine %	Codeine %	Papaverine %	Thebaine %	Noscapine %	Total %
A/2	1.4077	0.0187	0.1055	0.3874	0.1386	0.0044	2.0622
S/5-11	1.1745	0.0000	0.1093	0.1558	0.0490	0.2816	1.7702
A/16	1.8310	0.0229	0.1695	0.1086	0.1891	0.0031	2.3242
Alkaloid 1	0.6643	0.0066	0.0583	0.2140	0.0247	0.1794	1.1474

The average weight of a capsule, seeds per capsule and morphine content in six improved lines are presented in Table 1. All lines have large round or round-conic closed capsules, so that seeds are not shed. Some of the lines were selected in the program due to their improved content of specific alkaloids other than morphine. In 2015/16, breeding lines were evaluated for the content of several alkaloids (from bulk samples of capsules). The best three lines compared with the variety "Alkaloid 1" are presented in Table 2.

Starting from 2014, The Faculty of Agricultural Sciences and Food has been establishing a seed collection of Macedonian landraces which currently contains 63 samples collected from 53 sites in Macedonia. Nearly half of the farmers maintain white-seeded landraces, claiming that the seeds are very old. Although some of the older farmers are not cultivating poppy any more, they have been keeping the seeds in jars in their basements for more than 15 years.

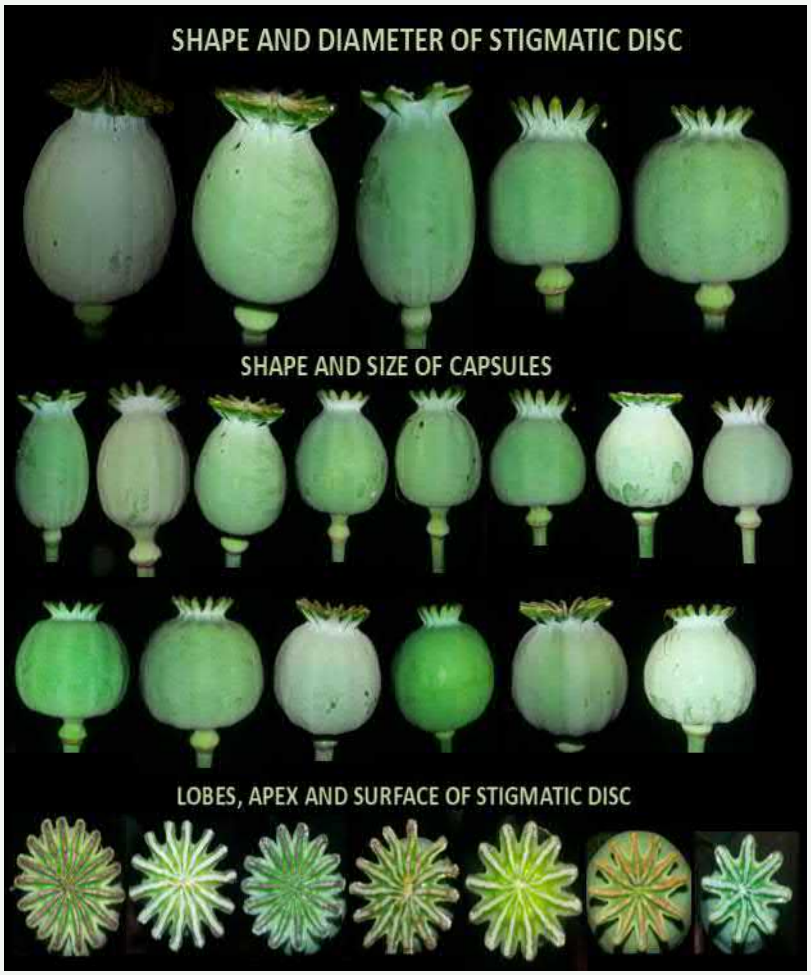

Figure 3. Variability of the capsule characteristics in Macedonian opium poppy breeding lines

Conclusion

The story of Macedonian poppy is a typical example of lost genetic resources that are valuable and may be needed and profitable in the future. All collected poppy samples may have the genetic potential for high morphine content as the old populations. Therefore they have to be multiplied, characterized, evaluated for their production and breeding value, and saved in a genebank for future exploitation.

Figure 4. Variability of the seed color characteristics in Macedonian opium poppy breeding lines.
Photo credits: M. Jankulovska.

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De Oerakker: a platform facilitating the conservation and use of old Dutch varieties

Chris Kik, Noor Bas, Willem van Dooijeweert and Frank Menting

Centre for Genetic Resources (CGN), Wageningen University & Research, Wageningen (The Netherlands); chris.kik@wur.nl

Abstract: A historic overview of the Dutch efforts concerning the conservation and use of old crop varieties is presented. Also attention is given to the current efforts to properly describe, multiply and market Dutch heritage varieties in order to maintain this precious material in a sustainable manner.

Introduction

Dutch bio-cultural heritage has not been conserved in an ideal manner for a long period. The value of maintaining old varieties[1] was only recognized by a few people. Most of these people operated more or less in isolation, hampering the exchange of ideas on cultivating these varieties and ultimately their maintenance. Perhaps the only exception were people interested in fruit crops like apple and pears. They established pomological organisations which were active over a number of decades although these organisations also did not have extensive contact among themselves. The only organisation which conserved old Dutch plant varieties in a systematic way was the Dutch national gene bank (CGN)[2], which is part of Wageningen University & Research. However CGN was established in 1985 which means that most probably a number of old Dutch varieties had disappeared by then. Currently there are 122 landraces present of different crops in the CGN collection.

Foundation De Oerakker

It is only since 2005 that CGN has started seriously to facilitate Dutch agro-initiatives in their efforts to conserve and use old varieties. At that time there was also a foundation focussing on maintaining old Dutch varieties called De Oerakker. This foundation was established in 1995 and facilitated one person namely Ruurd Walrecht in his conservation work. As there was contact between Walrecht and curators of CGN, namely Ietje Boukema and Loek van Soest, a considerable number of varieties in the collection of De Oerakker originated from CGN. However *vice versa* exchange also took place. In the years between 2005 and 2007 a number of meetings were organized between a group of Dutch agro-initiatives and CGN, which laid the basis for further cooperation. As there was only one legal body present among the participating agro-initiatives, foundation De Oerakker became the legal umbrella under which the other Dutch agro-initiatives joined forces. The first board existed of Obe Bootsma (chair), Rene Zanderink, Loek Hilgers, Johannes Spyksma and Chris Kik. In the beginning around 15 initiatives participated, this increased over the years to more than hundred initiatives nowadays.

During the first years the focus was on vegetables, and the network in which they operated was called Eeuwig Moes (Eternal Mash). The network was named after a vegetatively propagated kale landrace used by people (often miners) in the South-eastern part of the Netherlands. After some years it was felt that other networks should also be developed such as a cereal network and a fruit network. The cereal network, named De Bekoring, was established in 2012, but it did not lead to a network with a large number of initiatives. Perhaps this was due to the lack of acreage which many initiatives have. Often they cultivate their varieties in home gardens of only a few m^2. Nevertheless valuable varieties are maintained by this small network. The fruit network was established in 2016 and is called Nationaal Fruit Netwerk (NFN; National Fruit Network). This network functions appropriately and most pomological societies are involved. Concerning the organizational side, a deliberate choice has been made for a loose organization. Foundation De Oerakker has a board, but the initiatives have to organize their networks themselves.

Furthermore no membership fees are asked as this would inevitably lead to a more stringent organization structure which is not asked for by the members. Another characteristic of De Oerakker is that many participants are elderly pensioners.

The role of CGN in foundation De Oerakker

CGN facilitates the Oerakker by organizing two annual meetings: one is organised on-location and one in Wageningen. Both meetings are intended to promote the exchange of information: the on-location meeting has a more practical approach and the Wageningen meeting a more strategic approach (Figure 1). CGN also stores a back-up collection for the initiatives and gives advice for example in describing and regenerating varieties. Furthermore CGN has developed and maintains the De Oerakker website. Last but not least CGN acts as a liaison between De Oerakker and other initiatives: for example in the Netherlands this occurs with Stichting Zeldzame Huisdierrassen (SZH; Foundation Rare Breeds) and in a European context this often takes place via EU projects like TRAFOON.[4]

The Orange list[5]

Soon after 2005 it was realized that there was no proper overview of the Dutch bio-cultural heritage as regards to crop varieties. In fact this is strange as the Netherlands are very active in maintaining their cultural heritage. It was therefore fortuitous that Sierd Zijlstra and Lau Simonse, both retired and with a background in agricultural research, started in 2008 on request of CGN to identify varieties that were mentioned in variety lists and seed catalogues, issued between 1800 and World War II (WWII), from seed sellers located in the Netherlands. These lists and catalogues were available from the Special Collections of Wageningen University & Research Library. We assumed that the varieties identified were once cultivated in the Netherlands. WWII is chosen as a point in time because before that time the influence of breeding on the variation in crops was not very strong.

[1] A variety which is cultivated before World War II (WWII); before that time the influence of breeding on the genetic diversity of a variety is supposed to be low. [2] Centre for Genetic Resources, the Netherlands (CGN; www.cgn.wur.nl) [3] https://deoerakker.cgn.wur.nl [4] https://www.trafoon.eu/ [5] www.oranjelijst.nl

During a period of eight years Zijlstra and Simonse established the Orange list. The name Orange list was chosen as orange is the royal colour of the Netherlands and is also the colour in a traffic light indicating attention. The work of Zijlstra and Simonse resulted in the Orange list and is available on the web and can be searched on line with different search options. In total 6575 varieties of five arable, 34 vegetable and five fruit crops were identified (Figure 2). They observed that significant differences were present in the number of identified varieties between crops. For example in case of vegetables much more old varieties of beans, peas and cabbage were identified compared with the other vegetable crops. It was found that for around 20% of the old varieties seed or scions are still available. Currently the Orange list is seen as a reference list for Dutch bio-cultural heritage.

Figure 1. On-location meeting in 2016 of De Oerakker partners in Zeeland visiting Stichting Landschapsbeheer Zeeland.

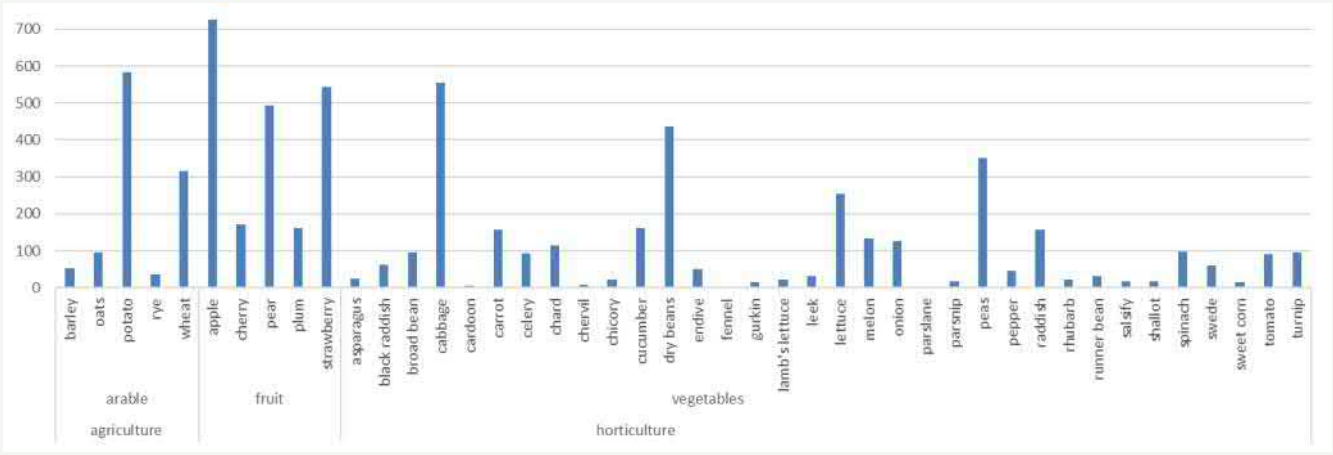

Figure 2. The Orange list: on the X-axis the crops cultivated in the Netherlands before WWII and on the Y-axis the number of identified varieties per crop before WWII

Heritage seeds (Erfgoedzaden)

After the Orange list was completed in 2016, it was observed that from around 1300 old varieties, seed was still present at seed companies, seedsavers aand genebanks. As these varieties could not all be conserved by De Oerakker a selection was made on the basis of a number of criteria. The most important criteria were landrace, overall economic importance, regional importance, and varieties with a story. A list of around 380 varieties was compiled in close cooperation between CGN, agro-initiatives and crop experts. This list was called Erfgoedzaden lijst[6] . In this context also a logo was developed (Figure 3). As half of the selected varieties are marketed by seedsavers and seed companies, the focus of the Heritage Seed project is on these varieties that are present only in genebanks. The next step in the project was to describe the varieties in a more formal way using UPOV descriptors, as it was felt that the old varieties selected should be maintained in a consistent way and maybe in the future registered as a conservation variety.

The UPOV descriptors indicated with an asterisk were used as these are the most discriminating ones. This resulted in around 10-15 descriptors per crop which had to be observed. As many staff from agro-initiatives found it hard to read English, all descriptors and accompanying information was translated in Dutch. Description of varieties for several crops was demonstrated in workshops during annual meetings of De Oerakker in Wageningen. Furthermore CGN assists initiatives during the growing season. Currently this work is still ongoing.

ERFGOED ZADEN

Figure 3. Logo of the Dutch heritage seeds.

A further step will be the multiplication of the selected varieties in considerable quantities, which also will allow for the marketing of the varieties and hopefully will contribute to a sustainable maintenance of these old varieties.

In the end we hope that all 380 Erfgoedzaden varieties will be available to interested growers and the general public, and that they will reach bakers, restaurants and ultimately the kitchens of the general public, raising awareness of the beauty and quality of our Dutch bio-cultural heritage.

Acknowledgements
We gratefully thank Theo van Hintum (CGN) for critically reviewing this article. The work was partly carried out in the framework of the Programme Genetic Resources (WOT-03; project WOT-03-002-064) funded by the Dutch Ministry of Agriculture, Nature and Food Quality and the EU Horizon 2020 project Farmer's Pride (contract number: 774271).

[6] https://www.deoerakker.nl/erfgoedzaden.htm

On-farm conservation of a common bean landrace in a Biosphere Reserve - a case study for Tarreste

Violeta Rolim Lopes and Ana Maria Barata

Banco Português de Germoplasma Vegetal (BPGV), Instituto Nacional de Investigação Agrária e Veterinária (INIAV, IP), Braga (Portugal); ana.barata@iniav.pt

Pulses in Portugal

Pulses are multifunctional crops with large importance in agriculture, environment and culture in the Mediterranean countries. The history of pulses in Portugal results from and reflects the presence of several and successive ancient civilizations and Portuguese expansion in the world, expressed in the Mediterranean diet. Public awareness of pulses' consumption and quality, is an opportunity for the development of new and more sustainable food products, where pulses play an important role.

Portugal is a rich repository of pulses genetic resources. The landraces collection of Portuguese pulses represents the variability of several ecogeographic conditions, different farming systems and comprises seeds, farmers' knowledge and heritage profile of 6,350 accessions.

The most traditional pulse produced and consumed in Portugal, *Phaseolus vulgaris* L. is well established in the market. Common bean has been introduced and cultivated in Portugal, since the 16th century, as a result of the Portuguese maritime voyages. This species is the most important source of plant protein consumed in Portugal, followed by chick pea (*Cicer arientinum* L.). Today, in Portugal the average *per capita* consumption of pulses is 4kg. Dry beans consumption in Portugal in 2016 represents on average 75% of the total pulses.

Common bean collection

Portugal is considered a secondary centre of genetic diversity of *P. vulgaris* L. (Santalla *et al*., 2002). The collection of Portuguese common bean landraces started four decades ago; between 1978 and 2015, as a result of 126 collecting missions and assessment of local practices and uses (Rocha *et al.,* 2017), it now holds 3,352 accessions maintained in *ex situ* conditions in Banco Português de Germoplasma Vegetal (National Genebank).

Note that there is no correlation between the geographic distance and the genetic differentiation among accessions. This fact is probably due to an extensive gene flow resulting from traditional seed exchange practices, like the trade in local markets or among farmers and neighbours. On the other hand, the collection has a large proportion of accessions originated from the north central and north interior regions of Portugal. Those regions have a more suitable climate to cultivate bean, with higher values of annual precipitation associated with warmer summers, reducing the need for additional costly irrigation.

The collection comprises the three genepools: Andean, Mesoamerican and, the Intermediate as a result of the introgression between the Mesoamerican and Andean gene pools (Leitão *et al*., 2017, Marques da Silva *et al*., 2010, Angioi *et al*., 2010, Igrejas *et al*., 2009. Rodiño *et al*., 2001, 2006; Santalla *et al.,* 2002).

The Portuguese common bean accessions present: high morphological diversity for seed shape and colour; leaf dimension and shape; growth habit; one hundred seeds weight; different precocity classes; protein content; seed yield and; different levels of sensitivity to the weevil. The Portuguese genetic resources substantiates a potential value, in providing an additional level of complexity and new gene combinations not yet explored in breeding (Leitão *et al.,* 2017, Gouveia *et al.,* 2014, Coelho *et al.,* 2009, Stoilova *et al.,* 2005).

The national collection of common bean contains added value to: i) the production of new varieties for sustainable intensive production systems, with characters of resistance to biotic and abiotic factors and also the challenges of climate change, and to support breeding programmes to produce organic seeds; ii) the implementation of short food chains, promoting markets and local trade systems, with the reintroduction of traditional varieties in the value chain and, making them commercially viable; iii) the recovery strategies for the territories and the communities, associated to the value of the products, where conservation in the farmers' field (*in situ*: on-farm conservation) is applicable.

On-farm conservation

Strategies to promote Portuguese varieties associated with territories are being implemented in some regions of the country. In S. Pedro do Sul, in the central region of the country, a similar task is to be done with the common bean, similar to the one conducted in the Northern region of the Peneda-Gerês National Park (PNPG) to Tarreste landrace. This national Park, located in the north-west mountain area of Portugal, covers areas of five counties and shares 100kms border with Spain, in Galicia Region since 2009 is a Region Gerês-Xurés Biosphere Reserve (Figure 1).

The common bean landrace "Tarrestre", originate in the Peneda Mountain, is among the landraces of Biosphere Reserve and it stands out in nutritional studies and studies in the framework of functional foods (Paula Cardoso *et al.,* 2000, Pereira *et al*., 2011). The production of this landrace is dependent on the older women farmers' knowledge and it was a local patrimony of recipes from this mountain. The collection and documentation of the "Tarreste" traditional knowledge started at the end of the 1990s, when the study of the mountain agriculture system started.

The first studies in PNPG showed the region to be an important source of genetic resources and the associated traditional knowledge. In the period of 2004-2008, on-farm conservation actions were taken, covering rye, maize and common bean. The work done highlighted the genetic variability of PNPG landraces for morphological descriptors and molecular markers (Barata *et al.,* 2011).

The major results from common bean evaluation were:

1. The variability evaluation between landraces from the *ex situ* collection and landraces on on-farm conservation showed that number of alleles per landrace decreased from *ex situ* to on-farm, 19.84 and 18.15 respectively. The number of loci with alleles nulls per landrace, the maximum number of alleles per locus and the number of loci heterozigotic per landrace increased.
2. Cluster analysis indicated a moderate genetic distance between landraces (maximum Nei's gene distance (1972) 0.55 for cophonetic coefficient r = 0.94). There was not an effect of collection site, neither of the collecting date in the number of absent l*oci*.
3. Landraces from Galicia, which were studied at the same time, demonstrated similarity between them and with some Portuguese landraces. Arcos de Valdevez county is characterised by its distinctive landraces.
4. The accessions from PNPG area were mostly characterised by 38 to 58 days to flowering, white to lilac wings, pod with few strings to very stringy, plant habitat type variable, seeds characters variable, and 100 seeds weight low (18.8 g) to high (50.1 g).
5. Among the sites evaluated, Arcos de Valdevez accessions were described as plant type indeterminate, length of pod medium to small and very stringy, and low 100 seeds weight (< 30 grams). Arcos Valdevez in PNPG can be an example of domestication in conditions of isolation where the original genetic variability is retained by natural selection and by farmers' action. It is the target region of "Tarrestre" landrace.

"Tarreste"

"Tarreste" landrace is briefly characterized by a fibrous pod wall, with a higher number of locules per pod, but with small seeds and low 100 seeds weight, which are morphological characteristics related to the Mesoamerican gene pool. "Tarreste" landrace was analyzed for the agro-morphological and molecular traits (Lopes *et al.,* 2015; and Reis & Miranda, 2000). Twelve morphological descriptors were used: colour of wings, pod dimension (length, width), locules per pod, pod suture string, plant habitat growth type, shape seed, seed coat darker colour - coat lighter colour, number of seeds per plant, height of plant, weight of 100 seeds (g), flowering date, seeds dimension (length, width, height).

"Tarreste" landrace conserved on-farm is characterised by 50 days to flowering date, colour of wings white with notes of purple and lilac, pod dimension 9,0 x 0,8-0,85 cm, 5-6 locules per pod, plant habitat growth bush or indeterminate type, cuboid shape seed, seed colour pale cream as dominant colour with notes of brown, yellow and black, 29-51 seeds per plant and 5-6 seeds per pod, height plant range between 114 and 161 cm, 100 weight seeds 29-22 g, seeds dimension 13,0-12,0x5,0 mm. For the microsatellites, the evaluation gave the following results: five *loci* are common and the range of number of alleles is 2-5; it was possible to establish a genetic profile.

These actions are a fundamental strategy for the genetic resources' conservation. The acquired knowledge supports maintenance of the landrace in on-farm conditions, with adequate traceability.

This knowledge was transferred to the local cooperative and local farmers.

Since 2009, "Tarreste" has been included in the Slow Food Catalogue. This landrace is registered as a traditional variety and it is locally marketed, as well as in gourmet retailing, while available in fairs and is present in a catalogue of traditional foods (Figure 2). The BPGV supported the reintroduction of this landrace with new farmers in the region.

Evidence was provided that the implementation of measures of the valorisation of landraces, in particular "Tarreste", promotes on-farm conservation. Actions should also contribute to maintain the genetic variability of this landrace.

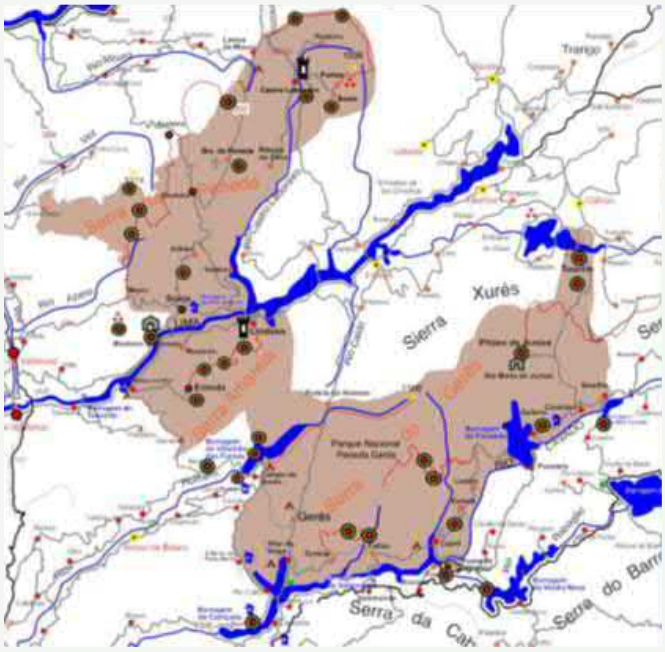

Figure 1. The Region Gerês-Xurés Biosphere Reserve – the characteristic terraces of the Arcos de Valdevez territory.

It is of paramount importance to continue and intensify the development and implementation of agro-environmental policies envisaged to promote the conservation, production and valorisation of landraces' products as well as to collect, document, study and promote the traditional farmers' knowledge associated with the development, production and utilisation of the traditional local products.

In doing so, it develops and strengthens the rural economy while helping to reduce the population exodus from those areas, as well as contributing to facing the challenges posed by the ever changing climate conditions.

The national pulses collection conserved in BPGV will allow the maintenance and intensification of these goals.

Acknowledgements

Thanks to Dr. Rena Farias, who for the past forty years has recognized the importance of common bean biodiversity and started to collect in Portugal. Also to Eliseu Bettencourt who was her partner in these collecting missions. Today, thanks to those who continue the work of the prospection and collection, Filomena Rocha and Carlos Gaspar. Thanks to Aida Reis, who performed the agro-morphological evaluation of the potential of local varieties from PNPG. Thanks to Prof. Agostinho Carvalho and his team that performed important tasks at the end of the 1990s contributing to this goal.

Figure 2. The Tarreste landrace - on-farm conservation and product valorisation.

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Recovering and enhancing the local tomatoes of the Vall d'Albaida, an inland district in the region of València (Spain)

Maria R. Figàs, Jaime Prohens, María J. Díez and Salvador Soler

Institut de Conservació i Millora de l'Agrodiversitat Valenciana, Universitat Politècnica de València (Spain); salsoal@btc.upv.es

Introduction

The region of València, situated on the Mediterranean coast of Spain, has a long horticultural tradition, with a plethora of local varieties of vegetables having been selected by traditional farmers. Tomatoes (*Solanum lycopersicum* L.) are no exception and a wide diversity of morphologically distinct local varieties can be found in this region (Cebolla-Cornejo *et al.,* 2013; García-Martínez *et al.,* 2013; Figàs *et al*., 2015).

Some districts ("comarques" made up of several municipalities) of the region of València, such as L'Horta (in the vicinity of the city of València), Plana Alta (in the northern part of the region of València), Baix Vinalopó, and Baix Segura (both in the southern part of the region of València), are well known for the cultivation of local tomato varieties (Cebolla-Cornejo *et al.,* 2007; Soler *et al.,* 2017). Many of these varieties have been characterized and are increasingly being used by farmers targeting local markets (Cebolla-Cornejo *et al.,* 2007, 2013; García-Martínez *et al.,* 2013; Figàs *et al.,* 2015; Soler *et al.,* 2017).

However, cultivation of tomatoes, mostly in small plots for local and self-consumption, has also been relevant in other districts where their cultivation is generally performed by farmers of advanced age. Consequently, there is a very high risk of loss of these local tomato varieties, something that was already recognized almost 40 years ago (Ferrer Ripollès and Saragossa Rovira, 1980).

The recovery and enhancement of Valencian local tomato landraces

One of the most efficient ways to conserve local tomato varieties is to recover their cultivation in their areas of origin (i.e. *in situ* conservation). This type of conservation may be efficient if these local varieties can be recovered for their commercial exploitation, so that they represent a profitable alternative for farmers (Soler *et al.*, 2010; Casañas *et al.,* 2017). In the current agricultural context, Valencian markets are flooded with a massive offer of cheap tomato fruits from modern varieties produced under highly intensive conditions in other Spanish regions (mostly from Almería in the southeast of Spain). However, Valencian consumers are increasingly demanding locally produced tomatoes from traditional varieties, which are associated with a better taste, with the local culture, and with a traditional agricultural system (Cebolla-Cornejo *et al.,* 2007; Soler *et al.,* 2017). These varieties reach much higher prices in the local markets, and have become profitable for farmers who specialize in their cultivation.

In this way, currently there are associations of tomato farmers involved in the production of certain local tomato varieties, such as the "Valenciana" local tomato variety (Soler *et al.,* 2017), which are in high demand.

The local tomatoes of the Vall d'Albaida district

In the Valencian inland central districts there are many areas of traditional cultivation of vegetables, including tomato. One of these cases is the Vall d'Albaida (Figure 1), which is an inland district made up of 34 municipalities covering an area of 722 km^2. Geographically, this district is a wide valley surrounded by mountains. Cultivation of local traditional tomatoes has taken place not only in the peri-urban area of the most important city (Ontinyent; aprox. 38,000 inhabitants), but also in most of the other villages, many of which have a very ancient tradition of vegetable crop cultivation thanks to the availability of water from natural watercourses or fountains. This is the case with small villages in the Vall d'Albaida region such as Agullent, Bocairent, or Fontanars dels Alforins. In the proximity of these villages there are farmland areas characterized by high levels of smallholdings with an increasing rate of abandonment, putting in risk the *in situ* conservation of these local varieties, many of which have not been collected, as well as their associated ethnobotanical knowledge and culture.

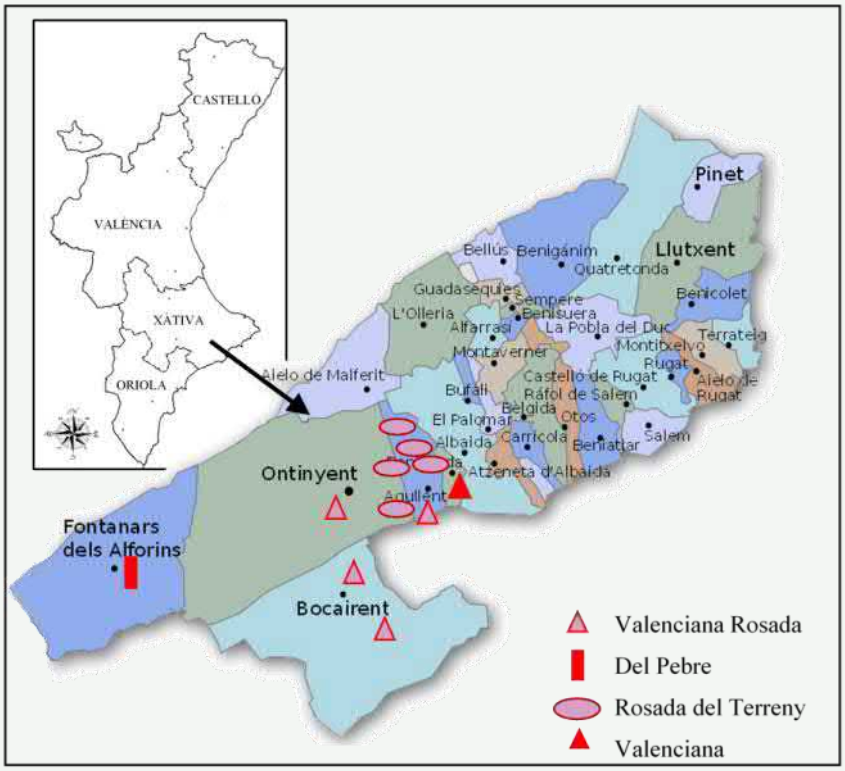

Figure 1. Map of Vall d'Albaida district within the historical demarcations of the region of València, showing locations of the 11 traditional varieties of tomato considered

One of the local tomato varieties from the Vall d'Albaida is the 'Rosada del Terreny', which is heart shaped and has a colour which is intermediate between off-white red and purple rose (Figures 2 and 3). This variety is especially valued for its fleshy fruits and its exceptional flavour. Another type of local variety in the area is the "Del Pebre" (meaning *Capsicum* pepper) tomato. This type has an elongated shape, and its flesh has an intense red colour. Another traditional type from the Vall d'Albaida district is the "Valenciana Rosada", which is characterized by the typical pointed shape of "Valenciana" tomato (Soler et al., 2017), and is very fleshy and tasty and pink coloured.

Table 1. Varietal types of the 11 traditional varieties of tomato from the Vall d'Albaida used in the present work

Local variety	Municipality of origin	Varietal type
AG1	Agullent	"Valenciana Rosada"
AG2	Agullent	"Rosada del Terreny"
AG3	Agullent	"Rosada del Terreny""
AG4	Agullent	"Rosada del Terreny"
AG5	Agullent	"Rosada del Terreny"
AG6	Agullent	"Rosada del Terreny"
AG7	Agullent	"Valenciana"
BOC1	Bocairent	"Valenciana Rosada"
BOC2	Bocairent	"Valenciana Rosada"
FONT1	Fontanars dels Alforins	"Del Pebre"
ONT1	Ontinyent	"Valenciana Rosada"

Characterization and enhancement of local tomatoes from the Vall d'Albaida

Enhancement of local varieties benefits from their characterization, which allows typification and differentiation from other similar materials. In this way, we have performed a morpho-agronomic characterization of a set of 11 accessions of local traditional tomato from the Vall d'Albaida district: five of "Rosada del Terreny", one of "Del Pebre", four of "Valenciana Rosada", and one of "Valenciana" (Table 1; Figure 1). The modern commercial varieties "Euphrates" and "TY12" have been included as controls. The local varieties were cultivated in a mesh greenhouse in two growing cycles (spring-summer and autumn-winter).

Figure 2. Group picture of the traditional tomato varietal types from the Vall d'Albaida district used in this work: "Rosada del Terreny" (left), "Del Pebre" (center) and "Valenciana Rosada" (right)

Figure 3. Immature fruits of the traditional tomato varietal types from the Vall d'Albaida district used in this work: "Rosada del Terreny" (left), "Del Pebre" (center) and "Valenciana Rosada" (right)

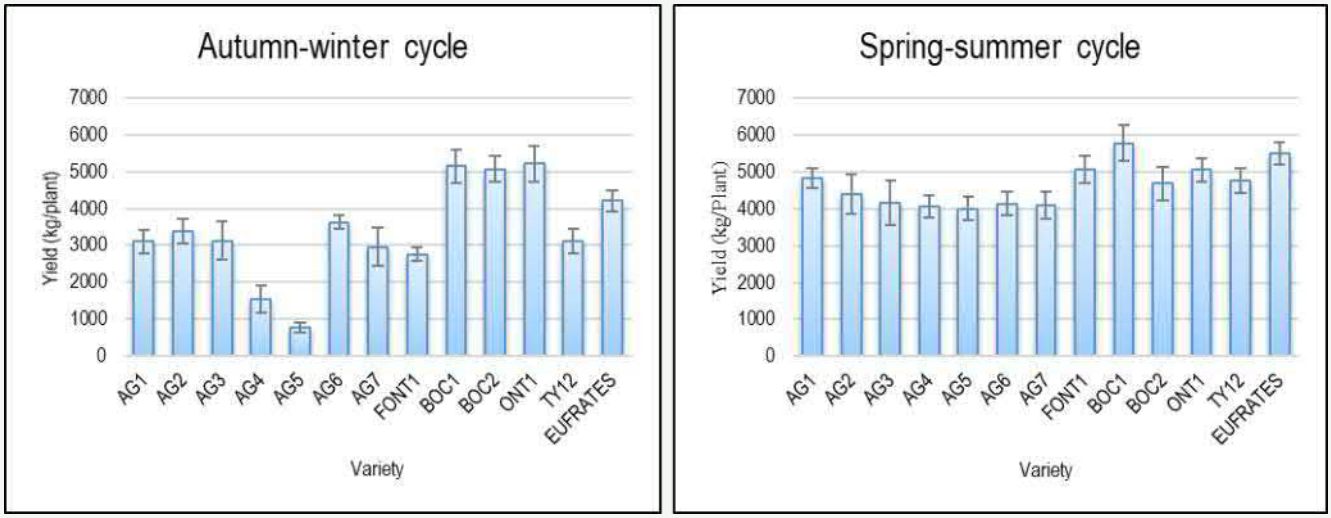

Figure 4. Yield (±SE) of the 11 local tomato varieties of the Vall d'Albaida district and the two commercial controls in the autumn-winter and spring-summer growing cycles

A large morpho-agronomic variation was found among the 11 accessions (Table 1). The highest variability was observed for fruit shape. Varieties AG2, AG3, AG4, AG5, and AG6, are slightly flattened; varieties AG1, AG7, BOC1, BOC2 and ONT1 have a cordiform fruit; and FONT1 has an elongated fruit. As observed in previous works (Figàs *et al.,* 2015), some morphological features such as the fruit shape, presence of green shoulders, different degrees of fasciation or the presence of green stripes are the most useful when describing and differentiating the local tomato varieties from the Vall d'Albaida district.

Amazingly, most of the varieties evaluated had high yields. Thus, under greenhouse cultivation in the autumn-winter cycle varieties BOC1, BOC2 and ONT1 had yields of around 5 kg/plant, higher than the two commercial controls (Figure 4). Other six varieties (AG1, AG2, AG3, AG6, AG7 and FONT1) had intermediate yields, while the two other (AG4 and AG5) had a comparatively lower yield. In the spring-summer cycle there was less variation among varieties in yield, with all of them (including the controls) being in the range of between 4 and 6 kg per plant. These results indicate that local varieties of the Vall d'Albaida have a good performance in the spring-summer season, and even some of them have promising agronomic behaviour in the autumn-winter season. This fact might make it possible to market these varieties throughout the year.

Based on the characterization and yield results, we have selected five local varieties of the Vall d'Albaida (AG1, BOC1, BOC2, FONT1 and ONT1; Figure 5) which might allow a recovery of local tomato cultivation in this district of the region of València. The results of this work suggest that there are local tomato varieties from the Vall d'Albaida that could be a profitable alternative for the farmers of this inland district of the region of València. The morphological characteristics regarding shape, colour and quality allow a differentiation of these traditional varieties with respect to other varieties.

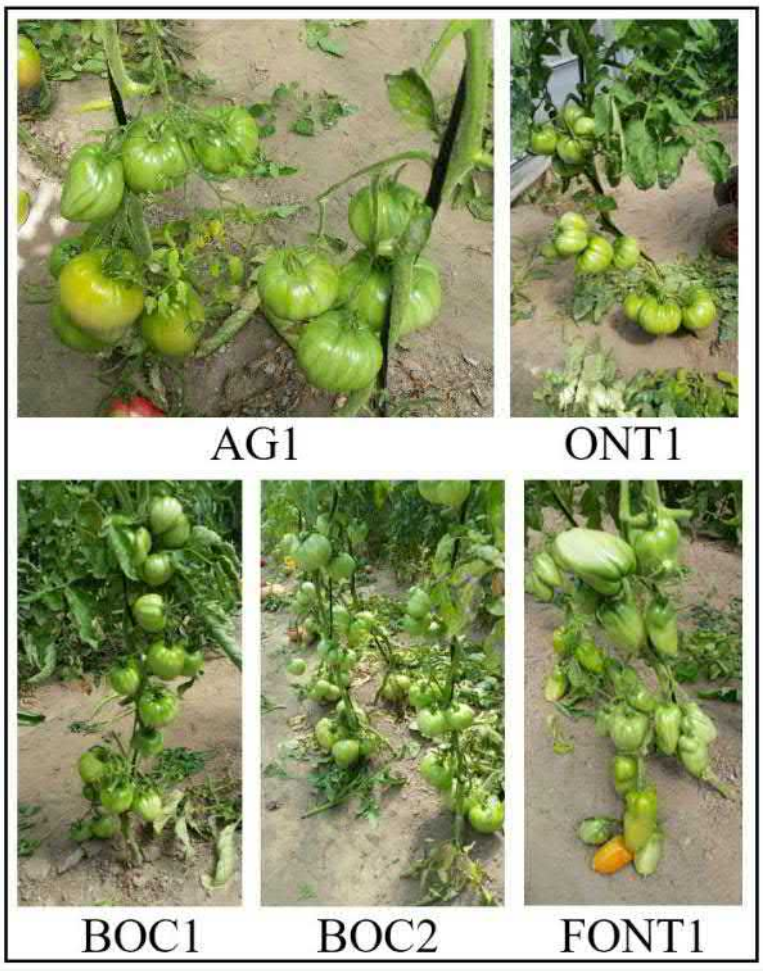

Figure 5. Plants of the varieties from the Vall d'Albaida district AG1 ("Valenciana Rosada"), ONT1 ("Valenciana Rosada"), BOC1 ("Valenciana Rosada"), BOC2 ("Valenciana Rosada"), and FONT1 ("Del Pebre") selected for their morpho-agronomic characteristics and yield

This may contribute to placing a differentiated high quality product in the market, for which the consumer may be willing to pay a price higher than for standard commercial varieties. This higher price can make an important impact in the economy of farmers from the Vall d'Albaida, especially if associations of farmers, such as those already existing in the village of El Perelló with the "Valenciana" tomato (Soler et al., 2017) or in Alcalà de Xivert with the tomato "De Penjar", are created.

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The authors wish to recognize the work done by the farmers of the Vall d'Albaida district who have conserved and cultivated local tomato varieties, including the ones used in this work. The authors are also grateful to the European Union's Horizon 2020 research and innovation programme for funding under grant agreements 634561 (Traditional tomato varieties and cultural practices: a case for agricultural diversification with impact on food security and health of European population; TRADITOM), 677379 (Linking genetic resources, genomes and phenotypes of Solanaceous crops; G2P-SOL), 774244 (Breeding for resilient, efficient and sustainable organic vegetable production; BRESOV), and 774271 (Networking, partnerships and tools to enhance *in situ* conservation of European plant genetic resources; Farmers' Pride).

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Scottish Isles landrace monitoring

Olivia Shoemark[1], Maria Scholten[2] and Nigel Maxted[1]

[1] School of Biosciences, University of Birmingham (United Kingdom); nigel.maxted@dial.pipex.com
[2] Independent researcher and project advisor "Farmer's Pride" (United Kingdom)

The Scottish Isles were first surveyed in 2003 because there was anecdotal evidence that the three island chains (Orkney, Shetland and Hebrides) retained significant landrace diversity and in the summer of 2018, 15 years after the initial survey, the islands were revisited to monitor landrace maintenance. Bere barley (*Hordeum vulgare*) a group of landraces endemic to the islands are still grown in significant numbers on Orkney, but cultivation is decreasing gradually over time. Continued maintenance is largely due to the efforts of Orkney College and The Heritage Trust, who provide seed to growers and store, save and use the product in beer, biscuit and whisky production.

On Orkney 31.5% (5 of 16) of landrace growers had stopped growing one or more landrace in the last 15 years. The reasons cited were lack of support, uncertainty in the face of Brexit, and climate change.

The situation on Outer Hebrides was more positive; several landraces are still grown included Bere barley, Black oats (*Avena strigosa*), and a variety of traditional potatoes, turnips, and carrots (the latter three grown only by hobbyists).

Figure 2. Various products produced for sale at the Heritage Trust Mill that add value to Bere barley landrace production.

Threats and fragility

All three island groups show evidence of erosion and loss of landrace diversity over the 15 year gap since the initial survey. The problem of the residential geese on the Outer Hebrides means almost all machair-based seed production is halted, which is likely to impact genetic diversity and landrace maintenance long-term.

Climate change is impacting the islands, causing more severe weather and reducing yields. The economics of landrace maintenance are fragile and support from agri-environmental schemes is essential to underpin long-term viability. There is concern about landrace maintenance by the next generation of maintainers, who despite their wishes must address issues of lack of farm support, local employment and housing. On Orkney and Shetland there was a lack of interest among the younger community in traditional farming.

Figure 1. Plots of 35 Bere barley landraces grown at the Orkney college and curated by Dr. Peter Martin

The fragility of production is underlined by the dominance of just Orkney College and The Heritage Trust in seed production.

On Shetland it was considerably more difficult to find current landrace growers on the islands, and anecdotal evidence would suggest a significant decline in grower numbers over recent years, possible due to the wealth of local jobs funded by the North Sea oil industry. Of those interviewed on Shetland 42.86% (3 of 7) had stopped growing one or more landrace in the last 15 years. Reasons cited included age, a lack of interest from younger generations, sparrows and other pests, and weather/climate concerns.

However, landraces still grown include Shetland Oats (*A. strigosa*), Shetland Kale (*Brassica oleracea*), and a tiny amount of Bere barley and one dedicated grower with 49 potato landraces growing on his farm. The Machair habitat makes the Hebrides a tough environment for cultivation however, farmers still commonly sow a mix of rye (*Secale cereale*), oat (*A. strigosa*) and sometimes barley (*H. vulgare*). Of those interviewed on the Hebrides, 21% (4 of 19) has stopped growing one or more landrace in the last 15 years. Reasons cited were problems with Greylag and Barnacle geese eating the crop before it could be harvested.

It was noted that the Hebrides had the youngest demographic with 94.74% (18 of 19) confirming they planned to keep up landrace maintenance and ensure the landrace was still maintained post their own retirement.

Landraces on the Isle of Man: a missed opportunity?

Andrew Lever

Freelance writer and consultant, 45 Cheltenham Street, Oldham OL1 4DA (United Kingdom); andrewdavidlever@aol.co.uk

Introduction

The Isle of Man is located in the middle of the Irish Sea. The island is closest to mainland Scotland which seems agriculturally significant. It is 52 km long and 22 km wide. It has an area of around 572 km^2 (Isle of Man Public Services, 2017). Ranges of hills in the north and south are separated by a central valley with northern plains being relatively flat.

The Isle of Man has a cool climate (Met Office, 2010) with an average temperate between 7.6 and 12.8ºC and an average annual rainfall of 864.4 mm. The island has independence and governance of its own domestic affairs. Due to the island's long standing independence the island is not technically apart of the UK or the European Union so does not follow the EU common agricultural policy. In 2016 the Isle of Man became the first whole nation to be awarded biosphere reserve status by UNESCO (UNESCO, 2016).

Agricultural History pre-1890

There is no account of agriculture before 1577 (Moore, 1900). Early farming was run by the women in small croft-like subsistent farms (Karren and Cain, 2009) similar to those used in the Scottish highlands and islands with farming methods and crops similar to those cultivated in the adjacent Hebridean Islands, whilst the men would be out at sea from March to September fishing. Farming families would also buy and sell Welsh pottery and Manx wool to supplement their incomes, especially during what was called the 'hunger gap' from May until harvest time or when there was a crop failure. Women remained the main labour force in farming and crofting on the island until the 1930s and most adults had thatching skills.

At this time the soil on the island was described as wet, coarse and poor, and that wheat production on the island was poor due to crop failures and recurrent infections of wheat smuts with imports of wheat coming from Ireland and Scotland common (Quayle, 1794).

There were two predominant types of farming (Page, 1999): (a) upland which was referred to as Quarterland farming, farming cattle and sheep, with sizes ranging from 50 to 100 acres; and (b) crofting, small farms ranging from 1 to 30 acres concerned with crop growing and keeping of a few animals for domestic use mainly for the production of buttermilk.

It was commented at this time that the agriculture was 'primitive' and sowing, weeding and harvesting were all done by hand, and the farmers practiced a cultivation method termed 'lazy bed': parallel banks of ridges and furrows dug with a spade, a practice also seen in Ireland and the Inner Hebrides.

Oats, bere barley and turnip were the main crop staple foods. The oats and bere barley were grown to make porridge and griddle cakes. Some sources say that oats and bere barley were used to make the native Bonnag flat bread but other sources say the bread was made from soda flour. Today the Bonnag has evolved into a spiced tea loaf containing sugar, dried fruits and spices such as ginger (Figure 1).

Quayle (1794) noted that the north end of the Isle of Man produce a high yield, high quality bere barley. Farmers would grow common white oat (*Avena sativa*) and 'The Poland' variety of oats (possibly *Avena strigosa*). Rye has been documented to have been grown on the Isle of Man but less so than oats and bere barley. Rye was more abundant in Ireland and the Hebrides. Potato crops suffered infections of blight and did not store well.

Crops of cabbage and carrot fared poorly and would be used as cattle and horse feed. Other root vegetables, beans and peas often failed and farmers were not keen to grow these crops. Turnip was a successful crop and commonly grown for both human consumption and winter feed for animals. Hemp and flax grew well. The flax would often be used as a substitute for hay and straw due to the scarcity of wheat. Villagers would thatch their roofs with flax and use it as bedding for farm animals.

Figure 1. The Bonnag tea loaf made on the Isle of Man (Photo: Scarlett Brooks)

Figure 2. The "Manx Loaghtan" breed at Cregneash. Photo: Manx National Heritage

In 1798, a Scottish farmer settled on the Isle of Man and introduced threshing mills to agriculture (Page, 1999). By the 1860s there were a large number of threshing mills and nearly all that grew cereals used them. In 1850 Okells brewery was established at Kewaigue and, with improvements in wheat varieties, a large industrial flour mill was established in 1860. These businesses are still present on the island today.

Due to the improvements of wheat varieties against smuts, villagers began to thatch their roofs with straw instead of flax and would start to save seed and breed their own variations of the wheat varieties so that they could achieve the desired length for thatching material. Traditionally the crofters (local name for traditional farmer) would weave the long roots of moorland heather to make rope to hook the straw to the roof (Manx Museum press, 2017).

The villagers had a custom of using mountain ash bark as a good luck charm in their cottages. The thatch would be replaced every 3 years, similar to the cottages seen in Ireland and Scotland, a contrast to English thatched roofs which use reeds producing roofs which could last 30 to 40 years.

Agriculture from 1890 to present

By 1890 (Page, 1999) farmers were still using methods from 1800. Fishing and mining jobs had almost disappeared from the island and there was serious decline in farming, especially Quarterland farming. In the 1890s tourism began to develop and many cottages were converted to holiday lets and tea rooms. Many cottages were also abandoned and left to ruin, becoming shelters for sheep. By the 1960s the Isle of Man was a popular holiday destination for the British working class.

Farming saw further declines in the 1930s as farming methods changed, seeing the end of Manx crofting, most upland farmers leaving the industry due to economic pressures, more importing of food; the use of tractors became common place and the mechanisation of agriculture meant lower demand for farm labour.

In 1916 the Douglas Allotments Association was formed encouraged by the "Grow More Food at Home" campaign during the First World War. The Association continues today and has celebrated its centenary. In the 1930s William Cubbon, the director of the Manx Museum, took the first steps to preserve the history of Manx crofting. Cubbon had been inspired by the folk museums in Olso and Skansen and wanted to create a living folk museum which would focus on the preservation of Manx traditional customs, practices and the Manx language.
The Cregneash settlement in the south of the Isle of Man which dates back to around 1700 was chosen for the site of the museum because the village maintained many of the island's traditions.

In 1938 Cregneash Folk village was officially opened to the public to exhibit working village life in the 19th Century, therefore indirectly preserving the thatching and crops associated with it. Cregneash became the first publicly owned open air museum in the British Isles. During World War II many cottages replaced the thatch with slate leading to a decline in wheat for straw production. There was concerns for the native and rarest sheep breed in Britain the "Manx Loaghtan" sheep (*Ovis aries*) (Figure 2) being close to extinction that prompted conservation efforts from the Manx National Trust in the 1950s to protect the breed. Successful breeding programmes of the Manx Loaghtan lead to further development and expansion of the living Museum at Cregneash in 1997 which now homes a small flock of the Manx Loaghtan and a number of the native Shorthorn cows. In recent times, there have been more focused efforts to protect the Manx text although speaking of the Manx language ended in the 1930s.

Current agriculture and resurgence of the allotments and grow your own on the Isle of Man

In 2017 101,210 acres, which is 75% of the Isle of Man's land, is utilised for agriculture, and is supported by the agricultural development scheme. The land in the south is now soil rich supporting mixed commercial farming. More farming has returned to the central uplands which, with their thin soils, are used for cattle and sheep. The flat northern plains are used for commercial arable and vegetable production. Due to a renewed interested in growing your own fruit and vegetables on the island, new plots for plant growing have developed in recent years to meet public demand. Braaid Allotment Association, Garey, the Loxley and Lonan Allotments, the organic allotments at Kerrowkneale, Johnny Watterson's Lane Allotments and Ballamaddrell allotments have all set up in the last decade.

Methodology

Research of the literature and telephone, email and face to face interviews were conducted on the Isle of Man during the summer of 2018.

Results and Discussion

Interviews with Sarah Cornish from the Society of Agriculture and John Howard from the Department of Agriculture Isle of Man stated that old varieties of cereal, forage and vegetable were no longer used and no seed had been saved i.e. in a seed bank for conservation purposes, and that farmers used commercial cereal, vegetable and forage varieties and no farmers save seed.

Loxley and Lonan Allotment members follow an environmental friendly growing policy on their plots with many organic growers. Members purchase seed from King's and have an annual seed swap event. The Douglas Allotment Society stated that some holders used old varieties of vegetables for personal use, saved seed and also used vegetable seed from Irish heritage seed schemes, particularly the seed savers association.

One particular allotment holder has started growing "Mr Jones" variety of broad bean from the Irish seed savers association; he says the variety produces tall plants with longer pods, "Hurst Greenshaft" pea variety produces a good yield and he had saved seed of the tomato variety "Gardener's Delight" for 14 years because of the fruit's good flavour. The other allotment associations are new and currently establishing so growers are only using commercial seed with no seed savers yet.

The brewers and bakers of the Isle of Man only use commercial cereal varieties in their products. According to Susan Creasey (Martin, 2013), who once lived and worked in Cregneash, wheat for straw to thatch the roofs of the museum buildings at Cregneash was grown on site and seed was saved so the wheat had been selectively bred for its height and strength. The growing of turnips for lanterns for the traditional annual Hollantide night (Figure3) continued till around 2014 but the commercial variety and the date could not be clarified by current volunteers.

Figure 3. Turnip Harvest at Cregneash 2014. Photo: S. Kelly & B. McCarthy

The loss of skilled personnel due to funding cuts and retirement, poor water supply and the lack of volunteers meant that the growing of crops at Cregneash ceased and no seed was saved. This could be seen as a missed opportunity and a loss of genetic diversity within cereal and vegetable crops.

A national request for information on landraces and old varieties in the British Isles was put out in 2003 which lead to a major report on Landraces on the UK mainland in 2009 (Kell *et al.*, 2009) but no-one responded from the Isle of Man. Funding restrictions meant that only landraces on the Shetland Isles (2006) which was then extended to the whole of Scotland (2011) were surveyed and conservation measures put in place.

The thatch on the cottage roofs at Cregneash are still replaced every 3 to 4 years but with bought in commercial wheat straw and Manx Heritage had to hire thatchers from Poland to carry out the task.

The rope to hook the thatch to the roof has been replaced by plastic instead of the traditional heather root rope.

There is no record on any heritage seed database in the UK of the oat variety called "The Poland" being conserved *ex situ*. The bere barley, white and small oat varieties can possible be similar to those used and conserved in the Hebrides and Ireland.

During the period termed the 'hunger gap' (May to early harvest) and during crop failures there is little evidence to suggest that residents had a great depth of knowledge of wild edible plants and crop wild relatives, and these were little used to supplement the diet during times of food shortages.

From the evidence we can conclude that landraces of oats, wheat, bere barley and turnip were once present on the island but are no longer. There is a keen interest in vegetable growers using old and heritage varieties of vegetables, becoming seed savers and guardians, and this may improve genetic diversity within their food crops. However, there is little interest in reintroducing and growing cereal landraces from Scotland for growers see no benefit in growing these plants.

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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/

Sister project

www.dynaversity.eu

Above: Paul and Tobias Watkins proudly showing their "Throws bean" (*Vicia faba)* landrace
Photo: N. Maxted

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