	EUROPEAN COMMISSION RESEARCH AND INNOVATION DG	Periodic Report

Project No: 266394

Project Acronym: PGR Secure

Project Full Name: Novel characterization of crop wild relative and landrace resources as a basis for improved crop breeding

Periodic Report

Period covered: from 01/09/2013 **to** 31/08/2014

Date of preparation: 16/09/2014

Start date of project: 01/03/2011

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Project coordinator name:
Dr. Nigel Maxted

Project coordinator organisation name:
THE UNIVERSITY OF BIRMINGHAM

Version: 1

Periodic Report

PROJECT PERIODIC REPORT

Grant Agreement number:	266394
Project acronym:	PGR Secure
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Declaration by the scientific representative of the project coordinator (1)

I, Dr. Nigel Maxted THE UNIVERSITY OF BIRMINGHAM , as scientific representative of the coordinator of the project PGR Secure and in line with the obligations as stated in Article II.2.3 of the Grant Agreement declare that:

The project has fully achieved its objectives and technical goals for the period.

The attached periodic report represents an accurate description of the work carried out in this project for this reporting period.

The public website is up to date.

To my best knowledge, the financial statements which are being submitted as part of this report are in line with the actual work carried out and are consistent with the report on the resources used for the project (section 6) and if applicable with the certificate on financial statement.

All beneficiaries, in particular non-profit public bodies, secondary and higher education establishments, research organisations and SMEs, have declared to have verified their legal status. Any changes have been reported under section 5 (Project Management) in accordance with Article II.3.f of the Grant Agreement.

Name	Dr. Nigel Maxted THE UNIVERSITY OF BIRMINGHAM
Date	31/10/2014

This declaration was visaed electronically byShelagh KELL(ECAS user name nkellksh) on 31/10/2014

1. Publishable summary

Summary description of project context and objectives
See attached pdf document, 'PGR_Secure_266394_Periodic_Report_3_Section_1'
Description of work performed and main results
See attached pdf document, 'PGR_Secure_266394_Periodic_Report_3_Section_1'
Expected final results and potential impacts
See attached pdf document, 'PGR_Secure_266394_Periodic_Report_3_Section_1'

Project public website address:	http://www.pgrsecure.org

2. Core of the report

Project objectives, Work progress and achievements, and project management during the period
The Project Summary Pdf document contains the core of the report.

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Section 1: Publishable summary

1.1 Summary description of project context and objectives

Introduction

Our food depends on the continued availability of novel sources of genetic variation to breed new varieties of crops which will thrive in the rapidly evolving agri-environmental conditions we are now faced with as a result of climate change. Wild plant species closely related to crops (crop wild relatives, or CWR) and traditional, locally adapted crop varieties (landraces, or LR) are vital sources of such variation, yet these resources are themselves threatened by the effects of climate change, as well as by a range of other human-induced pressures and socio-economic changes. Further, while the value of CWR and LR for food security is widely recognized, there is a lack of knowledge about the diversity that exists and precisely how that diversity may be used for crop improvement. This is despite the importance of these resources being recognized in a number of policy instruments, including the FAO Global Plan of Action for the conservation and sustainable use of PGRFA[1] (GPA), FAO International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), CBD Global Strategy for Plant Conservation, CBD Strategic Plan for Biodiversity 2011–2020, and European Strategy for Plant Conservation. PGR Secure aimed to address these issues by: a) developing fast and economic methods to identify and make available genetic material that can be used by plant breeders, for example to confer resistance to new strains of pests and diseases and tolerance to extreme environmental conditions such as drought, flooding and heat stress—the biotic and abiotic pressures which are rapidly evolving and having an increasingly detrimental effect on crop productivity; and b) developing a Europe-wide systematic strategy for the conservation of the highest priority CWR and LR resources to secure the genetic diversity needed for crop improvement; and c) ensuring that conserved diversity is made available to users in a manner that facilitates their ease of use.

PGR Secure context: a call for a step change in agrobiodiversity conservation and use

The EC Biodiversity Action Plan for Agriculture (www.epbrs.org/PDF/EPBRS-IR2004-BAP%20Agriculture.pdf) highlighted the need for a step change in crop cultivar production in Europe to ensure food security across the continent, particularly in light of the adverse impacts of climate change on crop yields, as well as to respond to rapidly changing consumer demands. If these requirements are to be met, plant breeders need a broader pool of diversity to supply the necessary range of traits, as well as greater efficiency in characterization and evaluation techniques to locate the desired traits and speed up the production of new varieties. The Action Plan also argued that maintaining the *status quo* for agrobiodiversity conservation and use is no longer tenable and that a step change in systematic conservation and use is also required. The two major components of agrobiodiversity that offer the broadest range of diversity for breeders are CWR and LR, but there is currently a gap between their conservation and their use and they remain under-exploited by the user community. In order to meet the needs of future generations, there are four key areas that need to be addressed: 1) development of novel approaches to characterization and evaluation to replace traditional resource intensive phenotypic methods; 2) systematic active *in situ* and *ex situ* CWR and LR conservation; 3) understanding the needs of the user communities and current constraints in the use of CWR and LR in crop improvement programmes; and 4) improved CWR and LR information management and accessibility.

[1] Plant genetic resources for food and agriculture

PGR Secure: answering the call

The overarching goal of PGR Secure was to underpin European food security in the face of climate change by advancing CWR and LR diversity conservation and use. To achieve this goal PGR Secure had four research themes: 1) novel characterization techniques, 2) CWR and LR conservation, 3) improved use of CWR and LR by breeders, and 4) informatics (see Figure 1). The objectives of themes 1 and 3 were to improve breeders' use of conserved CWR and LR diversity by a) applying novel characterization techniques such as genomics, transcriptomics, metabolomics, high-throughput phenotyping and GIS-based predictive characterization, and b) engaging the plant breeding community in a dialogue to identify exactly what is needed to bridge the conservation/use gap and to facilitate the flow of material from conservation facilities to breeders. The objectives of themes 2 and 4 were to enhance CWR and LR species and genetic diversity conservation through the development of CWR and LR inventories and systematic conservation strategies, and to improve the management and accessibility of CWR and LR conservation and trait data.

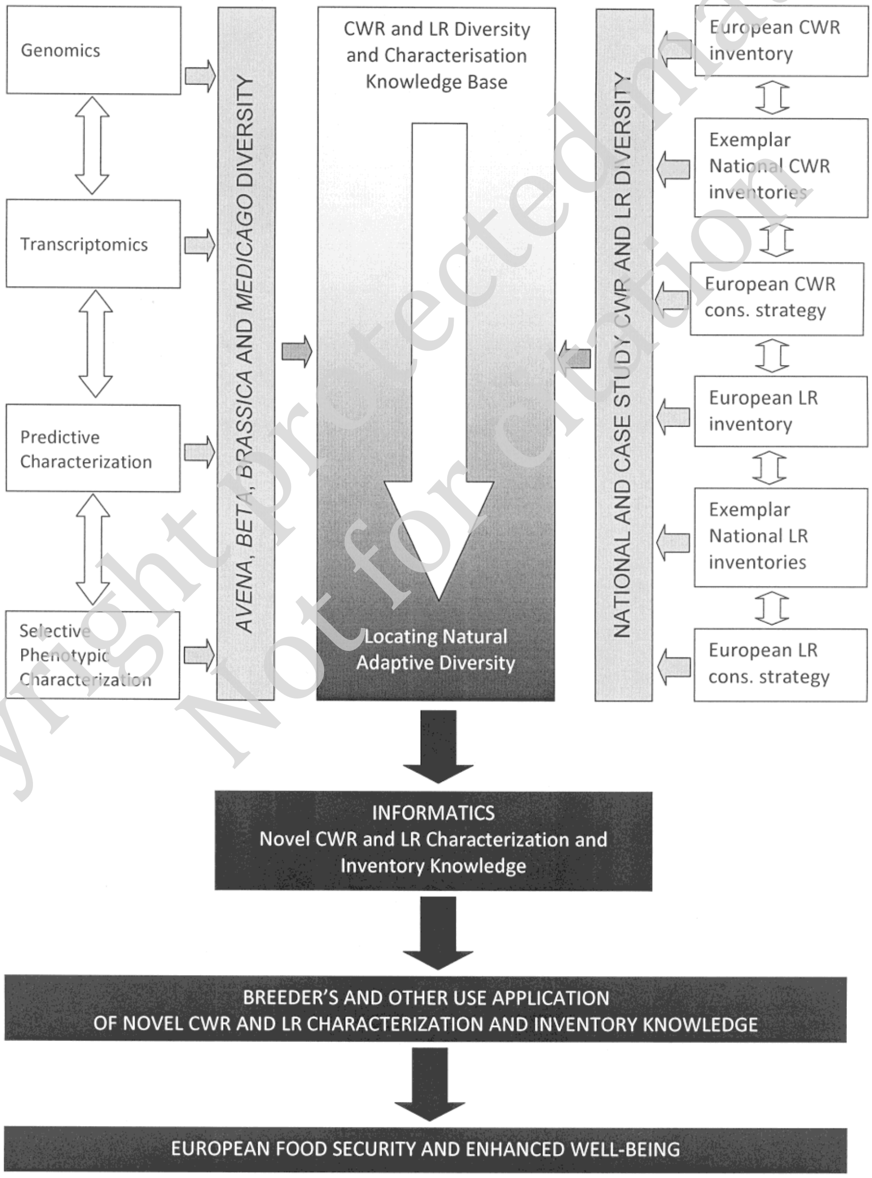

Figure 1. Schematic diagram of interrelated project themes

1.2 Description of work performed and main results

Theme 1: novel characterization techniques

Around 2 million single nucleotide polymorphisms (SNPs) were identified by comparing the leaf RNA sequences of 15 sequenced *Brassica* accessions, including several CWR. Based on their position on the *B. oleracea* reference genome, a selection of these SNPs was used to develop a 90k Affymetrix Axiom genotyping array that will be very useful for genetic analysis and is now available to the research community. Using the electrical penetration technique to study mechanisms of host plant resistance to phloem-feeding insects, we found large differences in feeding behaviour of cabbage aphids on different *Brassica* accessions and identified candidates with different mechanisms for further development of aphid resistance in brassica crops. We identified molecular markers linked to whitefly resistance in *B. oleracea* and *B. incana*, which will facilitate the introgression of quantitative trait loci (QTLs) and speed up the breeding process. Results of a differential gene expression study revealed candidate genes for resistance but their validation was outside the scope of the project.

A document providing technical guidelines for the application of predictive characterization has been completed and will be published under the title 'Predictive characterization of crop wild relatives and landraces. Technical guidelines version 1' by Bioversity International in November 2014.

Theme 2: CWR and LR conservation

National CWR conservation strategies for the three project case study countries Finland, Italy and Spain, as well as for Cyprus, have been completed and published. Significant progress has also been made in Albania, Bulgaria, the Czech Republic, Norway, Sweden and the UK. An integrated European CWR conservation strategy has been developed which combines national CWR conservation strategies and a regional CWR conservation strategy for priority taxa at European level. LR conservation strategies for the three project case study countries Finland, Italy and the UK have been completed and published and a regional LR conservation strategy and a specific strategy for target crops have also been prepared and published. A review of progress in national CWR and LR conservation in each European country is available via the online conservation Helpdesk (www.pgrsecure.org/helpdesk). The Helpdesk has been updated and regular communication has been maintained with National PGR Programmes.

Theme 3: improved use of CWR and LR by breeders

Since the launch of the web-based database PGR-COMNET ('Community Network' – www.pgrsecure.org/pgr-comnet) in 2013, its content has been expanded and updated on a regular basis and currently provides information on 462 institutions. The workshop, 'On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis' was convened in Wageningen in November 2013 to discuss the constraints in the conservation and use of PGR in Europe. Eighty participants from 21 European countries attended, representing five stakeholder groups: genebanks, public research institutes, breeding companies, agro-NGOs, and policy-makers/governments. Results informed a final report on the constraints of conservation and use of PGR in Europe and how it can be improved, as well as a policy paper on the same theme (www.nordgen.org/index.php/en/Plants/Innehaall/Workshops-Conferences/Plant-Genetic-Resource-Workshop-2013/Final-report). A stakeholder market day at the workshop resulted in a number of new or renewed partnerships and collaborations. Information on germplasm resistant to cabbage aphid and molecular markers for whitefly resistance identified in WP1 was sent to European companies involved in brassica crop improvement.

Theme 4: informatics

The ontology and infrastructure of the web-based information system 'Plant Genetic Resources Diversity Gateway for the conservation and use of crop wild relative and landrace traits' (PGR Diversity Gateway) was further developed and the system populated with a range of data, including national CWR inventories, as well as a number of data standards. The beta version of the system was presented at the stakeholder workshop in November 2013 where it was available for testing by delegates and the publicly available system was launched in July 2014 (http://pgrdiversity.bioversityinternational.org).

1.3 Expected final results and potential impacts

The expected final results of the project are: a) enhanced techniques to identify useful adaptive traits to support plant breeding; b) national and Europe-wide conservation strategies for high priority European CWR and LR resources; c) greater awareness amongst the plant breeding community of the breadth of genetic material available from CWR and LR and of the enhanced access to these resources for crop improvement; d) improved communication between the conservation and end user communities; and e) a resource base for access to CWR and LR conservation and trait data for use by the full range of stakeholders. The potential impacts are: a) better access to and wider take-up of conserved CWR and LR resources in plant breeding programmes; b) increased capacity and options for crop improvement to support European farming and back-stop food security; c) systematic national level action on conservation of European CWR and LR resources; and d) improved knowledge to inform coherent planning of plant breeding and agrobiodiversity conservation policy in Europe—all of which will ultimately result in greater European food security.

These results and impacts will benefit a range of stakeholders including: a) small and large plant breeding companies, b) scientists and policy-makers in public and private research institutes, c) farmers and others working in the agricultural sector, d) genebank and protected area managers, and the broader conservation community; e) government agencies and non-governmental organizations involved in plant conservation, plant breeding and national or local nutrition and food supply issues; f) the European Commission; and ultimately g) the European farm product consumer. However, it is the improved use of CWR and LR by plant breeders that will have potentially the greatest economic and social impact in Europe. A critical issue currently hindering the wider use of these resources was highlighted in FAO's Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture (www.fao.org/agriculture/crops/core-themes/theme/seeds-pgr/sow/sow2/en/) which stated that: "Considerable opportunities exist for strengthening cooperation among those involved in the conservation and sustainable use of PGRFA, at all stages of the seed and food chain. Stronger links are needed, especially between plant breeders and those involved in the seed system, as well as between the public and private sectors". Recognizing that the success of the initiative hinges on bridging the gap between the conservation and use communities, the PGR Secure project sought to strengthen these links and therefore involved collaboration between European policy, conservation and breeding sectors throughout Europe.

Sustainability of the results is also critical to the success of the project. Thus, the project was initiated by and involved members of the existing ECPGR[2] *In Situ* and On-farm Conservation Network (www.ecpgr.cgiar.org/networks/in_situ_and_on_farm.html) from 39 European countries who will be actively involved in planning, promoting and implementing national CWR and LR conservation strategies post-PGR Secure. Further, the Consortium itself included members of plant breeding and conservation research institutes, a SME specializing in the field of molecular genetics and applied genomics, as well as Europe's primary plant breeding research network, the European Association for Research in Plant Breeding (EUCARPIA), all of which have an interest in utilizing and taking forward the project results to benefit the wider conservation and use communities. In turn, and to further improve the dissemination and uptake of the results, the Consortium was supported by an External Advisory Board which involved senior researchers in plant breeding and PGRFA conservation and policy, as well as a Breeders' Committee comprising plant breeders and pre-breeders of major European food crops.

[2] European Cooperative Programme for Plant Genetic Resources

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Section 2: Project objectives, work progress and achievements, and project management

Contents

2.1 Project objectives for the period

2.1.1 Work package objectives

WP1: Phenomics and genomics

General objectives for the period

1. Identification of SNPs[1] and genotyping of populations

2. Identification of candidate genes and markers for insect resistance

Specific objectives for the period[2]

- Sequencing data of *Brassica* accessions (D1.3)

- Transcriptomics of *Brassica* accessions (D1.4)

- Identification of candidate genes and markers for insect resistance in *Brassica* (D1.5)

WP2: Informatics

General objectives for the period

- Produce a web-based CWR and LR Trait Information Portal (TIP) building on existing databases that will: (a) provide useful trait information (phenomics, genomics and transcriptomics data) on European crop wild relative (CWR) and landrace (LR) diversity, particularly for the case study genera, *Avena*, *Beta*, *Brassica* and *Medicago*; (b) provide baseline biodiversity information on CWR and LR diversity and its conservation; (c) establish links with related existing information systems regarding genomic characterization (e.g., EMBL Nucleotide Sequence Database) and ensure integration with other relevant PGRFA information systems (e.g., CWRIS, EURISCO, ECCDB, ENSCONET) across Europe.

- Research predictive characterization as a means of identifying CWR and LR in situ populations/*ex situ* accessions of diverse crop types (*Avena* for cereals, *Beta* for root/tubers, *Brassica* for leafy vegetables, and *Medicago* for legumes) which are likely to contain desirable traits through the innovative approach of Focused Identification of Germplasm Strategy (FIGS), as well as to explore the broad utilization of FIGS methodology to aid breeders' selection of CWR and LR accessions.

Specific objectives for the period

– Publish guidelines for the broader use of FIGS for trait identification (D2.2)

– Publish a report detailing the TIP conceptualization ontology (MS 10)

– Links established with other information systems (MS11)

– Characterization data from other relevant information systems made available to TIP (MS12)

– Populate the TIP with inventory, phenomics, genomics and transcriptomics data (MS13)

[1] Single Nucleotide Polymorphisms
[2] Specific WP objectives are based on the deliverables and milestones due to be delivered/achieved in the period.

- Make the Beta version of the TIP available for testing by breeders (MS14)
- TIP developed and tested (D2.4)
- TIP online publication (D2.5)

WP3: CWR conservation

General objectives for the period

- Produce national and Europe-wide inventories of CWR diversity that contain basic biodiversity data and are moderated by national plant genetic resources (PGR) programmes.
- Undertake exemplar national CWR conservation strategy case studies of Finland, Spain, Italy and the United Kingdom (UK) that prioritize *in situ* and *ex situ* conservation actions.
- Develop a European priority gene pool CWR conservation strategy that reviews European CWR wealth and conservation status, prioritizes *in situ* and *ex situ* conservation actions, and links to breeder-based exploitation of CWR diversity.
- Formulate a strategic and systematic European CWR conservation strategy that establishes conservation priorities and makes links to breeders' demands.

Specific objectives for the period

- Publish a European crops and CWR inventory (D3.1)
- Publish exemplar national CWR conservation strategies for Finland, Italy and Spain (D3.2)
- Publish a prioritized checklist of European crops and CWR (MS20)
- Complete ecogeographic data collation for priority European CWR (MS21)
- Complete conservation gap analysis of priority European CWR (MS25)
- Circulate 1st draft of European CWR conservation strategy (MS26)
- Circulate 2nd draft of European CWR conservation strategy (MS27)
- Publish a European priority gene pool CWR conservation strategy (D3.3)
- Publish a European generic CWR conservation strategy (D3.4)

WP4: LR conservation

General objectives for the period

- Undertake exemplar national LR conservation strategy case studies of Finland, Italy and the UK
- Produce a European specific LR conservation strategy for target crops (genera *Avena*, *Beta*, *Brassica* and *Medicago*)
- Develop a generic European LR conservation strategy

Specific objectives for the period

- Complete national inventories of extant LR and relative ecogeographic data completion (MS31)
- Complete collation of data on European *Avena*, *Beta*, *Brassica* and *Medicago* LR for all European countries (MS32)
- Circulate European LR conservation strategy draft 1 to PGR Secure partners and NFPs for comments (MS33)
- Complete Finnish LR conservation strategy (MS34)
- Publish Finnish LR conservation strategy for target crops (D4.1)
- Complete Italian LR conservation strategy (MS35)
- Publish Italian LR conservation strategy for target crops (D4.2)
- Complete UK LR conservation strategy (MS36)
- Publish UK LR conservation strategy for target crops (D4.3)
- Complete European specific LR conservation strategy for target crops (MS37)
- Publish European specific LR conservation strategy for target crops (D4.4)
- Complete European generic LR conservation strategy (MS38)
- Publish European generic LR conservation strategy (D4.5)

WP5: Engaging the user community

General objectives for the period

- Identify, visualize and discuss with the European CWR / LR diversity stakeholders concerned (breeders, governments, public research institutes, genebanks and NGOs) in Europe the present needs concerning CWR and LR use.
- Carry out SWOT analyses of the European PGR and use community needs in Europe resulting in clear action points to secure PGR conservation and use networks and to promote the use of CWR and LR.
- Create opportunities to develop new partnerships between the various CWR / LR diversity stakeholders in Europe.
- Facilitate and initiate the flow of material and knowledge from the project to commercial breeding programmes.

Specific objectives for the period

– Produce a draft report on PGR use constraints in the EU to be used as an input for the 2013 stakeholder workshop (D5.4)

– Convene European stakeholder workshop on CWR/LR diversity use and conservation (MS45)

- Convene meeting to strengthen partnerships in the CWR / LR diversity use and conservation community (MS46)
- Publish a final report on trends in CWR and LR use in breeding in Europe (D5.5)
- Publish a web-based map of stakeholders (D5.6)
- Publish a list of new partnerships (D5.7)
- Transfer knowledge on insect resistant *Brassica* material (from WP1) and knowledge where to obtain it to breeders (D5.2)
- Transfer information of linked markers to *Brassica* pests (from WP1) to breeders (D5.8)
- Produce a short report on feedback from breeding companies on the usefulness of material/knowledge transfer (MS44)

WP6: Dissemination and training

General objectives for the period

- Disseminate the PGR Secure project results to the CWR and LR conservation and breeder communities across Europe, particularly web-enabled the Europe-wide inventories of CWR and LR diversity and the Trait Information Portal in order to promote the use of the natural diversity of CWR and LR and its useful traits in breeding programmes.
- Raise scientific, professional and general public awareness of the PGR Secure project, its plans, results and potential benefits and to establish the link between the conservation and the CWR / LR diversity user communities, namely breeders, farmers and other users of germplasm, through workshops, publications and a final dissemination conference.
- Attract additional funds in order to sponsor a wide audience to attend the final dissemination conference that will show case PGR Secure project results at the end of the project.

Specific objectives for the period

- Publish six project newsletters (D6.3)
- Publish a list of TIP potential users (D 6.4)
- Web-enable Europe-wide inventories of CWR and LR diversity (MS50)
- Web-enable CWR and LR inventories (D6.5)
- Disseminate the TIP among potential users (MS52)
- Stage the project's final dissemination conference (MS53)
- Stage the final dissemination conference and prepare for the publication of proceedings (D6.6)

WP7: Management

General objectives for the period

- Complete the milestones in time and deliver the deliverables.
- Make sure that the Consortium contractual duties are carried out. Support and strengthen the participants to comply with the EU regulations and their contractual and legal requirements.
- Set up an effective communication infrastructure and foster the integrative process within the Consortium.

Specific objectives for the period

- Publish the second periodic report (D7.2)
- Convene an interim Consortium Committee meeting
- Convene the third annual consortium meeting (MS59)
- Prepare the final report (D7.3)

2.1.2 Work package tasks

In order to make progress towards/meet the stated objectives, activities were undertaken related to the following tasks:

- **WP1: Phenomics and genomics** – 1.3: Next generation sequencing; 1.4: Transcriptomics; 1.5: Identification of candidate genes
- **WP2: Informatics** – 2.1: Trait Information Portal; 2.2: Predictive characterization
- **WP3: CWR conservation** – 3.1: European and national CWR inventories; 3.2: Exemplar national CWR conservation strategies; 3.3: European priority gene pool CWR conservation strategy; 3.4: European generic CWR conservation strategy
- **WP4: LR conservation** – 4.1: LR inventory; 4.2: Exemplar national LR conservation strategies; 4.3: European LR priority gene pool conservation strategy; 4.4: European LR generic conservation strategy
- **WP5: Engaging the user community** – 5.1: Identification of and discussions with European stakeholders in the PGR conservation and use community; 5.2: SWOT analysis of European PGR conservation and use community needs to promote CWR and LR use; 5.3: Create opportunities to develop new partnerships between CWR and LR conservationists and breeders in Europe; 5.4: Prebreeding – channelling potential interesting germplasm into breeding programmes
- **WP6: Dissemination and training** – 6.1: Project website; 6.2: Web-enabled Europe-wide inventories of CWR and LR diversity; 6.3: Web-enabled Trait Information Portal; 6.4: Publications; 6.6: Dissemination conference
- **WP7: Management** – 7.1: Project Management; 7.2: Communication management

2.2 Work package reports: progress during the period

2.2.1 WP1: Phenomics and genomics (WP leader: Ben Vosman, DLO)

Task 1.3: Next generation sequencing. Task Leader: SXS. Partners involved: DLO, SXS

Sequencing of the 15 selected plants (see PGR Secure second periodic report) representing the diversity has been completed. All sequence data are now available with Partners 9 (SXS) and 2 (DLO). SXS has obtained the recently published reference genome sequence of *Brassica oleracea*, which has been used for mapping of the reads. In total, c. 2 million SNPs[3] could be identified in the leaf RNA of the 15 selected plants that were sequenced. From these SNPs a selection was made based on the position of the SNP on the *B. oleracea* reference genome to produce a 90k Affymetrix Axiom array. The array produced contains c. 40,000 SNPs selected from a set of broccoli varieties, 21,000 polymorphic SNPs from a set of heading cabbages, 4200 already validated *B. oleracea* SNPs and approx. 5000 SNPs that are polymorphic between *B. oleracea* and the wild relative *B. incana,* as well as 5000 that are polymorphic between *B. oleracea* and *B. montana.* The array also contains c. 5000 SNPs that are polymorphic within *B. fruticulosa*. Details are described in Deliverable 1.3. The array was used for genotyping in Task 1.5.

Task 1.4: Transcriptomics. Task Leader: UOB. Partners involved: UOB, UNOTT, DLO

In this task we studied the genome wide gene expression response(s) to insect pest infestation in *Brassica* CWR and landraces. Based on the results from the pilot experiment, it was decided to use the Affymetrix Arabidopsis Gene 1.0 ST array (see PGR Secure second periodic report). Plant materials (RNA samples) to be analysed were provided by Partners 1 (UOB) and 2 (DLO). UOB provided RNA from 16 accessions (see PGR Secure second periodic report). RNA was isolated in four replicates from aphid-infested leaves and from non-infested leaves. Of the 128 RNA samples, 16 were not used further as they failed the Quality Control standards at UNOTT (Partner 10). The RNA samples were obtained from the leaf tissue of 12-week-old plants. One set of plants was induced with aphids for 24 h while the other remained non-induced to determine constitutive gene expression differences.

Data analysis

Array data were analysed using Partek® Genomics Suite™ software. Affymetrix CEL data format files were uploaded into Partek and normalized by Robust Multichip Analysis (RMA). Descriptive statistics were generated from the normalized signal values for each sample. Analysis has resulted in eight different lists of candidate genes based on the different comparisons. All candidate genes were selected based on p-value $\leq$ 0.05 and fold-change in expression level of $\geq$1.5 (up-regulated genes) or $\geq$ -1.5 (down-regulated genes). The numbers of genes up- or down-regulated in the different comparisons are shown in Table 1. Accessions were rated as resistant or susceptible based on the field trial carried out at UOB in 2011 and also the feeding behaviour experiment using the Electrical Penetration Graph (EPG) undertaken at UOB in 2012–2013.

Analysis of Variance (ANOVA) was used to generate lists of genes that are significantly different between resistant and susceptible genotypes under control conditions and under aphid attack. All samples were subjected to the same statistical analysis to identify the constitutive and stress induced gene expression patterns in the *Brassica* species. The results from ANOVA on expression of

[3] Single Nucleotide Polymorphisms

38,408 genes were further reduced to lists of genes which passed statistical tests including p-value ≤ 0.05 and fold change of ≥ 1.5 for up-regulated genes or ≥ -1.5 for down-regulated genes. Table 1 shows the number of genes differentially expressed in the different comparisons. The genes from these lists were annotated by GO (gene ontology) analysis using the AgriGO web-based tool (Du *et al.* 2010), available from http://bioinfo.cau.edu.cn/agriGO/index.php. The Singular Enrichment Analysis (SEA) was applied using the 'Arabidopsis TAIR 10 gene model' as reference and 'Hypergeometric' as the statistical test method, 'Hochberg false discovery rate' (FDR) as a multi-test adjustment method, 0.05 as p-value cut-off and five as the minimum number of mapping entries or GO annotations allowable for detection of significant enrichment. However, when the number of genes was too low (below 15), a Fisher statistical test was conducted setting one as the minimum number of mapping entries.

Table 1. Number of genes showing significant resistant/susceptible differential expression patterns at p-value cutoff 0.05 and fold change of 1.5 to -1.5 for comparison of accessions assessed as resistant and susceptible in the field and through feeding behaviour assessment (EPG), the accessions either being induced by aphid infection or non-induced (constitutive gene resistance).

List no.	**Comparison** Resistant vs. susceptible	**No. of samples accessions x replicates**		**No. of genes**	**up-regulated**	**down-regulated**	**No. of annotated genes**
		Resistant	Susceptible				
Constitutive gene expression							
1	Field trial	40	20	54	11	43	16
2	EPG NP based	32	24	12	12	0	1
3	EPG pathway based	32	24	153	12	141	31
4	EPG E2 based	28	28	94	20	74	46
Induced expression							
1a	Field trial	28	20	7	4	3	2
2a	EPG NP based	24	20	160	58	102	34
3a	EPG pathway based	24	20	105	101	4	23
4a	EPG E2 based	16	16	143	109	34	40

The results of the analysis show that from the field experiment when resistant genotypes were compared to susceptible, the genes that were differentially expressed varied in number and identity between the induced and non-induced plants. A total of 54 genes were found to be differentially expressed in the case of non-induced plants where the majority of genes were down regulated. However, only seven genes were found to be significantly differentially expressed in induced plants. Only two genes were found common between induced and non-induced gene expression based on field experiment assessment.

More genes were found to be significantly differentially expressed when resistant genotypes were compared to susceptible based on the feeding behaviour experiment assessment (Table 1). The gene lists created from feeding experiments were based on three phases of feeding derived from the EPG analysis, each phase revealing potentially different modes of resistance that aphids could encounter when feeding on plants: 1) a plant surface resistant to penetration (non-penetration or NP phase); 2) intercellular resistance detected by the feeding pathway (pathway phase); and 3) resistance associated with components of the phloem (E2 phase). The statistical data analysis showed that gene expression differs in these three phases. In non-induced plants when resistant genotypes were compared with susceptible, only 12 genes were found to be significantly differentially expressed in the NP phase as compared to 94 in E2 and 153 in the pathway phase. Fourteen genes were found to be similarly expressed in the E2 and pathway phases while there were no common genes between NP and the other two phases. Similarly, when the gene expression for induced plants was analysed, we found 160 genes significantly differentially expressed in the NP phase, 143 in the E2 phase and 105 in the case of the pathway phase of feeding behaviour. In induced plants, two genes were found commonly expressed in both E2 and NP along with four genes common between E2 and pathway. The maximum number of common genes (33) was found between pathway and NP (Fig. 1).

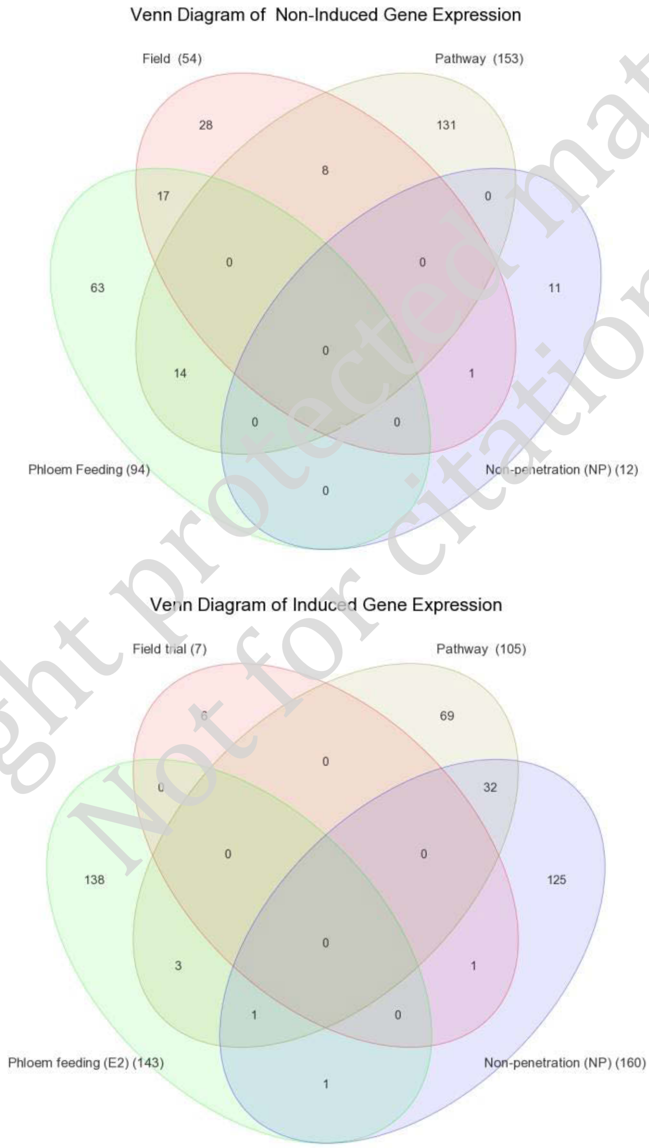

Figure 1: Venn diagrams showing the number of significantly differentially expressed genes in common among field trial assessment and EPG parameters (NP, pathway and E2 phases) for non-induced (top) and aphid induced (bottom) brassica plants

Genome wide gene expression response(s) to whitefly infestation (DLO)

DLO provided RNA for two experiments. Experiment 1 consisted of three bulk samples of resistant accessions and three of susceptible accessions which were collected from the 123 *B. oleracea* var. *capitata* landraces experiment carried out in 2012. Experiment 2 consisted of a time series of RNA samples from the white cabbage cultivar 'Rivera'. Whitefly resistance is expressed in Rivera plants when they are approximately nine weeks old. RNA samples (three replications) of 6, 8, 10 and 12 week old plants from whitefly infested and non-infested plants were subjected to microarray analysis. Data were analysed in the same way as described for the UOB samples. In the first experiment we identified 418 genes with significantly ($P < 0.05$, FDR < 5%) higher expression levels in the resistant bulk and 390 genes with higher expression levels in the susceptible bulk. In the second experiment comparisons were made for gene expression at 6–8 weeks vs. 10–12 weeks on whitefly-induced material. From this comparison we identified 1035 genes with higher levels of expression in 10–12 week old plants and 1161 genes with higher levels of expression in 6–8 week old plants ($P <$ 0.05, FDR < 5%). We also compared the response of Rivera to whitefly feeding when plants were 12 weeks old and found 316 induced and 344 repressed genes. These results point to major differences in gene expression among resistant and susceptible plants.

Main conclusions

1. Different sets of genes were found to be differentially expressed in field experiments in comparison with the feeding behaviour experiment. This is likely to be for a number of reasons, including plants being exposed to different environments, and in the case of induced plants, because of differences in plant physiological stage, time of exposure to the insect, but also because the EPG assessment is able to more critically dissect the physiological nature of any resistance.

2. The EPG experiment and assessment of gene ontology revealed that the NP phase showed more genes which were related to membrane or cell wall activity compared to the pathway phase. Whereas genes involved in the respiration electron transport chain, or genes involved in oxidation reduction processes and intracellular signal transduction genes, were significantly differentially expressed. The active feeding phase E2 was represented by genes like PP2-A10 which are known to be associated with phloem-based defence against insect pests in plants.

3. The strongest candidates for further development of aphid resistance in brassica crops are:

    a. Field assessment: ESM1 – At3g142101; pectin-lyase superfamily - At1g04680

    b. EPG non-penetration phase: PDCB3 – At1g18650; NPC6 – At3g48610

    c. EPG pathway phase: most of the highly significant differentially expressed genes code for hypothetical proteins, the value of which in terms of resistance is therefore unknown. However, NUDX1 – AT1G68760 which is highly significant and shows a fold change of two encodes the first defined nudix hydrolase in Arabidopsis, and may or may not be associated with disease susceptibility.

    d. EPG phloem feeding phase: PP2-A10 – At1g10155; At3g56240; At5g09650

4. Major changes in gene expression occur when cv. Rivera develops resistance against whiteflies.

Task 1.5: Identification of candidate genes

Mapping of whitefly resistance in the B. incana *backcross population*

Selfings and backcrosses (BC) with the resistant parent have been made from F1 plants of the *B. incana* x *B. oleracea* (24 x 111 and 111 x 24) and *B. villosa* x *B. oleracea* (363 x 111 and 111 x 363) crosses. Less than ten F2 seeds per selfing were obtained so no F2 screening could be performed. This is not entirely unexpected for such interspecific crosses. However, about 200 seeds per backcross were obtained and seeds from one backcross with *B. incana* as a resistance donor (111 x 24) were sown in January 2014 (week 4). A leaf assay was performed in week 12 when plants were seven weeks old. An evaluation on intact plants was carried out at a plant age of ten weeks, which consisted of a clip cage test to evaluate resistance against whitefly in terms of whitefly survival and oviposition rate. In addition, the trichome density of the leaf was measured. In this cross we mapped whitefly resistance to a single locus on chromosome 1 explaining 57% of the variance for whitefly adult survival (AS) and 82% for oviposition rate (OR). At the same locus we also mapped the presence/absence of trichomes. There was a strong correlation between the presence of trichomes and whitefly AS (-0.71) and OR (-0.89). The presence of the trichomes is likely responsible for the resistance observed. With additional markers we could narrow down the region to 3.4 cM on the genetic map, but due to suppressed recombination in this region the physical map still represents 15 million base pairs. Candidate genes involved in trichome development could be identified by using the synteny between the *B. oleracea* and *Arabidopsis thaliana* genome. One hundred and sixty-five genes related to trichome development were selected from the Arabidopsis (TAIR[4]) database and we located their position on the *B. oleracea* genome (BolBase[5]). From 165 genes, 120 were mapped on the different chromosomes and 45 on scaffolds. From these 120 mapped genes, nine could be mapped on chromosome 1 of which two are within the QTL region for AS, OR and presence of trichomes. Both candidate genes are classified as transcription factors. Further investigations will be needed to validate their putative role in trichome development.

Mapping of resistance genes in the B. oleracea *F2 population*

QTLs[6] for AS (Chr[7]. 9) and OR (Chr. 4) were found within the F2 population of a susceptible x resistant cultivar ('Christmas Drumhead' x 'Rivera'). QTLs for morphological characteristics were also detected: a major QTL for wax layer presence (Chr. 3) and minor QTLs for leaf toughness (Chrs. 3 and 6) and head formations (Chrs. 2 and 5). None of the morphological characteristics correlated significantly with AS or OR and the QTLs did not overlap. To confirm the QTLs for resistance, F3 lines from five resistant and four susceptible F2 plants were selected and 20 F3 plants per F3 line were screened for AS and OR. The markers with the highest LOD[8] score in the QTL mapping were significantly correlated with the resistance among the F3 plants. The F3 lines derived from F2 plants that carried the 'Rivera' alleles of the resistance related markers in either homozygous or heterozygous form were significantly more resistant (no survival and less than 0.1 eggs per female per day) than those homozygous for the 'Christmas Drumhead' alleles (>12% survival and more than 0.3 eggs per female per day). Fine mapping is needed to narrow down the regions of interest to identify candidate genes for AS and OR in cabbage.

[4] www.arabidopsis.org
[5] www.ocri-genomics.org/bolbase/
[6] Quantitative Trait Loci
[7] Chromosome
[8] Logarithm of the Odds

Association mapping of whitefly resistance genes in the cabbage landrace population

To link phenotypic variation to genotypic variation an association mapping was performed on cabbage landraces using the Affymetrix Brassica Axiom SNP array developed within this project. In total 114 *B. oleracea* var. *capitata* accessions were analysed with 62,000 SNPs. Data were analysed with and without correction for population structure using SNP data. Most of the structure within the population of landraces can be explained by variation in heading and origin. When analysing associations between whitefly resistance related traits, higher -10log (p-values) were obtained after correcting for population structure, but no major shifts in associations were observed. Associations for AS were found on chromosomes 1,2,4,5,6,7 and 9 (Fig. 2). In agreement with the high correlation (R=0.91) between AS and OR observed in 2012 field evaluations, comparable associations were obtained for OR (results not shown). Markers with a -10Log (p-value) higher than 7.8 for AS and OR were considered associated with resistance, and candidate genes were selected in a region 10Kb downstream and 10Kb upstream from the associated marker. This resulted in a list of 177 candidate genes of which 27 genes overlap with the QTL for AS or OR identified in the Christmas Drumhead x Rivera F2 population. Whether these genes actually play a role in resistance remains to be determined.

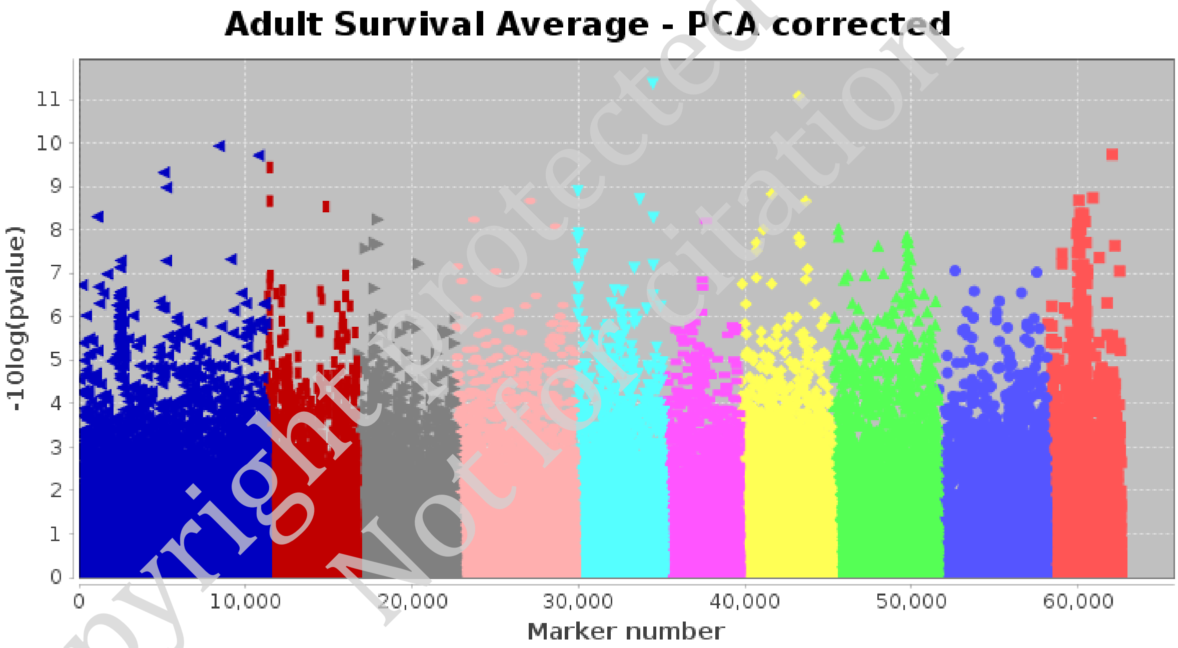

Figure 2. Manhattan plot for adult survival after correction for population structure. Chromosomes of *B. oleracea*, from left to right: unmapped scaffolds, chr. 1-2-3-4-5-6-7-8-9. Markers with a -10Log(p-value) higher than 7.8 for AS and OR are considered to be associated with resistance.

Development of a mapping population for cabbage aphid resistance

An F2 population between a susceptible and a resistant *B. fruticulosa* (451 x 453) was screened for cabbage aphid resistance. Two leaves (fifth and sixth leaf) of five week old plants were infested with 15 one day old aphids per clip cage and seven days later aphid survival was assessed. Differences in resistance were observed between the parental lines within the F2 population and F1 plants were found to be susceptible. However, a large variation was found within the resistant line. In order to reduce this variation, cuttings were made of all plants so that the phenotyping could be repeated multiple (three) times. Using the cuttings, we found that many aphids still survived after seven days even on the resistant line, resulting again in a large variation. Therefore, in a second and third experiment with cuttings, survival was scored after 12 days. Very low correlations were observed between F2 plants and cuttings (R=0.23) and also between different cuttings of the same plant (R=0.25) both scored 12 days after infestation. Based on these highly variable results it was decided that it was not useful to continue work on this population.

Conclusions

- QTLs for whitefly resistance could be identified in *B. oleracea*. However, in the 'Christmas Drumhead' x 'Rivera' population, these QTLs explained only a minor portion of the variance for this trait.
- One major QTL was identified in the CWR *B. incana,* which may be useful in breeding whitefly resistant *B. oleracea* varieties.
- Molecular markers linked to these QTLs were identified are available to breeders. These markers will facilitate the introgression of the QTLs and speed up the breeding process.
- Candidate genes for resistance have been identified, but their validation was outside the scope of the project.

WP1: Deviations from Annex I

Some deliverables and milestones have been submitted/achieved later than planned, but there have otherwise been no major deviations from the workplan during the period.

2.2.2 WP2: Informatics (WP leader: Ehsan Dulloo, BIOVER)

Task 2.1: Trait Information Portal. Partners involved: all partners

Work continued on the development of the infrastructure, ontology and data types of the information portal (now no longer known at the Trait Information Portal, but the Plant Genetic Resource Diversity Gateway – see PGR Secure second periodic report). During the first phase of the system development in 2013, the system was tested and evaluated by developers within Bioversity's Commodity Programme, who were very impressed by the solutions and speed of the system.

The system beta version was tested again by some partners and participants at the PGR Secure stakeholder workshop 'On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis', held in Wageningen, 25–29 November 2013. This workshop was attended by more than 80 people from 21 countries, representing stakeholders from public research institutes, breeding companies, governments, agricultural NGOs and genebanks. At this workshop, the beta version was presented and demonstrated, and access was given to all participants (password and user id). A working station was made available for participants to test the system and about 25 breeders, NGOs, policymakers and researchers were guided through the system by the developer and provided real time feedback. The feedback and discussions held during the workshop were mainly about features and the look of the fields. The feedback has been helpful to better inform the design of the search and output forms.

Data standards were added to the system such as the Darwin Core, EUFGIS standards for forest gene conservation units, various ISO standards, IUCN Red List standards, landrace descriptors, multi-crop passport descriptors and QTL data. The descriptors for the CWR checklist, national inventory, conservation strategies and QTL have been drafted and extensively reviewed and revised, and will be published in due course. This will be a resource for data providers and other users to harmonize and standardize such data types.

The system has been populated with passport, characterization and evaluation data from GENESYS (EURISCO, USDA and SINGER) and EUFGIS, environmental layers, trial results, and forest gene conservation unit data. An additional component developed is a web service, stored in all units that feature a coordinate, which provides climatic data at a 30-second resolution. This service provides current conditions from Worldclim, CWR conservation strategies and global environment stratification indexes, including data from climatic and environmental zones, the global human footprint, the harmonized world soil database, United Nations statistics division standards and data, and the World Bank institute standards and data. Data produced during the project (WP1, WP3 and WP4) have been gathered and uploaded into the system, and users can now search and visualize these data.

The database has been deployed on a cluster of four servers to test scalability. This is to test how to make the database faster even as it becomes larger (four servers serving the same database should be roughly four times faster than a single server serving the same database).

Searches can be conducted in one of two ways. Users who know what they are looking for can use a single text field. Otherwise, users can search within thematic forms specific to domains such as specific crop species, CWR or landraces.

At the PGR Secure final dissemination conference held in Cambridge, 16–20 June 2014, a presentation on the PGR Diversity Gateway was made to the delegates and project partners. The system was made open to the public on 20 July 2014 (http://pgrdiversity.bioversityinternational.org) and currently contains information on accessions (531,982 records), checklists (5490 taxon records), national inventories (4781 taxon records), forestry (3110 taxon records) and organizations (20,644 records). Furthermore, it contains three national CWR conservation strategies and one landrace regional conservation strategy. Population of the system with information is ongoing. The platform offers single and advanced searches and visualization of information through results views and summaries. It also features a mapping service to display and map the information, including the possibility to add to the map different types of layers such as satellite, terrain, boundaries, roads, precipitation, pressure (and contour), wind and temperature.

Task 2.2: Predictive characterization. Partners involved: UOB, DLO, BIOVER, UNIPG, JKI, MTT, URJC, SXS, UNOTT

Work on the guidelines for the broader application of the Focused Identification of Germplasm Strategy (FIGS) has been completed. The final title has been agreed as 'Predictive characterization of crop wild relatives and landraces. Technical guidelines version 1'. The guidelines are being published by Bioversity International (Thormann *et al.*, 2014).

WP2: Deviations from Annex I

Some deliverables and milestones have been submitted/achieved later than planned, but there have otherwise been no major deviations from the workplan during the period.

2.2.3 WP3: CWR conservation (WP leader: Nigel Maxted, UOB)

Task 3.1: European and national CWR inventories. Partners involved: UOB, BIOVER, UNIPG

European CWR inventory

The CWR Catalogue for Europe and the Mediterranean (Kell *et al*., 2005), which is a comprehensive list of CWR taxa in the region and their occurrences in geographical units (countries or sub-national units) related to cultivated plants of all types (including food, fodder, forage, industrial plants, ornamentals and medicinal plants) has been revised using the latest data provided by the Euro+Med PlantBase Secretariat (E. Raab-Straube pers. comm., Berlin, 2014). The Catalogue provides an overview of the breadth of crop and CWR diversity in the European region and the baseline data for conservation planning at regional scale (see Tasks 3.3 and 3.4). National CWR checklists were extracted from the original version of the Catalogue and provided to each European country for use in the national PGR programmes to form the basis of national checklists, inventories and subsequently, national CWR conservation strategies and action plans. The data were provided to the countries prior to the PGR Secure project and again at the Joint PGR Secure/ECPGR workshop, 'Conservation strategies for European crop wild relative and landrace diversity', 7–9 September 2011, Palanga, Lithuania (www.pgrsecure.org/palanga_workshop), as well as being made available via the PGR Secure online helpdesk.

The revised CWR Catalogue data are in the process of being uploaded to the PGR Diversity Gateway (Task 6.2) where they will be searchable and from where national checklists can be downloaded to form the basis of national checklists and inventories. A peer-reviewed publication describing the process of creating the CWR Catalogue is in preparation.

National CWR inventories

Seven European countries have to date completed national CWR checklists and inventories: Cyprus, Czech Republic, Finland, Italy, Norway, Spain and United Kingdom. The national checklists and inventories of Finland, Spain and United Kingdom have been web-enabled via the PGR Diversity Gateway (Task 6.2) and those of Cyprus, Czech Republic, Italy and Norway are in the process of being uploaded. The Italy and Spain CWR checklists and inventories are also available via the case study websites of those countries (see 3.2.3 and 3.2.4).

The online CWR and LR conservation helpdesk (www.pgrsecure.org/helpdesk) has been updated with the addition of new resources as they arise. UOB has been in regular contact by email with national experts to provide them with technical advice and assistance with the development of their national CWR inventories and conservation strategies.

Task 3.2: Exemplar national CWR conservation strategies. Partners involved: UOB, MTT, URJC, UNIPG

3.2.1 UK national CWR conservation strategy (UOB)

During the current reporting period, further progress has been made toward developing conservation strategies for priority CWR in England, Wales and Scotland. *In situ* gap analyses have been completed for each country according to the methods agreed by the involved conservation agencies: Natural England (NE), Natural Resources Wales (NRW) and Scottish Natural Heritage (SNH).

Mapping softwares were used to carry out taxon hotspot, observation richness, and complementarity analyses.

An *in situ* gap analysis was carried out for CWR in England which included wild relatives of human food crops, as recommended by NE. A total of 339,042 occurrence record data points belonging to 111 taxa were included in the analysis. Key taxon hotspots were located in Cornwall, the south coast of Dorset, Somerset, Norfolk and Cambridgeshire. The complementarity analysis revealed that the most suitable sites for the establishment of CWR genetic reserves are located in Purbeck (Dorset) and the Lizard (Cornwall). All sites were found to overlap with statutory protected areas, including Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC) and National Nature Reserves (NNR).

Two separate *in situ* gap analyses were carried out for CWR in Wales—one containing the 98 taxa classified as common and one containing the 24 taxa classified as rare. A total of 191,664 occurrence record data points were included in the analysis. Taxon hotspots were identified along the south coast of Wales (particularly the Gower peninsula), in north Wales (the northern reaches of Denbighshire and Flintshire) and a small number of localities along the west coast of Wales. Complementarity analysis of the common taxa revealed the Gower peninsula to be the most suitable site for a CWR genetic reserve (after the top site in Cardiff was disregarded due to observation bias). The complementarity analysis of the rare taxa found a site within the Brecon Beacons national park to be the most suitable site for the establishment of a CWR genetic reserve, with the Gower peninsula identified as the second most suitable site.

Of the 120 priority taxa in the Scottish national inventory (related to both human food crops and forage/fodder crops), 112 were included in an *in situ* gap analysis, as eight taxa were found to have insufficient records. This gave a total of 90,277 occurrence record data points. Taxon hotspots were identified to the west of the city of Glasgow stretching into the Loch Lomond and Trossachs national park, around the Firth of Forth to the west of Edinburgh, as well as areas further north in Moray and the Highlands, overlapping with the Cairngorms national park. Fewer occurrence records exist for areas further to the north of Scotland, perhaps due to their relative inaccessibility and isolation as a result of its mountainous landscape. The complementarity analysis revealed the area west of Glasgow to be the most suitable site for the establishment of a CWR genetic reserve.

Ex situ gap analyses based on accession data obtained from the UK National Plant Inventory database (UKNPI, 2013) and the Millennium Seed Bank, Kew have also been completed. The results have allowed the identification of those taxa across each country where accessions are lacking and those where accessions are not yet fully representative of their full range in the wild, indicating where further collection is required for UK CWR. Full conservation strategies for each country are currently being produced.

An inventory of priority CWR and an *in situ* gap analysis (*ex situ* analysis currently in progress) has also been undertaken for the UK as a whole. The UK inventory contains a total of 223 taxa covering both native and introduced taxa related to both food and forage/fodder crops. The *in situ* gap analysis was carried out with 803,625 occurrence record data points revealing taxon hotspots primarily in the south and southwest of England as well as East Anglia and Kent. Results of complementarity analysis suggest that sites in Purbeck in Dorset, Cambridgeshire, the Lizard in

Cornwall and in the Highlands of Scotland (within the Cairngorms national park) are all key sites for the conservation of UK priority CWR.

A genetic diversity study of eight CWR taxa on the Lizard Peninsula, Cornwall has now been completed. During the current reporting period all leaf samples collected during fieldwork in spring 2012 and 2013 were subject to AFLP analysis at the Institute of Biological, Environmental and Rural Sciences (IBERS). Training in genetic analysis software packages for AFLP data analysis was undertaken in November 2013 and full analysis of AFLP data was completed in February 2014.

The results of the study show that the level of genetic diversity on the Lizard Peninsula is comparable to levels of genetic diversity found in populations outside of the Lizard, across the southwest of the UK, despite the Lizard representing a much smaller geographic area. It was also found that CWR populations on the Lizard are largely distinct from those outside the Lizard. Both findings lead us to recommend that this site be established as the first UK CWR genetic reserve. Conservation and management implications have now been considered for the Lizard and a full report and conservation strategy written and submitted to Natural England. Further meetings have been held with representatives of Natural England to discuss the steps which need to be taken to declare the Lizard Peninsula as the first UK CWR genetic reserve.

3.2.2 Finland national CWR conservation strategy (MTT)

The national CWR conservation strategy for Finland was finalized in the 2nd period and published in November 2013 (see http://jukuri.mtt.fi/bitstream/handle/10024/481549/mttraportti121.pdf). During the current reporting period, preliminary discussions regarding the implementation of the strategy have been carried out, specifically regarding the collection of core CWR seed material for *ex situ* conservation at the Nordic Gene Bank (NordGen) during 2015, and monitoring CWR populations in up to five nature reserves in Finland.

3.2.3 Spain national CWR conservation strategy (URJC)

During the current reporting period, the URJC objectives were to fully complete the National Inventory of Spanish CWR on the basis of the prioritized CWR list developed (see the second periodic report) and to conclude the National Strategy of CWR conservation. To reach these objectives, the identification of high species richness and complementary areas for the 'industrial/other uses' CWR category was carried out, as well as a global analysis, and a joint analysis of results and discussion was developed. Furthermore, two undergraduate theses by students of the Faculty of Biology were completed dealing with the conservation of CWR of Spain related to forage and fodder and industrial/other uses.

Gap analyses

Industrial/ other uses CWR species in situ *gap analysis*

Good quality distribution data were obtained for 87 of the 95 CWR species prioritized in the industrial/other uses category. With this information the *in situ* conservation gap analysis was completed for this group. Results were expressed as the ratio of population occurrences within protected areas (PAs) over total occurrences. The overall picture is that 41 ± 21% (mean±SD) of the populations of the CWR species prioritized in the industrial/other uses category occur within PAs. In terms of ecogeographic representation, 69±22% (mean±SD) of the ecogeographic units are represented in the populations that lie within PAs.

Global CWR species in situ *gap analysis*

Overall, 42±24% (mean±SD) of the populations of the CWR species in the Spanish National Inventory under analysis are located in Sites of Community Interest (SCIs) belonging to the Natura 2000 network. Regarding the ecogeographic representation of the populations under study, 66±27% (mean±SD) of the ecogeographic units where the prioritized CWR species of the Iberian Peninsula and Balearic Islands are found, are represented in the populations that occur in PAs in the Natura 2000 network. The high variability in this parameter depending on the species under consideration and the uncertainty generated by the lack of high-quality occurrence data demand that these results be interpreted with caution and that additional efforts are made to improve the quantity and quality of occurrence data.

The results concerning the ecogeographical distribution of the prioritized species and the ecogeographical gap analysis were presented at the 6th Plant Biology Conservation Congress held in Murcia, Spain, 15–18 October 2013 (www.congresosebicopmurcia.es/index.aspx). The presentation is available at http://pgrsecurespain.weebly.com.

Identification of high species richness and complementary areas

Industrial/ other uses category richness analysis

For the industrial/other uses category, using 10x10 km grids, 22 areas have the highest richness, holding between 14 and 16 species (out of 87 species with high quality distribution data). Detailed information on the results of this group can be found in the National Strategy for the Conservation of Crop Wild Relatives in Spain (http://pgrsecurespain.weebly.com/spanish-proposal-for-the-national-strategy---european-deliverable-d-32.html).

Global richness analysis

The global richness analysis, using the joint shapefile for all prioritized CWR, identified 14 hotspots (10x10 km areas) that are the richest in number of species. The two locations with the highest species richness are found in the province of Navarra (79 species). Detailed information can be found at http://pgrsecurespain.weebly.com/spanish-proposal-for-the-national-strategy---european-deliverable-d-32.html.

Industrial/other uses category complementarity analysis

In the industrial/other uses category, 29 areas (10x10 km grids) encompass the 87 species under analysis. The first ten sites contribute three or more species and hold 37% of the species. Four of these ten sites are located in PAs and two sites are located less than 10 km away from a PA so they could potentially be annexed to the network, depending on local land use. Detailed information can be found at http://pgrsecurespain.weebly.com/spanish-proposal-for-the-national-strategy---european-deliverable-d-32.html.

Global complementarity analysis

The global complementarity analysis carried out for all categories of uses shows that 122 sites (10x10 km grids) would be required to protect all 508 CWR species under analysis and that only 20 sites are required if we consider that preserving two thirds of the prioritized CWR species *in situ* is a suitable goal for the short to medium term. Five of these 20 sites are found inside SCIs and seven additional sites are partially included in SCIs, and thus, could relatively easily be incorporated into the protection network. Finally, three additional sites are outside SCIs but located less than 10 km away. Discussions and detailed information on this analysis are available at http://pgrsecurespain.weebly.com/spanish-proposal-for-the-national-strategy---european-deliverable-d-32.html.

Spain national CWR conservation strategy

Synthesizing all the information generated throughout the project, the URJC team has produced the Spain national CWR conservation strategy, which is available at www.pgrsecure.bham.ac.uk/sites/default/files/documents/public/national_CWR_Conservation_Strategy_Spain.pdf.

Additional activities and dissemination actions

Experimental validation on ELC maps

To validate the use of the ecogeographic land characterization maps as a proxy to estimate genetic diversity of adaptive value, an experiment using *Lupinus angustifolius* L. (one of the prioritized species in the NI) as a reference species, has been completed. The second cycle of cultivation in a common garden was started in December 2013. Plants were kept in optimal conditions until the flowering period (mid-April), when a drought stress experiment was implemented. Fitness data regarding number of flowers, fruits and seeds were gathered and are now under analysis. These results will be included as part of a doctoral thesis that will be presented in summer 2015.

Dissemination of results and contacts with national and regional authorities

In July 2014, plant conservation authorities of all autonomous communities in Spain were contacted and results from the PGR Secure project in Spain, including the national CWR strategy and all the generated databases, were made available to them. We asked them for feedback with suggestions or comments and offered collaboration for implementation of CWR conservation actions. URJC also held a meeting with the Spanish National Genebank to disseminate the results of the PGR Secure project. As a result of this, the results are now also available at the web page of this institution (wwwsp.inia.es/Investigacion/centros/crf/BasesDatos/Paginas/BasesDatos.aspx).

In September 2014 a meeting with the Sub-Directorate General of the Department of Environment of the Ministry of Agriculture, Food and Environment was held in Madrid. In this meeting the main results from the PGR Secure project were communicated. Limitations of SCIs of the Natura 2000 network that are not currently protected areas were discussed in connection with the establishment of CWR genetic reserves The URJC team proposed the creation of a pilot genetic reserve of CWR in Spain. The Sub-Directorate General offered to raise this possibility in the next meeting of the Spanish Conservation Committee formed by authorities of the different autonomous regions. URJC will prepare an executive summary of the National CWR Strategy for this meeting, highlighting the most interesting sites where this pilot genetic reserve could be established.

3.2.4 Italy national CWR conservation strategy (UNIPG)

During the current reporting period, results of the activities carried out within PGR Secure were published in a peer-reviewed journal (Landucci *et al.*, 2014) and at http://vnr.unipg.it/PGRSecure, where a Working Database of the Italian Vascular Plants, a full Italian CWR/WHP (wild harvested plants) List, an Italian CWR/WHP priority list, a Sicilian CWR/WHP priority list, a Sardinian CWR/WHP priority list and other materials are available for consultation and download.

On the basis of the research activities carried out during the project, the first steps to be taken towards the conservation of CWR in Italy were identified and published (see www.pgrsecure.bham.ac.uk/sites/default/files/documents/public/National_CWR_Conservation_Strategy_Italy.pdf). They can be summarized as follows:

1. Awareness on the importance of CWR is to be raised at national and regional level.
2. Attention should be focused on the priority taxa (i.e. those taxa that are most in need of protection and monitoring, are native to Italy, and are of importance for local and worldwide food security), as an initial step at least.
3. Since the knowledge of the distribution of CWR taxa is lacking, information on actual occurrence, precise location and census of CWR populations that are reported in the literature should be assessed in order to confirm (or reject) the priorities based on endemism and threatened status.
4. At the same time field investigations should also be carried out in order to detect new and extant unrecorded CWR populations.
5. Location data should then be used to identify the populations most in need of conservation: a gap analysis process, similar to that described in Landuccci *et al*. (2014) should be used to identify populations present/not present in protected areas, and safely duplicated/not duplicated *ex situ*.
6. Appropriate conservation plans should then be drafted, starting from top priority taxa.
7. Appropriate funding is to be raised for carrying out the above-mentioned activities.

Furthermore, in the current reporting period, a PhD thesis was completed dealing with the conservation of CWR of Italy.

3.2.5 Other national CWR conservation strategies

In addition to the exemplar national CWR conservation strategies reported above and progress in other national strategies reported in the second periodic report, further progress has been made in the development of strategies for Bulgaria, the Czech Republic, Lithuania and Norway through collaboration between UOB[9] and the PGR National Programmes of those countries. Reports and other publications arising from this work have been published, submitted, are in press or are in preparation (see Appendix 1). Talks are also ongoing between UOB and the NFPs in Greece and Turkey about initiating the development of national CWR conservation strategies in those countries.

As reported in the second periodic report, a pilot study was undertaken in Norway during late 2012/early 2013 with the technical assistance of a volunteer from UOB. This initial study was used to leverage funding for a more detailed follow-up project which started in September 2013. The project, 'Establishment of PGR *in situ* conservation in protected areas in Norway' is being carried out over three years with funding from the Norwegian Ministry for Agriculture and Food. The project is partly being carried out as PhD research in cooperation with UOB. Other partners and contributors are GBIF Norway and the Natural History Museum (both located at the University of Oslo), the Directorate for Nature Management, Nordic Genetic Resource Centre (NordGen) and the county authorities in relevant counties as they are the managers of protected areas.

[9] UOB has provided staff/student expertise and technical support, and in some cases, partial funding (e.g., travel and subsistence costs of researchers).

Task 3.3: European priority gene pool CWR conservation strategy. Partners involved: UOB, BIOVER, UNIPG, MTT, URJC

The starting point for Task 3.3 is the CWR Catalogue for Europe and the Mediterranean (Kell *et al.*, 2005)[10] which provides an overview of the breadth of crop and CWR diversity in the European region and the baseline data for conservation planning at regional scale, as well as national CWR checklists for use in the national PGR programmes to form the basis of national checklists, inventories and subsequently, national CWR conservation strategies and action plans (see Task 3.1). For the development of a Europe-wide CWR conservation strategy, it is necessary to select regional priority species from the Catalogue—those with the greatest potential to contribute to food and economic security in the region.

A draft list of 339 priority CWR species native to Europe (Maxted *et al.*, 2013; Milestone 20) was produced based on three main criteria that are of greatest relevance when assigning priorities to CWR species in the context of conservation planning (Kell *et al.*, in prep. a):

a) The socio-economic value of the crop to which they are related (Ford-Lloyd *et al.*, 2008)
b) Their potential ease of use or known value in crop improvement programmes (Maxted and Kell, 2009; Maxted *et al.*, 2012)
c) Their relative threatened status (Ford-Lloyd *et al.*, 2008; Maxted and Kell, 2009).

Wild relatives of more than 30 priority crop gene pools were included in this draft priority list. Subsequently, the prioritization process was reviewed and refined, and while the same three main criteria were applied, the revised priority list comprises 192 species in 23 human food crops or crop groups. A publication detailing the revised prioritization process is in preparation (Kell *et al.*, in prep. b).

Occurrence data were collated for these 192 priority CWR species and results of initial diversity and gap analyses were presented at the Joint PGR Secure/EUCARPIA conference, 'Enhanced Genepool Utilization – Capturing wild relative and landrace diversity for crop improvement', incorporating the PGR Secure final dissemination conference, 16–20 June 2014 (see www.pgrsecure.bham.ac.uk/sites/default/files/documents/public/conference_presentations/Kell_et al.pdf).

Preliminary results indicate that 31 countries in Europe each contain 20 or more of these priority species and that the highest taxonomic diversity is found in Spain, Italy and Greece. Complementarity and *in situ* gap analyses, as well as an *ex situ* taxon gap analysis were carried out. Results indicate that less than half of the species occur within protected areas and from previous research we know that it is likely that most, if not all of these species are not actively conserved (i.e., not included as target species in the protected area management plans and therefore not monitored or actively managed). Results of analysis of data available in EURISCO (M. Skofic pers. comm., Rome, June 2014) (http://eurisco.ipk-gatersleben.de) reveal that accessions of European origin of 91 (47%) of the high priority species related to 16 crops/crop groups are represented in European collections, indicating a vast gap in *ex situ* conservation of these priority European plant genetic resources. Further, of these 91 species, 48 are represented by only eight or less accessions, indicating a severe

[10] Now revised (see Kell *et al.*, 2014)

lack of diversity available for characterization and evaluation and subsequent use in crop improvement programmes.

These results are based on the readily available occurrence data. We found that there is a paucity of occurrence data available for some species, while for others the distribution is well studied and the available occurrence data are likely to be reasonably representative of the taxon's distribution. Further, the quality of the available data is variable, with many records lacking detailed location information and sample status (i.e., whether wild, weedy or cultivated). For the small proportion of records that include geographic coordinates, a significant number cannot be reliably used in the analyses due to insufficient accuracy. In order to obtain more accurate results, the research is ongoing in the context of the lead researcher's PhD. Additional searches for distribution data and species distribution modelling will be undertaken with the aim of providing a more complete picture of the priority species' distribution and thus more viable and useful results of complementarity and *in situ* gap analyses.

Complementarity analysis at taxon level is informative for conservation planning but it is also desirable to undertake infra-taxon diversity analyses (genetic where existing information is available combined with ecogeographic diversity) to identify specific locations representing the widest range of diversity of each priority species with the aim of focusing conservation efforts on populations of target taxa that represent the widest pool of genetic diversity and that are most likely to contain adaptive traits of interest for crop improvement (Kell *et al.*, 2012; Maxted *et al.*, 2013; Kell *et al.*, in prep. b). Ecogeographic diversity analysis will also be undertaken in the context of the lead researcher's PhD and will be used to inform *in situ* and *ex situ* gap analyses at infra-taxon level for the priority CWR species.

Task 3.4: European generic CWR conservation strategy. Partners involved: UOB, BIOVER, UNIPG, MTT, URJC

The national (Tasks 3.1 and 3.2) and regional (Task 3.3) approaches to CWR conservation in Europe may be considered as bottom-up and top-down respectively, but what is critical is that the two approaches are not viewed as independent of one another—rather that they are harmonized and implemented in a coordinated way towards an integrated European CWR conservation strategy (Maxted *et al.*, 2013; Kell *et al.*, in prep. b) (Box 1).

Box 1. Approach to the integrated European CWR conservation strategy (Maxted *et al.*, 2013; Kell, Maxted and contributors, 2014; Kell *et al.*, in prep.)

a) National CWR conservation strategy – each country should have its own national CWR conservation strategy implemented through *in situ* and *ex situ* activities undertaken by national agencies.
b) Regional CWR conservation strategy – the regional strategy comprises a network of *in situ* conserved priority CWR populations backed up with samples conserved *ex situ*. The regional target populations are identified/endorsed by a regional authority (such as the ECPGR *In situ* and On-farm Conservation Network) without consideration of national borders. Responsibility for *in situ* and *ex situ* conservation actions will be taken by national agencies in the appropriate countries with oversight and support provided by the regional authority.

c) Integrated European CWR conservation strategy – two distinct levels of strategies are married into one coherent integrated whole:

- Bottom-up integration – Priority national CWR populations (MAWPs) are nominated by the national PGR coordinator for inclusion in the integrated European CWR conservation strategy for formal recognition as part of the European network of priority *in situ* CWR populations. For a country to designate a MAWP, the population should meet specified selection criteria. Note: a single site may contain more than one MAWP; in fact this would be encouraged where appropriate to maximize the value of the conservation site and to focus conservation resources. A MAWP may occur within an existing protected area but may also occur outside of PAs. In these cases, MAWPs outside of PAs may be designated and the necessary active and sustained *in situ* CWR conservation management commitment made.
- Top-down integration – Priority CWR populations identified in the regional CWR conservation strategy are implemented at national level as detailed in b above.

A critical aspect of the strategy is the integration of national and regional CWR conservation actions. This requires the inclusion of regional priority species in national CWR conservation planning. European nations should have an obligation to monitor/conserve populations of these species, whether nationally threatened or not. This approach will require a regional authoritative body to oversee its implementation; therefore, the practicalities of implementing this integration need to be addressed and incorporated into European policy on agrobiodiversity conservation. As no European legislation with a focus on CWR conservation currently exists, there is at present no means of enforcing this obligation on EU member states or those European countries not within the EU. Emphasis therefore needs to be placed on the development of a clear regional policy on CWR conservation with buy-in from national PGR programmes throughout the region.

In relation to the policy aspects of the integrated European CWR conservation strategy, there are a number of other practical issues to consider, including the creation of a regional network of MAWPs that combines priority populations at regional and national levels, how to ensure the success of conservation actions that depend on cross-border cooperation, and the need for a central coordinating body to collect reports on the conservation of priority CWR resources.

The integrated European CWR conservation strategy will require periodic review and updating according to future developments in CWR conservation and utilization science and practice, as well as regional agrobiodiversity conservation policy. For example, the initial strategy may be developed to include other socio-economically important (non-food) crops in Europe, particularly when a number of national CWR conservation strategies are available for review and comparison and in which particular non-food crop gene pools may be highlighted as priorities across the region. The planning and implementation of the initial strategy can act as a blueprint for the inclusion of further crop gene pools. Continual monitoring of the implementation of the strategy will be required to highlight aspects requiring adaptation in the future.

The integrated CWR conservation strategy for Europe will be driven by EU and national policy on conservation and utilization of plant genetic resources for food and agriculture (PGRFA) and implemented at national level (Maxted *et al.*, 2013). The purpose of the integrated strategy is to preserve CWR genetic resources for use in crop improvement—in particular, to provide a wide pool of diversity as insurance against the negative impacts of climate change on crop production.

Therefore, a fundamental element of the strategy is making conserved CWR germplasm available to the user community and to achieve this, the interface between *in situ*, *ex situ* and use of CWR conservation needs to be strengthened. Planning and implementing *in situ* conservation of CWR in Europe is an iterative process requiring periodic review and updating as CWR conservation and utilization policy, science and practice develops. Promoting awareness of the value of CWR to food and economic security, as well as raising additional funding, will be critical to support this process and ensure long-term *in situ* CWR conservation in Europe (Maxted *et al*., 2013). As highlighted in Box 1, the integrated European CWR conservation strategy will have practical and policy implications that will require further development by the relevant players beyond the lifetime of the PGR Secure project.

A comprehensive complementary regional CWR conservation strategy has been drafted and will be published on the PGR Secure website in December 2014 (Kell, Maxted and contributors, 2014). This document comprises the national (Task 3.2), regional (Task 3.3) and integrated (Task 3.4) approaches to CWR conservation in Europe and will include recommendations for a proposed regional network of genetic reserves and germplasm collection and *ex situ* conservation needs for Europe's priority CWR species.

WP3: Deviations from Annex I

The objective of Task 3.1 is to provide support for the production of CWR NIs in European countries and to begin the process of creating a European CWR inventory based on the NIs. The production of the NI is one essential step in the process of developing a national CWR conservation strategy—we have taken this task further by encouraging and providing support for the development of national CWR conservation strategies. This deviation has strengthened the outputs and added value to the project.

The Consortium is contracted to develop national CWR conservation strategies for Finland, Italy and Spain. In addition, strategies for Albania, Bulgaria, Cyprus, the Czech Republic, Norway and the UK have been developed or initiated, in part with project funds but also with the addition of funding from other sources as well as student and volunteer time. The addition of these national CWR conservation strategies have strengthened the outputs and added value to the project.

Some deliverables and milestones have been submitted/achieved later than planned, but these delays have not impacted on the overall workplan.

2.2.4 WP4: LR conservation (WP leader: Valeria Negri, UNIPG)

Task 4.1: European LR inventory. Partners involved: UOB, BIOVER, UNIPG, MTT

In spite of having prepared relevant tools for the accomplishment of the work at European level (i.e., Deliverables 4.6 and 4.7), lack of dedicated funding for each European country hampered the possibility of completing a European inventory. Inventory data were obtained only for Finland and Italy.

142 LR were inventoried in Finland and 4806 accessions belonging to 2365 LR were inventoried in Italy (see below). For these countries the inventorying work is completed.

Task 4.2: Exemplar national LR conservation strategies. Partners involved: UNIPG, MTT, UOB

4.2.1 Italy national LR conservation strategy (UNIPG)

During the current reporting period, and in order to develop the Italian strategy for LR conservation, a review of the literature and of case studies was carried out to identify present constraints to LR conservation (in international and national contexts), and LR data gathered during the project were analysed.

The review of the international context showed the need to address the obligations of Italy and the EU under the Convention on Biological Diversity (CBD) (SCBD, 1992), the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) (FAO, 2001) and the Second Global Plan of Action for Plant Genetic Resources (GPA) (FAO, 2011). It also showed that there is the possibility of registering LR into the Common Catalogue of varieties as 'conservation varieties' and consequently overcome one of the main limitations to their continued cultivation—their seed commercialization.

To meet its obligations under these international agreements, Italy has a National Plan for Agro-biodiversity conservation (Fig. 3) and has drafted specific Guidelines for the Conservation of Genetic Resources for Food and Agriculture (www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/305). A summary of these guidelines was submitted by the Italian government to the ITPGRFA for the implementation of Article 6 (www.planttreaty.org/sites/default/files/Submission_Italy.pdf) with a focus on PGRFA.

Both documents are downloadable from the PGR Secure LR helpdesk (www.pgrsecure.org/helpdesk_lr).

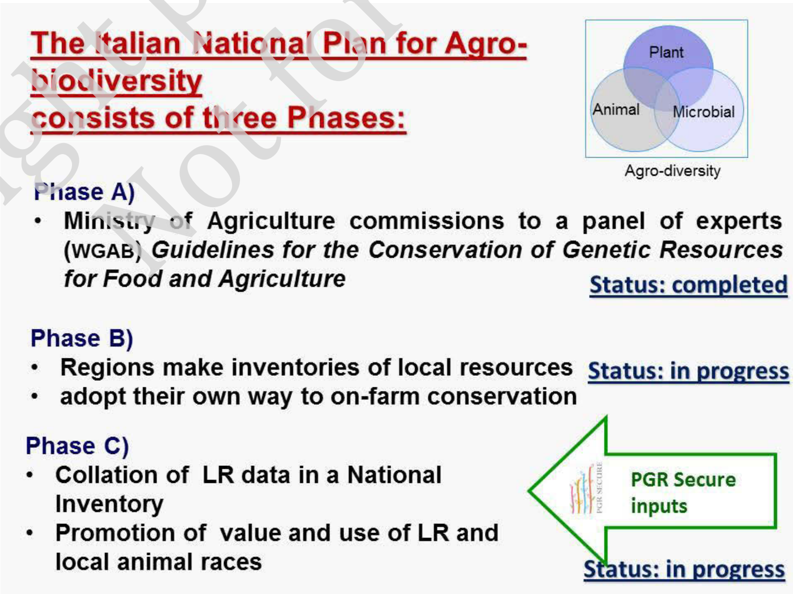

Figure 3. The three phases of the Italian National Plan for Agro-biodiversity

The Guidelines focus on *in situ* (on-farm) conservation of LR. The analysis of several case studies and available literature carried out during this period showed that this is motivated by the fact that many typical Italian products are based on the cultivation of LR, which is often profitable for farmers. The strict link between a LR and its territory, and the people and diversity of the landscape, has *de facto* favoured the maintenance of LR cultivation in the country.

The main steps in the Italian approach to *in situ* (on-farm) LR conservation are identified by the Guidelines as follows:

1. Collection of information on existing LR (inventory) and collection of propagation material for *ex situ* backup and for characterization;
2. Identification of the priority areas to be allocated for *in situ* (on-farm) conservation (i.e., the choice of areas to implement this activity, with priority on the promotion, organization and monitoring of activities);
3. Characterization and assessment of the distinctiveness of local varieties;
4. Assessment of population size and genetic structure of local varieties maintained *in situ* (on-farm);
5. Monitoring the effectiveness of *in situ*/on-farm conservation (periodic assessment of the maintenance of an adequate level of genetic diversity and absence of genetic erosion);
6. Set up and operation of an information system for work related to *in situ* (on-farm) conservation.

PGR Secure has initially contributed to the National Plan for Agro-biodiversity conservation with the compilation of the First Inventory of *In Situ* Maintained Landraces (Negri *et al*., 2013 – http://vnr.unipg.it/PGRSecure/start.html).

Following step 2 of the Italian Guidelines for the Conservation of Genetic Resources for Food and Agriculture (i.e., the identification of the priority areas to be allocated for *in situ* (on-farm) conservation), the Italian Most Appropriate Areas (MAPAs) for conservation were also identified. These areas were defined on the basis of three criteria (Negri *et al*., 2012a): 1) the highest LR density and diversity, 2) the level of agro-ecosystem diversity, and 3) the number of protected areas. MAPAs can be proposed to the National or Regional Authorities as areas in which to set up or enhance political and economic actions in favour of priority LR and agrobiodiversity conservation (Negri *et al*., 2012a).

The approach used to identify these areas is the same proposed and tested in the previous EC-funded project AEGRO (AGRIGENRES 870/2004, Agreement n. 057 – see Negri *et al*., 2012a). The Italian territory was initially divided into 20 x 20 km^2 areas. Subsequently, to apply each one of the above-mentioned criteria, the following indices were calculated per area: 1) the number of LR and the LR Shannon Diversity Index, 2) the percentage of land belonging to agricultural areas, forests and semi-natural areas, wetlands and water bodies, and 3) the percentage of land covered by protected areas.

Finally, the areas were prioritized following two prioritization strategies: a Restrictive Strategy and an Additive Strategy. In the Restrictive Strategy the criteria were applied in sequence, and for each index a threshold was defined below which areas were not admitted to the following level. The passage from one step to the next took place after having excluded the quadrants with a value lower than that of the thresholds. The Additive Strategy applied the same criteria but a score for each criterion was assigned in proportion to the index value and values added each other for each quadrant. A representative threshold was then established for prioritizing the MAPAs.

Using the Restrictive Strategy, 53 MAPAs were prioritized, which are mainly located in the Regions of Lazio, Abruzzo, Molise, Umbria and Basilicata. The Additive Strategy prioritized 123 MAPAs which are located also in different Regions.

During the current project period, as a further contribution to define the future Italian strategy for LR, a gap analysis was carried out by matching LR occurrences of Italian origin recorded in EURISCO with data included in the above-mentioned First Inventory of In situ Maintained Landraces of Italy (Negri *et al*., 2013). This showed that most of the LR inventoried in Italy (97.4%) have no matching record in EURISCO and seem not to be conserved in the main genebanks. In particular, for the target crops, out of the 88 LR that were recorded *in situ*, only 44 (50%) are also conserved *ex situ*.

Based on all data and information collected, the main constraints for the Italian approach to *in situ* (on-farm) LR conservation were identified as follows:

- Not all extant LR have been officially inventoried;
- Most of them need to be safely duplicated *ex situ*;
- There is a general lack of appropriate *in situ* (on-farm) conservation actions for those LR that have scarce possibilities to reach the market (home garden crop LR);
- LR use, on which *in situ* (on-farm) conservation should rely, is not sufficiently promoted.

A strategic approach to conservation of Italian LR was finally identified (see also D4.2 at www.pgrsecure.bham.ac.uk/sites/default/files/documents/deliverables/D4.2_IT_landrace_conservation_strategy.pdf) which recommends that public bodies responsible for LR conservation should:

- Increase their responsibility and complete the national inventory and continuously update it;
- Promote safe backup of LR in public *ex situ* collections;
- Increase their coordination in developing and implementing measures for LR conservation and use;
- Develop specific conservation actions for home garden LR (i.e., horticultural crop LR) which are fundamental PGR for the Italian economy and future food security, while being the type of LR under major threat;
- Provide adequate funds for *ex situ* and *in situ* (on-farm) conservation and, for the latter, as requested by the Italian Guidelines for the Conservation of Genetic Resources for Food and Agriculture, initially concentrate efforts on the most threatened LR and on MAPAs;
- Support research aimed to understand the level of genetic diversity which characterize LR, how LR populations evolve on-farm under different climatic constraints and management systems,

and to identify genes that underpin evolution and key genetic traits for robustness (e.g., resistance against biotic and abiotic stresses, adaptation to local conditions) and quality;

- Promote the registration of LR as ‘conservation varieties’.

In addition, the strategy concludes that public and private stakeholders should:

- Promote the use of home garden LR in community and home gardens;
- Promote the awarding of quality marks for products coming from LR;
- Better promote typical, local products derived from LR;
- Promote local economies based on locally sourced products obtained from LR;
- Promote the use of LR in formal and participatory plant breeding programmes.

4.2.2 Finland national LR conservation strategy (MTT)

During the current reporting period, *in situ* LR inventory data were compiled following the format of the Descriptors for Web-Enabled National *In Situ* Landrace Inventories (Negri *et al*., 2012b). During the project, 139 LR maintained *in situ* were identified and verified (Table 2). LR verification using morphological and/or DNA analysis is required before recording the LR inventory data.

Table 2. Number of identified and verified LR maintained on-farm/in garden in Finland

Crop vernacular name	Scientific name	Total no. of *in situ* accessions	No. registered as conservation varieties	Accepted for inclusion in the Finnish Plant Variety List
Potato onion	*Allium cepa* Aggregatum Group	41[11]	0	0
Oat	*Avena sativa*	2	1	0
Swede	*Brassica rapa* var. *napobrassica*	2	0	1
Turnip[12]	*Brassica rapa* subsp. *rapa*	1	1	0
Barley	*Hordeum vulgare*	1	1	0
Apple	*Malus domestica*	56[13]	0	0
Timothy	*Phleum pratense*	2	0	2
Rye	*Secale cereale*	22[14]	8	1
Potato	*Solanum tuberosum*	2	0	1
Red and white clover	*Trifolium spp.*	10	7	3

Except for some potato onions *in situ*, all inventoried LR are extant in their original area and no duplicated samples are included. Many of the seed propagated LR are registered as conservation

[11] Includes several clones
[12] In slash-and-burn cultivation
[13] These are mother trees or old clones—one accession per local variety. In total, we identified about 100 LR apple varieties. Approximately 50 samples are still under variety verification using morphological analysis and DNA-fingerprinting.
[14] Includes some duplicates (i.e., the same LR is cultivated in two or three farms)

varieties (27) and many LR apples are distributed by nurseries. Therefore, most of them are also cultivated in some other areas in Finland as introduced LR.

The draft *in situ* LR conservation strategy report for Finland was circulated and discussed with the relevant national PGR experts. The final report (Heinonen and contributors, 2014) is published in the MTT report series.

4.2.3 UK national LR conservation strategy (UOB)

Initial progress towards producing a UK LR inventory was made prior to the commencement of PGR Secure. However, completion of the full UK inventory and strategy is dependent upon obtaining further substantial funding. An application was submitted to the UK government and indications were that it would be successful. However, negotiations have been protracted and changes in management at UK Defra resulted in the allocated of promised funding being withdrawn. In the meantime, through collaborative research projects, significant progress has been made on surveys of allotment-holdings in the West Midlands, Gloucestershire, Essex and Gloucestershire regions of the UK. A consolidated report of progress in the development of the UK national LR conservation strategy to date (D4.3) is published on the PGR Secure website (www.pgrsecure.bham.ac.uk/sites/default/files/documents/deliverables/D4.3_UK_landrace_conservation_strategy.pdf).

Task 4.3: European LR priority gene pool (Avena, Beta Brassica and Medicago) analysis and specific European conservation strategy. Partners involved: UNIPG, MTT, UOB

During the current reporting period and based on available inventory and ecogeographic diversity data and discussions among involved project partners (which was carried out through Skype and personal meetings), a European specific LR conservation strategy for target crops was outlined (see www.pgrsecure.bham.ac.uk/sites/default/files/documents/helpdesk/D4.4_European_specific_LR_conservation_strategy.pdf). The main requirement highlighted in the strategy is for the compilation of detailed national and European inventories of target crop LR that are maintained *in situ* (on-farm).

The national *in situ* maintained LR inventories will serve to:

- Target materials for collection that are not already present in *ex situ* collections;
- Promote the use LR in agriculture as a means of enacting *in situ* (on-farm) conservation;
- Promote the use of LR in formal and participatory plant breeding;
- Identify research needs to increase knowledge of LR diversity (e.g., within- and among- genetic diversity levels; *in situ* genetic diversity evolution under changing climatic conditions; levels of genetic diversity that can be maintained under different agro-ecosystems; different management systems; socio-economic factors that drive conservation);
- Identify agrobiodiversity hotspots (Most Appropriate Areas) for conservation activities;
- Compile a LR European inventory by merging country data.

The development of a European LR inventory will:

- Allow the assessment of progress in the implementation of the actions required under the GPA (FAO, 2011);
- Facilitate cooperation among European countries;
- Facilitate cooperation among the formal sector and the networks of farmers and farmer organizations;
- Provide a useful example to develop *in situ* LR conservation actions in other regions.

The strategy also points out the need to: a) promote better integration between *ex situ* and *in situ* (on-farm) conservation of LR (i.e., between the formal sector, which holds LR collections and farmers/farmer networks that need LR material for introduction or re-introduction activities), b) raise awareness, and c) raise appropriate funds for *in situ* (on-farm) conservation of LR.

Task 4.4 Generic European LR conservation strategy. Partners involved: UNIPG, MTT, UOB

During the current reporting period, a generic European LR conservation strategy was developed which recommends conservation and use enhancement actions that are immediate priorities.

It was initially recognized among the involved project partners that a European strategy should be based on the main recommendations from i) the European continental perspective and ii) the national perspective of the exemplar countries.

The recommendations included in the documents 'European specific LR conservation strategy for target crops' (D4.4) and the 'Present constraints and opportunities for LR *in situ* (on-farm/in garden) wider cultivation in Europe' (www.nordgen.org/ngdoc/plants/Samarbeten_och_natverk/PGR_secure_workshop2013/5_LR_Conservation.pdf) were used to inform the European strategy. In addition, the recommendations included in the 'The ECPGR concept for *in situ* (on-farm) conservation in Europe' (www.pgrsecure.org/documents/OnFarm_Conservation_Concept.pdf) were considered. This document was prepared during the PGR Secure lifetime on the request of the ECPGR Steering Committee and involved Paul Freudenthaler, Fuad Gasi, Isabelle Goldringer, Pedro Mendes Moreira, Silvia Strãjeru, Ayfer Tan, Merja Veteläinen, Rudolf Voegel and Jens Weibull as co-authors.

The recommendations from the national perspectives of Finland, Italy and UK (Deliverables 4.1, 4.2 and 4.3), which represent different situations across Europe for pedo-climatic conditions, LR on-farm diversity and socio-economic context, were also used to inform the European strategy.

Common recommendations arising from both the European continental and national perspectives were considered to be the best structure of a future European conservation LR strategy.

A draft document was initially prepared and circulated among the project partners for comments and improvements.

The European LR conservation strategy (www.pgrsecure.bham.ac.uk/sites/default/files/documents/deliverables/D4.5_European_generic_LR_conservation_strategy.pdf) includes recommendations for both conservation and use enhancement actions:

Conservation actions

- Educate and raise public awareness of local LR diversity;
- Compile a European LR inventory and continuously update it;
- Safely backup LR populations in *ex situ* collections;
- Promote LR reintroduction from genebanks to cultivation on-farm;
- Increase European coordination in developing and implementing measures for LR conservation;
- Make available adequate funds for LR *ex situ* and *in situ* (on-farm) conservation actions;
- Make available adequate funds for carrying out research into LR diversity in the context of climate change and unpredictability.

Enhancement of the LR use

- Promote the use of home garden LR in community and home gardens;
- Promote the registration of LR as 'conservation varieties';
- Promote the awarding of quality marks for products coming from LR;
- Promote typical, local products coming from LR;
- Carry out campaigns aimed to promote local economies based on locally sourced products derived from LR;
- Stimulate the use of LR in formal and participatory plant breeding programmes, especially those aimed at creating varieties suitable to environmentally friendly agronomic systems.

A European LR conservation strategy will have practical and policy implications that will require further development by the relevant players beyond the lifetime of the PGR Secure project.

WP4: Deviations from Annex I

Some deliverables and milestones have been submitted/achieved later than planned, but these delays have not impacted on the overall workplan.

2.2.5 WP5: Engaging the user community (WP leader: Chris Kik, DLO)

Task 5.1: Identifying European stakeholders in the PGR conservation and use community. Partners involved: DLO, JKI, NordGen

The implementation of PGR-COMNET (www.pgrsecure.org/pgr-comnet; pgrsecure.jki.bund.de)—a stakeholder network and online map of European institutions involved in PGR conservation and use—was described in the second periodic report (D5.6). Since its launch on August 29th, 2013, PGR-COMNET's content has been expanded and updated on a regular basis and currently harbours 462 institutions.

Task 5.2: SWOT analysis of European PGR conservation and use community needs to promote CWR and LR use. Partners involved: DLO, JKI, NordGen

During the final project period, an input paper for the stakeholder workshop was finalized (D5.4). Data collected in semi-structured interviews and an online questionnaire directed at stakeholders from all over Europe (described in the previous reports) were summarized in this input paper and used to identify internal (strengths and weaknesses) and external (opportunities and threats) factors affecting the state of conservation and use of PGR in Europe. In addition, in this input paper we describe what we consider the target states of the European plant germplasm system and suggest strategies on how the target states can best be reached. Also, individual country/regional reports are included. Before distribution to the workshop participants, the input paper was sent to the PGR Secure Breeders' Committee for feedback. The input paper is publically available and can be downloaded from the workshop homepage (www.nordgen.org/index.php/en/content/view/full/2481/), where also a programme, participant list and general information about the workshop can be found.

The WP5 team organized a stakeholder workshop entitled 'On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis' in Wageningen in November 2013. Stakeholders representing the PGR sector were invited to the workshop to discuss the constraints in the conservation and use of PGR in Europe. More than 80 participants from 21 European countries attended the workshop, representing stakeholders from the five different stakeholder groups: genebanks, public research institutes, breeding companies, agro-NGOs, and policy-makers/governments. Two of the workshop days were devoted to discussions of the SWOT analysis: of the strengths, weaknesses, opportunities and threats, as well as the target states and the best strategies to reach these target states. The discussions were extremely productive and substantial feedback was received on the analysis presented in the input paper. Results of the workshop have been channelled into a final report on the constraints of conservation and use of PGR in Europe and how it could be improved (D5.5). It is publically available together with a policy paper on the same theme (www.nordgen.org/index.php/en/Plants/Innehaall/Workshops-Conferences/Plant-Genetic-Resource-Workshop-2013/Final-report).

A second goal of the stakeholder workshop was to communicate the results of the PGR Secure project and a half day was therefore devoted to delivering reports on WPs 1–4. The following talks were presented: 'Introduction to the PGR Secure project'; 'Novel characterization techniques: the phenomics and genomics approach'; 'Novel characterization techniques: the predictive characterization approach'; 'A strategy for European crop wild relative diversity conservation'; 'Landrace conservation'; 'Informatics: Plant Genetic Resources Diversity Gateway'. In addition, a side event was arranged to give the participants the opportunity to test the Plant Genetic Resources Diversity Gateway and to give feedback.

Task 5.3: Create opportunities to develop new partnerships between CWR and LR conservationists and breeders in Europe. Partners involved: DLO, JKI, NordGen

A third goal of the stakeholder workshop was to promote partnerships between the workshop participants from different stakeholder groups and countries. A stakeholder market day was organized by the WP5 team at the workshop with the aim of establishing new or renewed partnerships and potential future cooperation among the participants. In preparation for the market day, workshop participants were asked to express their specific interests in future partnerships and cooperation. Nearly 100 requests were collected in advance and organized according to stakeholder groups. The participants were also asked to show posters representing their institutions. Partnership requests and posters were displayed during five market sessions to promote new, or to renew partnerships among the participants. After the sessions, the participants gave feedback on the stakeholder market day by providing information on their partnerships or potential cooperation established. The replies were categorized into six clusters of interests: 1) *ex situ* conservation (eight consortia, each representing two to five partners); 2) *in situ* conservation (two consortia, each representing two to four partners); 3) on-farm management (three consortia, each representing three to four partners); 4) characterization and evaluation (five consortia, each representing two to three partners); 5) (pre-)breeding (five consortia, each representing two to four partners); and 6) knowledge transfer (five consortia, each representing two to five partners). The clusters were further analysed according to the specific subjects, methods and species the partners are interested in. About three months after the workshop, the stakeholder market day participants were asked to give further feedback on the status of their partnerships. Out of 26 partnerships or potential cooperations being asked, replies from 13 consortia were collected. There was generally positive feedback on the stakeholder market, and many respondents stated that they had been able to establish contacts to colleagues through this event. Since then, most respondents have been in contact with their partners or will soon meet at upcoming workshops or conferences. Some of the respondents are already planning future cooperations like the preparation of joint Horizon 2020 project proposals (D5.7).

The workshop participants unanimously stressed the need for PGR information systems allowing easy access to a wide range of high quality data. The data quality can be increased if characterization and evaluation data are recorded following the single observation concept (raw data) and usefulness of the data can be improved by combining PGR information systems with those operated by the genomics research sector. Finally, data should be made publicly available in web-based information systems accessible through a single entry point. JKI approached stakeholders interested in a partnership to set up such an integrated European information system and network for beet genetic resources. This resulted in a proposal for a respective COST Action submitted in March 2014.

Task 5.4: Prebreeding – channelling potential interesting germplasm into breeding programmes. Partners involved: DLO, UOB

The WP5 team collaborated with Ben Vosman (WP1 lead beneficiary) in the production of a list of European companies involved in brassica crop improvement. Information on germplasm and molecular markers identified in WP1 was sent to these companies by Ben Vosman (see D5.2 and D5.8).

WP5: Deviations from Annex I

Some deliverables and milestones have been submitted/achieved later than planned, but these delays have not impacted on the overall workplan.

2.2.6 WP6: Dissemination and training (WP leader: Ehsan Dulloo, BIOVER)

Task 6.1: Website for PGR Secure. Task leader: UOB. Partners involved: UOB, BIOVER

The project website (www.pgrsecure.org) and partner intranet have been periodically updated as required by Partner 1, UOB. New web pages were created for the final dissemination conference to provide access to information about the conference objectives, themes and programme, abstract submission and registration, logistical information and events, sponsors, potential sources of funding for participants from developing countries, and information about guest speakers and the conference organizing and scientific programme committees. Access to some of this content (which is no longer required) has now been disabled. A page providing access to presentations given at the conference has been added. The book of abstracts is also available for download.

In the partner intranet, information about project and associated meetings has been updated, and the contract and reporting and deliverables and milestones pages (and all associated documents) have been updated as required.

Task 6.2: Web-enabled Europe-wide inventories of CWR and LR diversity. Task leader: BIOVER. Partners involved: UOB, BIOVER, UNIPG, JKI, MTT, URJC

The Task 6.2 activities are also linked to Tasks 6.3 and 2.1 (development of the PGR Diversity Gateway), as well as to Tasks 3.1–3.4 and 4.1–4.4 as the CWR and LR information management models provide the essential backbone to the development of national and European CWR and LR conservation strategies.

The Spanish, United Kingdom and Finnish CWR checklists/inventories have been web-enabled and links to other CWR and LR national inventories have been established as follows:

- CWR national inventories: Armenia, Benin, Bolivia, Germany, Guatemala, Ireland, Madagascar, Sri Lanka, Switzerland, United Kingdom, United States of America.
- Landrace national inventories: Austria, Germany, United Kingdom.

All these can be viewed from http://pgrdiversity.bioversityinternational.org/National_Inventories.

In addition to the national inventories/checklists, three CWR national conservation strategies have been uploaded to the system: Finland, Italy and Spain (http://pgrdiversity.bioversityinternational.org/Conservation_Strategies), as well as one regional landrace conservation strategy (http://pgrdiversity.bioversityinternational.org/API/?view=cGRmL0NvbnNlcnZhdGlvbl9TdHJhdGVnaWVzL0xhbmRyYWNlcy9SZWdpb25hbCBTdHJhdGVnaWVzL0Q0LjRfRXVyb3BlYW5fc3BlY2lmaWNfTFJfY29uc2VydmF0aW9uX3N0cmF0ZWd5LnBkZg==).

Task 6.3: Web-enabled Trait Information Portal. Task leader: BIOVER. Partners involved: UOB, DLO, BIOVER, JKI, NordGen

The web-enabling of the PGR Diversity Gateway (the new name for the Trait Information Portal as of August 2013)[15] has involved the creation of the search functionalities for the trait search, and for

[15] Based on a recommendation of the second annual consortium meeting and project mid-term review held in Cyprus in October 2012, it was decided that the name of the TIP should be changed to better reflect the nature of the information (i.e. both traits and conservation status of CWR and LR) contained therein. In consultation with the consortium, the TIP

searching other data domains such as passport, landraces, checklist and taxonomy. A Data Sharing Agreement (DSA) has been finalized and will be available to data providers and the PGR Secure consortium along with terms of use of the data and the website.

Links to other information systems have been implemented and can be searched through the links page at http://pgrdiversity.bioversityinternational.org/Links. Currently, links to the following databases are available: European *Avena* Database (EADB); International Database for Beta (IDBB); The ECPGR *Brassica* Database; the Crop Wild Relative Information System (CWRIS); European Native Seed Conservation Network (ENSCONET); EURISCO; Genesys; The ECPGR Annual and Perennial *Medicago* Databases; and AEGRO Population Level Information System (PLIS).

Task 6.4: Publications. Task leader: BIOVER. Involved partners: all partners

Newsletters

Partner 1 (UOB) edited, produced and published *Crop wild relative* Issues 9 in October 2013 (www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_9.pdf) and Issue 10 will be published in November 2014 at www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_10.pdf). Issue 9 highlights the considerable progress made in CWR conservation strategy planning in the Czech Republic, Finland, Spain, Sweden, Cyprus and Norway, as well as publicizing work undertaken outside the region, such as in China and Egypt. Articles on the utilization of CWR are also included. Issue 10 focuses on publicizing the PGR Secure project products and achievements.

Issue 2 of the sister newsletter, *Landraces* was edited, produced and published by Partner 4, UNIPG with assistance from Partner 1, UOB and was published on the project website in October 2013 (www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/Landraces_Issue_2.pdf). This issue includes: i) information on national and regional actions in favour of LR conservation; ii) the first Italian official inventory of LR; iii) a contribution on new a niche product developed in Finland based on a barley landrace; iv) European experiences concerning LR inventorying, characterization and use; v) two articles concerning LR conservation outside Europe. *Landraces* Issue 3, which will be published in late December 2014 at www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/Landraces_Issue_3.pdf, focuses on the Italian and European LR conservation strategies developed during the PGR Secure project. This issue will include: i) three articles regarding LR diversity *in situ* (on-farm) conservation strategies in Finland, Italy and the UK; ii) some examples of LR grown in Italy; iii) two articles concerning common bean and olive tree LR grown in Portugal.

Other publications

Publications which are direct products of the work undertaken in the PGR Secure project are listed in Appendix 1. Publications that are closely related and therefore of relevance to the project are listed in Appendix 2.

name was changed to 'Plant Genetic Resource Diversity Gateway for the conservation and use of crop wild relative and landrace traits', shortened to 'PGR Diversity Gateway'.

Task 6.6: Dissemination conference. Task leader: BIOVER. Involved partners: UOB and BIOVER

During the final project period, the conference organizing committee (OC) met regularly to review progress and take executive decisions on the organization of the final dissemination conference. The project website was updated regularly to provide the most up to date information about the conference. The conference programme was reviewed and finalized and uploaded to the conference website. The lists of dignitaries for the opening ceremony and keynote speakers for the conference were also finalized.

Guidelines for abstract submission were prepared and the announcement was launched on 26 November 2013. NIAB Innovation Farm (the host organization) launched the registration website. The call for abstracts was sent to more than 500 people registered on the conference listserver and it was advertised on the conference website as well as through partners' websites, discussion fora, social media, blogs and on Twitter. An abstract submission tool was selected to manage the submission of abstracts for the conference. At the closing date, 141 abstracts for oral and poster presentations had been received. The scientific programme committee was solicited to review abstracts and make the final selection for the oral presentations and posters for each of the four themes of the conference.

The budget for the conference was prepared. It was estimated that around 120 people would attend the conference, and the budget was prepared based on this number of participants. Major costs included the main conference venue (Churchill College, University of Cambridge), conference proceedings, conference dinner and welcome reception, field trips and local transportation costs. Based on these costs, early bird and late conference fees of £470 and £510 respectively were set. Lower registration fees were provided for EUCARPIA members (£430/£470) and students (£400/£440).

Efforts were made to seek additional sponsorship for the conference, but with little success. Sponsorship letters as well as a document on sponsorship and exhibition opportunities were prepared and sent to about 60 potential donors. In addition to funding from the EU Seventh Framework Programme, sponsors of the conference were NIAB Innovation Farm, EUCARPIA, Graminor Ltd. (a plant-breeding company) and Limagrain (an international agricultural co-operative seed company) (see www.pgrsecure.org/conference_sponsors).

The specific objectives of the conference were to: 1) showcase innovative and potential novel characterization techniques and conservation strategies to identify and safeguard CWR and LR genetic diversity to increase potential options for crop improvement as a means of underpinning food security in the face of climate change; 2) to disseminate PGR Secure products to the European and global PGR community; and 3) to discuss their wider application and continued use. The conference brought together a wide range of biodiversity expertise from the international community to debate current and future enhanced conservation and use of CWR and LR diversity for improving agricultural production, increasing food security and sustaining the environment for better livelihoods.

A total of 140 participants from 42 countries, of which half were from outside Europe, attended the conference, making it a truly international conference. The conference comprised twelve sessions organized within four themes: 1) characterization techniques, 2) conservation strategies, 3) facilitating CWR and LR use and 4) informatics development. Fifty-nine oral presentations and 56 posters were shared under these themes. The full conference programme and book of abstracts can be consulted online at: www.pgrsecure.org/conference. A summary of the conference will be published in *Crop wild relative* Issue 10 in November 2014 (www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_10.pdf).

A round table discussion on the future of PGRFA conservation and use in Europe was convened in the final conference session. The session, 'Vision of future European PGRFA conservation/use' was organized to discuss issues important for the future of the European PGRFA conservation and use for the next 10 years. Chaired by Nigel Maxted (PGR Secure Project Coordinator, University of Birmingham), the panel comprised: Eva Thörn (Swedish University of Agricultural Sciences and Chair, EUCARPIA Genetic Resource section); Beat Boller (President, EUCARPIA); Brian Ford-Lloyd (Emeritus Professor, University of Birmingham); Jean-Louis Pham (Agropolis Fondation, France); and Lorenzo Maggioni (Coordinator, European Cooperative Programme for Plant Genetic Resources – ECPGR). Panelists were selected to represent plant breeders, PGRFA conservation/utilization researchers and policymakers. Representatives from the EC were invited but were not able to attend.

Each panelist was invited to give their views and the discussion was opened to the floor. The ensuing discussions brought forth viewpoints, expectations and outlooks, bottlenecks, coordination needs, the roles of European institutions, responsibilities of networks, and actions needed. The ultimate recommendation is that a facilitated and inclusive dialogue be pursued and continued by the stakeholders to address a number of key issues and challenges that were raised, including the need for:

- A more strategic approach to the conservation of plant genetic diversity, including greater collaboration between *ex situ* and *in situ* conservation professionals and improved links between the conservation and user communities, including farmers;
- Increased financial support for CWR and LR characterization and conservation which will require all stakeholders to develop a common strategy and to lobby for support from all sectors;
- Alternative solutions for transferring traits from CWR into crops, including the use of re-sequencing and functional analysis;
- Improved exchanges between stakeholders in different parts of the world, for example, by expanding concepts and strategies on how to conserve, access and use CWR and LR diversity developed in Europe to regions such as Africa and Asia;
- Consideration of the impact that legislation is likely to have on *in situ* CWR conservation;
- The development of a plant germplasm release system to store pre-breeding material and a journal to accept and publish this information;
- Improved communication on the importance of PGRFA, bringing together all stakeholders with one voice;
- Greater recognition of farmers as custodians of CWR and LR.

It was also recommended that it should now be possible to re-sequence ecogeographically diverse samples of priority CWR, given the current capability for whole genome sequencing. This challenge was based on examples given during the conference such as rice, barley and *Medicago,* which have all been successfully sequenced.

Participation in the conference exceeded expectations due to the high number of last minute registrations. This required re-organization of the main conference venue and revised catering services. The budget expenses were for: premises of NIAB Innovation Farm and Churchill College, conference dinner and welcome reception, lunches and breaks, proceedings, field trips, local transportation, keynote speakers, USB sticks, conference bags and materials, and logistics. Since the project did not have any budget line for the conference, the biggest challenge was to secure sufficient funds to cover all conference expenses. However, the conference succeeded in breaking even.

The conference proceedings will be a book published by CABI entitled 'Enhancing Crop Genepool Utilization: Capturing wild relative and landrace diversity for crop improvement', edited by Nigel Maxted, Ehsan Dulloo and Brian Ford-Lloyd. The book aims to include about 60 papers from the presentations given at the conference and will be published in 2015.

Associated with the conference, live exhibits of CWR and landraces provided by PGR Secure project partners were presented in NIAB Innovation Farm demonstration plots and glasshouses (for further information, see item in *Crop wild relative* Issue 10 (www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_10.pdf). Information about the PGR Secure project and the exhibits was published in NIAB Innovation Farm's annual visitor guide. Handouts on the exhibits were prepared and provided in print to visitors to NIAB Innovation Farm, as well as in electronic format to the conference delegates along with other conference materials on a flash drive.

Two conference field trips were organized for participants to visit the John Innes Centre in Norwich and the Minsmere Nature Reserve in Suffolk. A traditional English dinner in the historical 16th century hall of St. John's College and world food party for tasting PGR from participating countries were also organized.

WP6: Deviations from Annex I

The project website is being hosted by UOB instead of Bioversity because of costs associated with hosting it at Bioversity. Some deliverables and milestones have been submitted/achieved later than planned, but these delays have not impacted on the overall workplan.

2.2.7 Compliance with the Ethics Review

None of the ethical issues related to research on humans, human embryo/foetus, privacy, research on animals, research involving developing countries, or dual use applied throughout the PGR Secure action as the project research was only on CWR and LR (plant species) conservation and characterization and the promotion of conserved germplasm use by the European stakeholder community.

2.3 Project management

2.3.1 Consortium management tasks and achievements during the period

Management tasks and achievements of the Coordinator

As specified by Article II.2.3 of the Grant Agreement (GA), the Coordinator (UOB) has:

a) Administered the financial contribution of the EU regarding its allocation between beneficiaries and activities in accordance with the GA and the decisions taken by the Consortium Committee[16];

b) Ensured that all the appropriate payments due in the current period have been made to the other beneficiaries;

c) Kept the records and financial accounts making it possible to determine at any time what portion of the financial contribution of the EU has been paid to each beneficiary for the purposes of the project;

d) Informed the Commission of the distribution of the financial contribution of the EU and the date of transfers to the beneficiaries, as required by the GA and by the Commission;

e) Monitored the compliance by beneficiaries with their obligations under the GA.

As specified by Article II.16.5 of the GA, during the current period the Coordinator has:

- Updated attachment 5 of the Consortium Agreement (list of members and other contact persons) as required;
- Carried out the overall legal, ethical, financial and administrative management of the project;
- Carried out other general project management activities; including:
  - Coordinating the production of the second and third periodic reports (to months 30 and 42 – D7.2 and D7.3) and fourth interim report (to month 36);
  - Organizing and writing a report of a meeting of the Consortium Committee, 25 November 2013, Wageningen, the Netherlands and the third annual consortium meeting (including the meeting of the Consortium Committee and External Advisory Board (EAB));
  - Updating the project's dissemination, capacity building and exit strategies;
  - Updating the password protected partner intranet which contains details of project meetings as well as contractual and reporting information;
  - Maintaining regular communication with/providing advice to the Consortium Committee on matters related to project management, contractual obligations and reporting;

[16] The Consortium Committee is the executive body of the project responsible for overseeing the managerial and financial operation of the project. It is chaired by the Project Coordinator (Dr. Nigel Maxted) and its members are representatives of each beneficiary organization plus the Chair of the EAB and the Project Manager. As defined by the CA, the Consortium Committee is the ultimate decision making body of the Consortium.

– Maintaining regular communication with the members of the project's EAB and facilitating their participation at the third annual consortium meeting;

– Communicating with the EC Project Officer, Financial Officer and Legal Officer on behalf of the Consortium on matters related to reporting, reimbursement of costs and a contract amendment.

Management tasks and achievements of the rest of the Consortium

In addition to management tasks undertaken by the Coordinator, the other members of the Consortium Committee have:

- Contributed to the preparation of agendas for the interim Consortium Committee meeting and third annual consortium meeting;
- Attended the interim Consortium Committee meeting (in association with the Stakeholder Workshop) and third annual consortium meeting to discuss and agree on managerial and financial operation of the project;
- Contributed to the reports of the interim Consortium Committee meeting and third annual consortium meeting;
- Contributed to the project's dissemination, capacity building and exit strategies;
- Prepared financial reports for the second period and explanations of use of resources for the fourth (to month 36) internal interim report;

2.3.2 Problems which have occurred and how they were solved or envisaged solutions

No problems arose during the final project period.

2.3.3 Changes in the Consortium

Participant 4, UNIPG: change of contact for receipt of notices and address.

2.3.4 List of project meetings, dates and venues

- PGR Secure third Breeders' Committee meeting, 05 November 2013, Bonn, Germany
- PGR Secure Consortium Committee meeting, 25 November 2013, Wageningen, the Netherlands
- PGR Secure stakeholder workshop: 'On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis', 26–28 November 2013, Wageningen, the Netherlands
- PGR Secure third annual consortium meeting, 16 June 2014, NIAB Innovation Farm, Cambridge, UK
- Joint PGR Secure/EUCARPIA conference, 'Enhanced Genepool Utilization – Capturing wild relative and landrace diversity for crop improvement', incorporating the PGR Secure final dissemination conference, 16–20 June 2014, NIAB Innovation Farm and Churchill College, Cambridge, UK

Further information about project meetings, including reports and presentations, can be found in the partner intranet: www.pgrsecure.org/project_meetings. Information on PGR Secure dissemination at non-project meetings is also available: www.pgrsecure.org/associated_meetings.

2.3.5 Project planning and status

The project tasks are proceeding as planned (see Table 6 of Annex I to the Grant Agreement – GANTT chart indicating timing of the different WPs and their components); however, some of the deliverables and milestones are expected to be submitted/achieved later than planned (see Section 2.3.6).

2.3.6 Impact of possible deviations from the planned deliverables and milestones

There are currently no foreseen significant deviations from the planned deliverables and milestones. However, some of the deliverables and milestones have been submitted/achieved later than planned (see Section 3, deliverables and milestones tables). These delays have not had any significant impact on meeting the overall project objectives.

2.4 Person-months used per WP and per partner

The person-months (PMs) planned[17], actual[18] and remaining[19] per WP and per partner for the project duration are shown in Table 3.

Table 3. PMs planned (grey shaded), actual (no shading) and remaining (black) per WP and per partner

Partner	1 UOB	2 DLO	3 BIOVER	4 UNIPG	5 JKI	6 NORDGEN	7 MTT	8 URJC	9 SXS	10 UNOTT	WP totals	Notes
	38.00	58.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	5.00	**113.00**	
WP 1	37.11	78.14	0.16	0.00	0.00	0.00	0.00	0.00	8.28	10.88	**134.57**	
	0.89	-20.14	-0.16	0.00	0.00	0.00	0.00	0.00	3.72	-5.88	**-21.57**	
	1.10	0.40	20.00	1.00	0.50	1.00	1.00	1.60	1.20	0.50	**28.30**	
WP 2	0.23	3.68	25.60	0.01	0.00	0.00	0.90	3.93	0.00	0.00	**34.35**	
	0.87	-3.28	-5.60	0.99	0.50	1.00	0.10	-2.33	1.20	0.50	**-6.06**	
	14.00	0.00	2.00	12.00	0.00	0.00	8.00	24.00	0.00	0.00	**60.00**	
WP3	44.84	0.00	0.59	16.10	0.00	0.00	10.05	36.45	0.00	0.00	**108.03**	20, 21
	-30.84	0.00	1.41	-4.10	0.00	0.00	-2.05	-12.45	0.00	0.00	**-48.03**	
	1.10	0.00	2.00	21.50	0.00	0.00	8.00	0.00	0.00	0.00	**32.60**	
WP4	0.04	0.00	0.80	19.53	0.00	0.00	25.77	0.00	0.00	0.00	**46.14**	22
	1.06	0.00	1.20	1.97	0.00	0.00	-17.77	0.00	0.00	0.00	**-13.54**	
	0.00	7.00	0.00	0.00	21.00	6.00	0.00	0.00	0.00	0.00	**34.00**	
WP 5	0.00	15.01	0.11	0.00	47.75	9.75	0.00	0.00	0.00	0.00	**72.62**	
	0.00	-8.01	-0.11	0.00	-26.75	-3.75	0.00	0.00	0.00	0.00	**-38.62**	
	6.00	0.50	17.00	6.00	7.00	1.00	0.00	0.00	0.00	0.00	**37.50**	
WP 6	12.76	1.33	11.75	5.73	1.11	1.14	0.50	1.28	0.00	0.00	**35.60**	
	-6.76	-0.83	5.25	0.27	5.89	-0.14	-0.50	-1.28	0.00	0.00	**1.90**	

[17] The number of PMs planned per WP as stated in Annex I.
[18] The actual number of PMs spent on the WP for the project duration.
[19] The number of PMs remaining per partner and per WP.
[20] MTT PMs include work undertaken by a subcontractor.
[21] UOB staff time has been part-financed from other sources.
[22] MTT has received additional funding from national sources for the inventory of LR apples and pears. Total PMs includes PMs funded by these sources.

Table 3 cont'd. PMs planned (grey shaded), actual (no shading) and remaining (black) per WP and per partner

Partner	1 UOB	2 DLO	3 BIOVER	4 UNIPG	5 JKI	6 NORDGEN	7 MTT	8 URJC	9 SXS	10 UNOTT	WP totals	Notes
WP 7	14.00	2.00	1.00	0.50	1.00	1.00	0.50	1.00	1.00	0.50	**22.50**	
	11.63	2.84	0.98	1.09	0.40	1.01	0.95	0.96	0.76	0.29	**20.91**	
	2.37	-0.84	0.02	-0.59	0.60	-0.01	-0.45	0.04	0.24	0.21	**1.60**	
Partner totals	**74.20**	**67.90**	**42.00**	**41.00**	**29.50**	**9.00**	**17.50**	**26.60**	**14.20**	**6.00**		23,24
	106.61	**101.00**	**39.99**	**42.46**	**49.26**	**11.90**	**37.13**	**42.62**	**9.04**	**11.17**		
	-32.41	**-33.10**	**2.01**	**-1.46**	**-19.76**	**-2.90**	**-19.63**	**-16.02**	**5.16**	**-5.17**		

[23] UOB staff time has been part-financed from other sources. Total PMs includes PMs funded by these sources.
[24] MTT has received additional funding from national sources for the inventory of LR apples and pears. Total PMs includes PMs funded by these sources.

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Kell, S., Maxted, N., Ford-Lloyd, B.V. *et al*. (in prep. b) A methodological approach to complementary conservation of priority European CWR.

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Appendix 1. Publications and presentations arising from the research

This list includes publications and presentations involving project partners which are direct products of the work undertaken in the PGR Secure project. Publications and presentations are listed by work package and are cumulative from the start date of the project. Oral communications given at conferences are included, apart from those presented at the CWR and LR conservation training workshop which are published in the public domain at: www.pgrsecure.org/palanga_presentations.

WP1: Phenomics and genomics

Broekgaarden, C., Riviere, P., Steenhuis, G., Del sol Cuenca, M., Kos, M., Pelgrom, K., Voorrips, R. and Vosman, B. (2013) *Phloem-specific resistance in* Brassica oleracea *against the whitefly* Aleyrodes proletella. Oral communication, 6th meeting of the IOBC-WPRS Working Group 'Induced resistance in plants against insects and diseases', June 10–13 2013, Avignon, France.

Pelgrom, K. (2012) *Host plant resistance to cabbage whitefly in Brassica oleracea and wild relatives*. Oral communication, NWO-ALW meeting 'Experimental Plant Sciences', Lunteren, The Netherlands, 03 April 2012.

Pelgrom, K., Sharma, G., Broekgaarden, C., Voorrips, R., Bas, N., Pritchard, J., Ford-Lloyd, B. and Vosman, B. (2012) Looking for resistance to phloem feeders in *Brassica oleracea*. *Crop Wild Relative* 8, 12–14. www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_8.pdf

Pelgrom, K., Sharma, G., Voorrips, R., Broekgaarden, C., Pritchard, J., May, S., Adobor, S., Janssen, B., van Workum, W., Ford-Lloyd, B. and Vosman, B. (2014) *Using phenomics and genomics to unlock landrace and wild relative diversity for crop improvement*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Pelgrom, K., Broekgaarden, C., Voorrips, R. and Vosman, B. (2014) *Mapping and validation of QTLs for resistance to whitefly in cabbage.* Poster presentation, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Pelgrom, K., Broekgaarden, C., Voorrips, R. and Vosman, B. (2014) Successful use of crop wild relatives in breeding: easier said than done. *Crop wild relative* 10, in press.

Pelgrom, K. *et al*. (2015) Using Phenomics and Genomics to unlock landrace and wild relative diversity for crop improvement. In: Maxted, N., Ford-Lloyd, B.V. and Dulloo, M.E. (eds.), *Enhancing Crop Genepool Utilization: Capturing Wild Relative and Landrace Diversity for Crop Improvement*. CAB International, Wallingford, in prep.

Pritchard, J., Broekgaarden, C. and Vosman, B. (2013) Effects of climate change on plant–insect interactions and prospects for resistance breeding using genetic resources. In: Jackson, M, Ford-Lloyd, B. and Parry, M. (eds.), *Plant Genetic Resources and Climate Change*. CAB International, Wallingford. Pp. 270–284.

Sharma, G., Pritchard, J. and Ford-Lloyd, B. (2014) *Looking for insect resistance in brassicas: combining physiology with plant transcriptomics to identify new sources of resistance and candidate* *genes*. Poster presentation, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Vosman, B. (2012) A phenomics and genomics approach to the use of landraces and crop wild relatives for crop improvement. *Crop Wild Relative* 8, 11–12. www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_8.pdf

Vosman, B., Pelgrom, K., Voorrips, R. and Broekgaarden, C. (2013) *Breeding for cabbage whitefly resistance in* Brassica oleracea. Poster presented at the conference 'Future IPM in Europe', 19–21 March 2013, Riva del Garda, Italy.

Vosman, B. (2013) *High throughput screening of plant collections for increased resistance towards phloem feeding insects*. Oral communication, annual meeting of the Entomological Society of America. 10–13 November 2013, Austin, USA.

Vosman, B. (2013) *Breeding for insect resistant crops*. Oral communication, mini-symposium on novel technologies to study plant/herbivore interactions. Arkansas State University, 8 November 2013, Jonesburo, USA.

Vosman, B. (2013) *Novel characterization techniques: the phenomics and genomics approach*. Oral communication, PGR Secure workshop, 'On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis', Wageningen, The Netherlands, 25–29 November 2013.

Vosman, B. (2014) *Insect resistance in vegetable crops*. Oral communication, Applied Vegetables Genomics Conference, Vienna, 19–20 February 2014.

Vosman, B., Pelgrom, K., Sharma, G., Vooripps, R., Broekgaarden, C., Pritchard, J., May, S., Adobor, S., Castellanos-Uribe, M., van Kaauwen, M., Janssen, B., van Workum, W. and Ford-Lloyd, B. (2014) Phenomics and genomics tools for facilitating brassica improvement. *Crop wild relative* 10, in press.

WP2: Informatics

Dias, S. (2012) Pieces of the puzzle—Trait Information Portal. *Crop Wild Relative* 8, 28–30. www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_8.pdf

Dias, S. (2013) *EURISCO, GENESYS and the TIP: an update*. Oral communication, UK PGR Group meeting, London, UK, 13 March 2013. Available at: http://ukpgrg.org/01-SDias_UKPGR_13March2013.pdf.

Dias, S. (2014) Plant Genetic Resources Diversity Gateway for the conservation and use of crop wild relative and landrace traits. *Crop Wild Relative* 10, in press.

Dias, S. and Skofic, M. (2014) *Thoughts and experiences building an* in situ/ex situ *information system*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Dias, S., Skofic, M., Dulloo, E. and Maxted, N. (2014) *Plant Genetic resources Diversity gateway – a way forward*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Dias, S. et al. (2015) Plant Genetic Resources Diversity Gateway – a way forward. In: Maxted, N., Ford-Lloyd, B.V. and Dulloo, M.E. (eds.), *Enhancing Crop Genepool Utilization: Capturing Wild Relative and Landrace Diversity for Crop Improvement*. CAB International, Wallingford, in prep.

Dias, S. et al. (2015) Thoughts and experiences building an *in situ*/*ex situ* information system. In: Maxted, N., Ford-Lloyd, B.V. and Dulloo, M.E. (eds.), *Enhancing Crop Genepool Utilization: Capturing Wild Relative and Landrace Diversity for Crop Improvement*. CAB International, Wallingford, in prep.

Iriondo, J.M., Parra-Quijano, M., Rubio-Teso, M.L., Torres, E. and García, R. (2013) *Ecogeographical approaches to characterize CWR adaptive traits useful for crop adaptation*. Oral communication, EUCARPIA Genetic Resources section meeting, 'Pre-breeding – fishing in the gene pool', June 10–13 2013, Alnarp, Sweden.

Rubio-Teso, M.L., Parra-Quijano, M. and Iriondo, J.M. (2013) *Finding the most drought-resistant plant populations. Evaluation of the FIGS methodology.* Oral communication, XI National Congress of the Spanish Association of Terrestrial Ecology. Pamplona/Iruña 6–10 May 2013.

Rubio Teso, M.L., Thormann, I., Parra-Quijano, M., Dias, S., Van Etten, J. and Iriondo, J.M. (in prep.) An ecogeographical approach to optimizing focused identification germplasm strategy in crop wild relatives. *BMC Bioinformatics*.

Thormann, I. (2012) Applying FIGS to crop wild relatives and landraces in Europe. *Crop Wild Relative* 8, 14–16. www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_8.pdf

Thormann, I., Parra-Quijano, M., Iriondo, J.M., Rubio-Teso, M.L., Endresen, D.T., Dias, S., van Etten, J. and Maxted, N. (2014) *New predictive characterization methods for accessing and using CWR diversity*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Thormann, I., Rubio Teso, M.L., Parra Quijano, M. and Iriondo, J.M. (2014) *Predictive characterization of Beta CWR using the ecogeographical filtering method*. Poster presentation, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

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WP3: CWR conservation

Asdal, Å., Phillips, J. and Maxted, N. (2013) Boost for crop wild relative conservation in Norway. *Crop Wild Relative* 9, 20–21. www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_9.pdf

De la Rosa, L., Aguiriano, E., Mallor, C., Rubio-Teso, M.L., Parra-Quijano, M., Torres, E. and Iriondo, J.M. (2013) Prioritized CWR in Spain: status on the National Inventory of Plant Genetic Resources for Agriculture and Food. *Crop Wild Relative* 9, 23–26. www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_9.pdf

Fielder, H., Hopkins, J., Smith, C., Kell, S., Ford-Lloyd, B. and Maxted, N. (2012) UK wild species to underpin global food security: species selection, genetic reserves and targeted collection. *Crop Wild Relative* 8, 24–27. www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_8.pdf

Fielder, H., Hosking, J., Brotherton, P., Woodman, J., Smith, S., Hopkins, J., Ford-Lloyd, B. and Maxted N. (2014) *Developing methodologies for the genetic conservation of UK crop wild relatives*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Fielder, H., Ford-Lloyd, B. and Maxted, N. (2014) Enhancing the conservation and use of *Medicago* genetic resources using Next-Generation Sequencing. *Crop Wild Relative* 10, in press.

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Fitzgerald, H. and Korpelainen, H. (2014) Discovering Finnish crop wild relative diversity and gaps in their conservation. *Crop wild relative* 10, in press.

Iriondo, J.M., Kell, S.P., Fitzgerald, H., Negri, V., Magos Brehm, J. and Maxted, N. (2014) *National strategies for the conservation of CWR*. Keynote oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Iriondo, J.M. (2014) *Origen silvestre de las plantas cultivadas: ¿por qué resulta tan importante ahora?* Oral communication (invited speaker), Conferences of the Jardin Atlántico Botanical Garden, Gijón, Spain, 26 June 2014.

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Negri, V., Gigante, D., Donnini, D., Torricelli, R., Landucci, F., Panella, L. and Venanzoni, R. (2013) *Attività del DBA_UNIPG per la salvaguardia dei progenitori selvatici delle piante coltivate nell'ambito del progetto EC FPVII PGR Secure*. Oral communication, Banche di germoplasma e conservazione *in situ* scientific meeting, Orto Botanico, Rome, 23 April 2013.

Panella, L., Donnini, D., Gigante, D., Negri, V. and Venanzoni, R. (2011) Crop Wild Relatives of *Apium*, *Avena*, *Beta*, *Brassica* and *Prunus* genera in Umbria. Poster presented at the 106° Società Botanica Italiana Congress, Genova (I) 21–24 September 2011.

Panella, L., Gigante, D., Donnini, D., Venanzoni, R. and Negri, V. (2012) Progenitori selvatici e forme coltivate di Apiaceae, Chenopodiaceae, Poaceae e Rosaceae: primi risultati per il territorio dell'Umbria (Italia Centrale). *Quaderni Botanica Ambientale ed Applicata* 23, 3–13.

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Panella, L., Landucci, F., Donnini, D., Gigante, D., Venanzoni, R., Raggi, L., Torricelli, R. and Negri, V. (2014) Italian crop wild relatives and wild harvested plants conservation strategy. *Crop wild relative* 10, in press.

Parra-Quijano, M., López, F., Torres, E. and Iriondo, J.M. (2014) *CAPFITOGEN tools. Facilitated spatial and ecogeographical germplasm analysis for efficient PGR conservation and utilization*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Phillips, J., Kyratzis, A., Christoudoulou, C., Kell, S. and Maxted, N. (2013) Development of a national crop wild relative conservation strategy for Cyprus. *Crop Wild Relative* 9, 16–19. www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_9.pdf

Phillips, J., Asdal, Å. and Maxted, N. (2014) *National implementation of the conservation of plant genetic resources within Norway.* Poster presentation, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Phillips, J., Kyratzis, A., Christoudoulou, C., Kell, S.P. and Maxted, N. (2014) Development of a national crop wild relative conservation strategy for Cyprus. *Genetic Resources and Crop Evolution* 61(4), 817–827. DOI: 10.1007/s10722-013-0076-z

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Appendix 2. Related publications and presentations

This list includes publications and presentations involving project partners which have not directly arisen from the project research activities but whose subject matter is closely related and therefore of relevance to the project. Publications and presentations arising directly from research undertaken in the project are listed in Appendix 1.

The publications are listed by the project partner who is lead author and is cumulative since the start date of the project. Oral communications given at conferences are included, apart from those presented at PGR Secure consortium meetings and at the CWR and LR conservation training workshop, the latter which are published in the public domain at: www.pgrsecure.org/palanga_presentations.

Partner 1, UOB

Bilz, M., Kell, S.P., Maxted, N. and Lansdown, R.V. (2011) *European Red List of Vascular Plants*. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-20199-8. http://ec.europa.eu/environment/nature/conservation/species/redlist/downloads/European_vascular_plants.pdf

Castañeda Álvarez, N.P., Vincent, H.A., Kell, S.P., Eastwood, R.J. and Maxted, N. (2012) Ecogeographic surveys. In Guarino, L., Ramanatha Rao, V., Goldberg, E. (eds.), *Collecting Plant Genetic Diversity: Technical Guidelines. 2011 Update.* Bioversity International, Rome. http://cropgenebank.sgrp.cgiar.org/index.php?option=com_content&view=article&id=679

Castañeda Álvarez, N.P., Khoury, C., Sosa, C., Bernau, V., Achicanoy, H., Vincent, H., Jarvis, A. and Maxted, N. (2014) *The distributions and* ex situ *conservation of crop wild relatives: a worldwide approach*. Oral communication, 'Enhanced genepool utilization – capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Ford-Lloyd, B.V., Schmidt, M., Armstrong, S.J., Barazani, O., Engels, J., Hadas, R., Hammer, K., Kell, S.P., Kang, D., Khoshbakht, K., Li, Y., Long, C., Lu, B., Ma, K., Nguyen, V.T., Qiu, L., Ge, S., Wei, W., Zhang, Z. and Maxted N. (2011) Crop wild relatives – undervalued, underutilized, and under threat? *Bioscience* 61(7), 559–565.

Hunter, D., Maxted, N., Heywood, V.H, Kell, S. and Borelli, T. (2012) Protected areas and the challenge of conserving crop wild relatives. *Parks* 18(1), 87–98.

Idohou, R., Assogbadjo, A.E., Fandohan, B., Gouwakinnou, G.N., Kakai, R.L.G., Sinsin, B. and Maxted, N. (2012) National inventory and prioritization of crop wild relatives: case study for Benin. *Genetic Resources and Crop Evolution*, DOI: 10.1007/s10722-012-9923-6.

Kell, S.P., Maxted, N. and Bilz, M. (2012) European crop wild relative threat assessment: knowledge gained and lessons learnt. In: Maxted, N., Dulloo, M.E., Ford-Lloyd, B.V., Frese, L., Iriondo, J.M. and Pinheiro de Carvalho, M.A.A. (eds.) *Agrobiodiversity Conservation: Securing the Diversity of Crop Wild Relatives and Landraces*. CAB International, Wallingford. Pp. 218–242.

Kell, S.P., Maxted, N., Frese, L. and Iriondo, J.M (2012) *In situ* conservation of crop wild relatives: a strategy for identifying priority genetic reserve sites. In: Maxted, N., Dulloo, M.E., Ford-Lloyd, B.V., Frese, L., Iriondo, J.M. and Pinheiro de Carvalho, M.A.A. (eds.) *Agrobiodiversity Conservation:*

Securing the Diversity of Crop Wild Relatives and Landraces. CAB International, Wallingford. Pp. 7–19.

Kell, S., Maxted, N., Magos-Brehm, J. and Ford-Lloyd, B.V. (in prep.). Broadening the base, narrowing the task: setting priorities for the conservation of crop wild relative diversity. *Journal to be decided.*

Khoury, C.K., Greene, S., Wiersema, J., Maxted, N., Jarvis, A. and Struik, P.C. (2013) An inventory of crop wild relatives of the United States. *Crop Science*, DOI: 10.2135/cropsci2012.10.0585.

Magos Brehm, J., Ford-Lloyd, B.V., Maxted, N. and Martins-Loução, M.A. (2012) Using neutral genetic diversity to prioritize crop wild relative populations: a Portuguese endemic case study for *Dianthus cintranus* Boiss. & Reut. subsp. *barbatus* R. Fern. & Franco. In: Maxted, N., Dulloo, M.E., Ford-Lloyd, B.V., Frese, L., Iriondo, J.M. and Pinheiro de Carvalho, M.A.A. (eds.) *Agrobiodiversity Conservation: Securing the Diversity of Crop Wild Relatives and Landraces*. CAB International, Wallingford. Pp. 193–210.

Maxted, N. (2012) *Lathyrus belinensis*: a CWR discovered and almost lost. *Crop Wild Relative* 8, 44. www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_8.pdf

Maxted, N**.** (2013) *In Situ*, *Ex Situ* Conservation. In: Levin S.A. (ed.) *Encyclopedia of Biodiversity, Second Edition, Volume 4*. Waltham, MA: Academic Press. Pp. 313–323.

Maxted, N. and Kell, S. (2012) *A role for botanic gardens in crop wild relative conservation. Report of a workshop convened at EUROGARD VI: European Botanic Gardens in a Changing World, 28 May–June 02, 2012, Chios, Greece*. www.pgrsecure.bham.ac.uk/sites/default/files/meetings/others/EuroGard_VI_CWR_workshop_summary.pdf

Maxted, N. and Kell, S. (2012) *Greece: cradle of European plant genetic diversity and hotspot for conservation action*. Oral communication, AGRIC 2012 – Phytogenetic Wealth and Agricultural Heritage of the Aegean Islands, 06–07 July 2012, Santorini, Greece. http://www.pgrsecure.bham.ac.uk/sites/default/files/meetings/others/Greek_Agrobiodiversity_FINAL.pdf

Maxted, N. and Kell, S.P. (2013) A role for botanic gardens in CWR conservation for food security. *BGjournal* 10(2), 32–35.

Maxted, N., Kell, S. and Magos Brehm, J. (2011) *Options to promote food security: on-farm management and in situ conservation of plant genetic resources for food and agriculture*. Commission on Genetic Resources for Food and Agriculture, FAO, Rome, Italy. 27 pp.

Maxted, N., Kell, S.P., Ford-Lloyd, B.V., Dulloo, M.E. and Toledo, A. (2012) Toward the systematic conservation of global crop wild relative diversity. *Crop Science* 52(2), 774–785.

Maxted, N., Hargreaves, S., Kell, S.P., Amri, A., Street, K., Shehadeh, A., Piggin, J. and Konopka, J. (2012) Temperate forage and pulse legume genetic gap analysis. *Bocconea* 24, 5–36.

Maxted, N., Dulloo, M.E., Ford-Lloyd, B.V., Frese, L., Iriondo, J.M. and Pinheiro de Carvalho, M.A.A. (eds.) (2012) *Agrobiodiversity Conservation: Securing the Diversity of Crop Wild Relatives and Landraces*. CAB International, Wallingford. 365 pp.

Maxted, N. *et al*. (2012) Current and future threats and opportunities facing European crop wild relative and landrace diversity. In: Maxted, N., Dulloo, M.E., Ford-Lloyd, B.V., Frese, L., Iriondo, J.M. and Pinheiro de Carvalho, M.A.A. (eds.) *Agrobiodiversity Conservation: Securing the Diversity of Crop Wild Relatives and Landraces*. CAB International, Wallingford. Pp. 333–353.

Maxted, N., Castañeda Álvarez, N.P., Vincent, H.A. and Magos Brehm, J. (2012) Gap analysis: a tool for genetic conservation. In Guarino, L., Ramanatha Rao, V., Goldberg, E. (eds.), *Collecting Plant Genetic Diversity: Technical Guidelines. 2011 Update.* Bioversity International, Rome. http://cropgenebank.sgrp.cgiar.org/index.php?option=com_content&view=article&id=678

Maxted, N., Magos Brehm, J. and Kell, S. (2013) *Conservation and Sustainable Use of PGRFA: A Toolkit for National Strategy Development – DRAFT*. Food and Agriculture Organization of the UN, Rome Italy. 398 pp.

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Underwood, E., Poláková, J., Berman, S., Dooley, E., Frelih-Larsen, A., Kretschmer, B., Maxted, N., McConville, A.J., Naumann, S., Sarteel, M. and Tostivint, C. (2013) *Options for Feeding 10 Billion People. Sustainable Intensification of Crop Production: Climate Change and Agriculture; Biodiversity and Agriculture.* Report prepared for the STOA Panel of the European Parliament. Contract IP/A/STOA/FWC/2008-096/LOT3/C1/SC5. European Parliament Science and Technology Options Assessment STOA. www.europarl.europa.eu/stoa/cms/studies

Maxted, N., Ford-Lloyd, B.V., Kell, S.P., Pooni, H.S. and Lawrence, M.J. (2014) *Plant Genetic Conservation*. Cambridge University Press, Cambridge. In prep.

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Smỳkal, P., Coyne, C.J., Ambrose, M.J., Maxted, N., Schaefer, H., Blair, M.W., Berger, J., Greene, S.L., Nelson, M.N., Besharat, N., Vymyslickỳ, T., Toker, C., Saxena, R.K., Roorkiwal, M., Pandey, M.K., Hu, J., Li, J.H., Wang, L.X., Guo, Y., Qiu, L.J., Redden, R.J. and Varshney, R.K. (2014) Legume crops phylogeny and genetic diversity for science and breeding. *Critical Reviews in Plant Sciences* 33, 1–61.

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Vincent, H., Wiersema, J., Kell, S.P., Dobbie, S., Fielder, H., Castañeda Alvarez, N.P., Guarino, L., Eastwood, R., León, B. and Maxted, N. (2013) A prioritized crop wild relative inventory as a first step to help underpin global food security. *Biological Conservation* 167, 265–275.

Partner 2, DLO

Broekgaarden, C., Snoeren, T.A.L., Dicke, M. and Vosman, B. (2011) Exploiting natural variation to identify insect-resistance genes. *Plant Biotechnology Journal* 9, 819–825.

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Chen, X., Vosman, B., Visser, R.G.F., van der Vlugt, R.A.A. and Broekgaarden, C. (2012) High throughout phenotyping for aphid resistance in large plant collections. *BMC Plant Methods* 8, 33.

Partner 3, BIOVER

Barata, A.M., Rocha, F., Oliveira, J., Lima, J.M., Nobrega, H., Pinheiro de Carvalho, M.A.A. and Dias, S. (2014) *Implementation of a PGR global documentaion system in Portugal*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Dias, S. (2013) *Thematic node manager.* Oral communication, GBIF European Regional Nodes Meeting, The Finnish Digitarium, 6–8 March 2013, Joensuu, Finland.

Dias, S. (2013) *EURISCO, GENESYS and the TIP update.* Oral communication, UK PGR Group meeting, 13 March 2013. http://ukpgrg.org/01-SDias_UKPGR_13March2013.pdf

Dias, S. and Skofic, M. (2013) *TIP overview*. Oral communication, Bioversity International, Rome, Italy, 13 March 2013.

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Gioia, T., Logozzo, G., Attene, G., Bellucci, E., Benedettelli, S., Negri, V., Papa, R. and Spagnoletti Zeuli, P. (2013) Evidence for introduction bottleneck and extensive inter-gene pool (Mesoamerica x Ande) hybridization in the European common bean (*Phaseolus vulgaris* L.) germplasm. *PLoS ONE*, 8(10): e75974. doi:10.1371/journal.pone.0075974

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Padulosi, S., Bala Ravi, P., Rojas, W., Sthapit, S., Subedi, A., Dulloo, E., Hammer, K., Vögel, R., Antofie, M.M., Negri, V., Bergamini, N., Galluzzi, G., Jäger, M., Sthapit, B., Rana R., Oliver King, I. and Warthmann, N. (2012) *Red Lists for Cultivated Species: why we need it and suggestions for the way forward.* Poster presented at IUCN World Conservation Congress, Jeju, Korea, 6–15 September 2012.

Raggi, L., Tiranti, B. and Negri, V. (2013) Genetic diversity and structure of a collection of common bean (*Phaseolus vulgaris* L.) Italian landraces. *Genetic Resources and Crop Evolution* 60, 1515–1530. DOI: 10.1007/s10722-012-9939-y.

Raggi, L., Ceccarelli, S. and Negri, V. (2014) *Morphological and molecular characterization of a barley composite cross derived population*. Poster presentation, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

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Torricelli, R., Silveri, D.D., Ferradini, N., Venora, G., Veronesi, F. and Russi, L. (2012) Characterization of the lentil landrace 'Santo Stefano di Sessanio' from Abruzzo, Italy. *Genetic Resources and Crop Evolution* 59, 261–276.

Torricelli, R., Tiranti, B., Spataro, G., Castellini, G., Albertini, E., Falcinelli, M. and Negri, V. (2012) Differentiation and structure of an Italian landrace of celery (*Apium graveolens* L.): inferences for on farm conservation. *Genetic Resources and Crop Evolution* DOI: 10.1007/s10722-012-9896-5.

Partner 5, JKI

Frese, L., Bjorn, G.K., Branca, F., Ford-Lloyd, B.V., Germeier, C.U., Iriondo, J.M., Katsiotis, A., Kell, S.P., Maxted, N., Negri, V. and Pinheiro de Carvalho, M.A.A. (2012) Genetic reserve conservation of European crop wild relative and landrace diversity. In: Maxted, N., Dulloo, M.E., Ford-Lloyd, B.V., Frese, L., Iriondo, J.M. and Pinheiro de Carvalho, M.A.A. (eds.) *Agrobiodiversity Conservation. Securing the Diversity of Crop Wild Relatives and Landraces*. CAB International, Wallingford. Pp. 1–6.

Germeier, C.U., Iriondo, J.M., Frese, L., Höhne, C. and Kell, S.P. (2012) Population level information management for crop wild relatives. In: Maxted, N., Dulloo, M.E., Ford-Lloyd, B.V., Frese, L., Iriondo, J.M. and Pinheiro de Carvalho, M.A.A. (eds.) *Agrobiodiversity Conservation. Securing the Diversity of Crop Wild Relatives and Landraces*. CAB International, Wallingford. Pp. 256–263.

Partner 6, NordGen

Palmé, A., Marum, P., Öhlund, L., Leino, M., Hagenblad, J., Solberg, S.Ø. and Asdal, Å. (2014) *Genetic Consequences of* Ex Situ *and* In Situ *Conservation of Plant Genetic Resources: An On-going Study in Red Clover (*Trifolium pratense*).* Poster presented at the conference 'Genetic resources for food and agriculture in a changing climate, Lillehammer, Norway, 27–29 January 2014.

Palmé, A., Svensson, J., Rasmussen, M. and Nilsson, N. (2014) Breeding goals and actions to ensure future food security and sustainable growth. *Sveriges Utsädesförenings Tidskrift* 2014 (1), 32–35.

Partner 7, MTT

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3. Deliverables and milestones tables

Deliverables (excluding the periodic and final reports)

Del. no.	Deliverable name	Version	WP no.	Lead beneficiary	Nature	Dissemination level	Delivery date from Annex I (proj month)	Actual / Forecast delivery date	Status	Comments
1	High throughput phenot yping data of Brassica accessions	1.0	1	STICHTING DIENST LAN DBOUWKUNDI G ONDERZOEK	Report	RE	24	25/10/2013	Submitted	
2	Metabolomic data of B rassica accessions	1.0	1	STICHTING DIENST LAN DBOUWKUNDI G ONDERZOEK	Report	RE	30	05/02/2014	Submitted	
3	Sequencing data of Bras sica accessions	1.0	1	ServiceXS BV	Report	RE	36	02/10/2014	Submitted	
4	Transcriptomics of Bra ssi ca accessions	1.0	1	THE UNIVER SITY OF BI RMINGHAM	Other	RE	36	21/10/2014	Submitted	
5	Identification of can dida te genes and mark ers for insect resista nce in Bras sica	1.0	1	STICHTING DIENST LAN DBOUWKUNDI G ONDERZOEK	Report	RE	42	21/10/2014	Submitted	
1	Case study database	1.0	2	INTERNATIO NAL PLANT GENETIC RE SOURCES IN STITUTE*IPGRI	Other	PU	18	08/05/2013	Submitted	
2	FIGS usage Guidelines	1.0	2	INTERNATIO NAL PLANT GENETIC RE SOURCES IN STITUTE*IPGRI	Report	PU	30	21/10/2014	Submitted	
3	TIP conceptualization fra mework	1.0	2	INTERNATIO NAL PLANT GENETIC RE SOURCES IN STITUTE*IPGRI	Report	PU	12	22/03/2012	Submitted	
4	TIP developed and tes ted	1.0	2	INTERNATIO	Prototype	RE	24	01/04/2014	Submitted	

				NAL PLANT GENETIC RE SOURCES IN STITUTE*IPGRI						
5	TIP on-line publicati on	1.0	2	INTERNATIO NAL PLANT GENETIC RE SOURCES IN STITUTE*IPGRI	Other	PU	34	29/10/2014	Submitted	
1	European crops and CW R inventory	1.0	3	THE UNIVER SITY OF BI RMINGHAM	Report	PU	28	29/10/2014	Submitted	
2	Exemplar national CWR conservation strateg ies	2.0	3	THE UNIVER SITY OF BI RMINGHAM	Report	PU	30	09/04/2014	Submitted	
3	European priority gen e pool CWR conservati on strategy	1.0	3	THE UNIVER SITY OF BI RMINGHAM	Report	PU	37	31/10/2014	Submitted	
4	European generic CWR c onservation strategy	1.0	3	THE UNIVER SITY OF BI RMINGHAM	Report	PU	40	31/10/2014	Submitted	
1	Finnish LR conservatio n strategy for target crops	1.0	4	MAA JA ELI NTARVIKETA LOUDEN TUT KIMUSKESKUS	Report	PU	38	30/10/2014	Submitted	
2	Italian LR conservatio n s trategy for target crops	1.0	4	UNIVERSITA DEGLI STUDI DI PERUGIA	Report	PU	38	12/08/2014	Submitted	
3	UK LR conservation str ategy for target crop s	1.0	4	THE UNIVER SITY OF BI RMINGHAM	Report	PU	38	28/07/2014	Submitted	
4	European Specific LR c onservation Strategy for target crops	1.0	4	UNIVERSITA DEGLI STUDI DI PERUGIA	Report	PU	40	07/05/2014	Submitted	
5	European generic LR c onservation strategy	1.0	4	UNIVERSITA DEGLI STUDI DI PERUGIA	Report	PU	40	12/08/2014	Submitted	
6	Descriptors for Web-En abled National In Sit u Landrace Inventorie s	1.0	4	UNIVERSITA DEGLI STUDI DI PERUGIA	Other	PU	24	28/02/2013	Submitted	

7	MS Access database fo r in situ LR data recor ding	1.0	4	UNIVERSITA DEGLI STUDI DI PERUGIA	Other	PU	27	29/08/2013	Submitted	
1	Report on identificat ion and discussions wi th stak eholders	1.0	5	STICHTING DIENST LAN DBOUWKUNDI G ONDERZOEK	Report	PU	12	15/08/2012	Submitted	
2	Transfer of knowledge on insect resistant Bra ssica material (fro m WP1) and knowledge w here to obtain it to br e eders	1.0	5	STICHTING DIENST LAN DBOUWKUNDI G ONDERZOEK	Other	RE	30	24/10/2014	Submitted	
3	List of interesting A vena and Beta accessio ns sent to breeders	1.0	5	STICHTING DIENST LAN DBOUWKUNDI G ONDERZOEK	Report	RE	26	16/04/2013	Submitted	
4	Draft report as input f or 2013 workshop	1.0	5	STICHTING DIENST LAN DBOUWKUNDI G ONDERZOEK	Report	PU	28	04/12/2013	Submitted	
5	Final report on trends CW R/LR use in breedin g in Europe	1.0	5	STICHTING DIENST LAN DBOUWKUNDI G ONDERZOEK	Report	PU	37	02/10/2014	Submitted	
6	Web-based map of stak eholders	1.0	5	STICHTING DIENST LAN DBOUWKUNDI G ONDERZOEK	Prototype	PU	39	24/10/2013	Submitted	
7	List of new partnersh ips	1.0	5	STICHTING DIENST LAN DBOUWKUNDI G ONDERZOEK	Report	RE	40	21/05/2014	Submitted	
8	Transfer information o f l inked markers to Br a ssica pests (from WP1) to breeders	1.0	5	STICHTING DIENST LAN DBOUWKUNDI G ONDERZOEK	Report	RE	40	24/10/2014	Submitted	
1	Project website	1.0	6	INTERNATIO NAL PLANT GENETIC RE SOURCES IN	Other	PU	6	28/09/2011	Submitted	

				STITUTE*IPGRI						
2	CWR and LR conservation workshop reports	1.0	6	THE UNIVERSITY OF BIRMINGHAM	Report	PU	6	29/02/2012	Submitted	
3	Project newsletters	1.0	6	THE UNIVERSITY OF BIRMINGHAM	Other	PU	39	24/10/2014	Submitted	
4	TIP potential user li st	1.0	6	INTERNATIONAL PLANT GENETIC RESOURCES INSTITUTE*IPGRI	Report	PU	24	25/10/2013	Submitted	
5	Web-enabled CWR and LR inventories	1.0	6	INTERNATIONAL PLANT GENETIC RESOURCES INSTITUTE*IPGRI	Other	PU	34	29/10/2014	Submitted	
6	Dissemination conference proceedings	1.0	6	INTERNATIONAL PLANT GENETIC RESOURCES INSTITUTE*IPGRI	Other	PU	42	21/10/2014	Submitted	
1	First periodic report	1.0	7	THE UNIVERSITY OF BIRMINGHAM	Report	PU	12	22/10/2013	Submitted	
2	Second periodic report	1.0	7	THE UNIVERSITY OF BIRMINGHAM	Report	PU	30	30/10/2013	Submitted	
3	Final Report	0.0	7	THE UNIVERSITY OF BIRMINGHAM	Report	PU	42	31/08/2014	Not submitted	

Milestones

Milestone no.	Milestone name	Work package no	Lead beneficiary	Delivery date from Annex I	Achieved Yes/No	Actual / Forecast achievement date	Comments
1	Phenotyping protocol established	1	2	30/11/2011	Yes	01/06/2011	Phenotyping protocol established and available by contacting lead bene

							ficiary
2	Accessions for pheno typing selected	1	2	30/11/2011	Yes	01/05/2011	Set of accessions selecte d for phenotyping and lis t of accessions available by contacting lead benef iciary
3	Metabolomics and tra nscriptomics material selected	1	9	31/05/2012	Yes	30/04/2012	Selection of plant materi al for metabolomics and t ranscriptomics and list of accessions available
4	Material selected for cro sses	1	1	31/05/2012	Yes	30/04/2012	Selection of plant materi al for crosses and list of accessions available
5	Plant material for s equencing selected	1	2	30/11/2012	Yes	31/08/2012	Selection of plant materi al for sequencing and list of accessions available
6	Datasets on biotic/abioti c stress resistance/toler ance traits	2	3	29/02/2012	Yes	31/01/2012	Datasets containing infor mation on biotic and abio tic resistance traits in Avena, Beta, Brassica and Medicago available in partner intranet
7	Distribution maps of CWR and LR produced	2	3	29/02/2012	Yes	29/02/2012	Distribution maps of Avena, Beta, Brassica an d Medicago CWR and L R produced and available in partner intranet
8	European map of ecog eographic regions pr oduced	2	3	31/05/2012	Yes	31/03/2012	Ecogeographic Land C haracterization (ELC) maps for Avena, Beta, B rassica and Medicago produced and available i n partner intranet
9	Environment profiles of the habitats of CWR and LR likely to contain r esistance/tolerance produced	2	3	31/08/2012	Yes	30/08/2012	Environmental profiles of the habitats of CWR and LR likely to contain abiotic resistance traits have been described and documentation is availab le in the partner intranet
10	Trait Information Portal	2	3	31/10/2012	Yes	30/10/2014	Report on the ontology

	conceptualization on tology						completed and published on the PGR Secure websi te
11	Links established with other information syst ems	2	3	28/02/2013	Yes	16/10/2013	List of links available in the partner intranet
12	Characterization data fro m other relevant inf ormation systems made available to TIP	2	3	28/02/2013	Yes	16/10/2013	List of characterization data sources available in the partner intranet
13	TIP populated with the inventory, phenomics, genomics and transcr iptomics data	2	3	31/08/2013	Yes	20/07/2014	CWR inventory data f rom UK, Spain and Fi nland, as well as Brassica QTL data generated in W P1, 'Phenomics and g enomics' have been u ploaded and are sear chable through the PGR Diversity Gateway
14	Beta version of the TIP available for testing by b reeders	2	3	31/08/2013	Yes	27/11/2013	Beta version of the TIP (aka PGR Diversity Ga teway) launched at the st akeholder workshop on 26 November 2013 w here it was also available for testing by the work shop participants
15	Guidelines for the b roader use of FIGS for tr ait identification develo ped	2	3	31/05/2012	Yes	30/08/2012	Relevant datasets co mpiled and tested for tra it identification with FI GS for the CWR and LR of the four target genera
16	CWR NFPs nominated	3	1	31/03/2011	Yes	30/06/2011	36 CWR NFPs and 21 In Situ NFPs nominated fro m 38 countries; list of n ominees available in CWR and LR conserva tion workshop report and/or by contacting the lead beneficiary
17	Draft national CWR c hecklists sent to CWR NFPs	3	1	30/04/2011	Yes	07/09/2011	Draft national CWR c hecklists generated from PGR Forum European C

							WR Catalogue made av ailable to NFPs at the CWR and LR conser vation training work shop; national checklists available in online hel pdesk and/or by cont acting the lead beneficia ry
18	Outline of implement ation plan agreed by CWR NFPs	3	1	31/07/2011	Yes	08/09/2011	Outline of implement ation plan for revision of national CWR checklists and generation of nation al CWR conservation strategies debated and ag reed by NFPs at the CWR and LR conservat ion training workshop; implementation plan av ailable in the CWR and LR conservation training workshop report
19	Helpdesk facility establi shed	3	1	31/07/2011	Yes	08/09/2011	NFPs informed of the availability of the help desk during the CWR and LR conservation training workshop; h elpdesk facility available online and/or by contac ting the lead beneficiary (for CWR) and partner 4 (for LR)
20	Priority European crops and CWR identified	3	1	31/07/2013	Yes	31/08/2013	Draft list of priority cr ops and CWR produced and available by contact ing lead partner.
21	Completion of priority European CWR ecog eographic data collation	3	1	31/10/2013	Yes	28/02/2014	Distribution data for Eur opean priority species an d ecogeographic land characterization data for Europe collated
23	Italian CWR conserva tion strategy interim rep ort	3	4	31/12/2012	Yes	07/03/2013	Report produced and available in partner intr anet

24	Spanish CWR conserva tion strategy interim rep ort	3	8	31/12/2012	Yes	18/02/2013	Report produced and available in partner intr anet
25	Conservation gap ana lysis of priority Europea n CWR completed	3	1	31/12/2013	Yes	30/10/2014	In situ complementarity a nd gap analysis, and ex s itu taxon gap analysis co mpleted for priority Euro pean CWR
26	European CWR conserv ation strategy draft 1 ci rculated	3	1	31/01/2014	Yes	25/09/2013	Draft concept for in situ conservation of CWR in Europe developed invo lving PGR Secure par tners
27	European CWR conserv ation strategy draft 2 ci rculated	3	1	30/04/2014	Yes	25/09/2013	Draft concept for in situ conservation of CWR in Europe developed by P GR Secure partners and circulated to ECPGR In Situ Network and NFPs
28	LR NFPs nominated	4	4	30/06/2011	Yes	30/06/2011	34 LR NFPs and 30 On -Farm NFPs nominated from 38 countries; list of nominees available in CWR and LR conservat ion workshop report and/or by contacting the lead beneficiary
29	Outline of agreed im plementation plan for national LR inventories by NFPs	4	4	31/08/2011	Yes	08/09/2011	Outline of implement ation plan for national L R inventories debated and agreed by NFPs at t he CWR and LR conser vation training work shop; implementation plan available in the CW R and LR conservation training workshop report
30	LR conservation work shop	4	4	31/10/2011	Yes	09/09/2011	Workshop held and at tended by 31 LR NFPs and 20 On-Farm NFPs; workshop report publish ed in website
31	National inventories of e	4	4	28/02/2014	Yes	29/04/2014	Complete for Italy and Fi

	xtant LR and relative ecogeographic data complete						nland. Italy data availab le at http://vnr.unipg.it /PGRSecure/ or on CD (Negri et al., 2013)
32	European Avena, Beta, Brassica and Medicago LR data complete for all European countries	4	4	28/02/2014	Yes	29/04/2014	Complete for Italy and Fi nland. Italy data availab le at http://vnr.unipg.it /PGRSecure/ or on CD (Negri et al., 2013)
33	European LR conserva tion strategy draft 1 cir culated to PGR Secure partners and NFPs for c omments	4	4	28/02/2014	Yes	27/06/2014	
34	Finnish LR conservation strategy completed	4	7	31/03/2014	Yes	30/10/2014	
35	Italian LR conservation strategy completed	4	4	31/03/2014	Yes	31/07/2014	Italian LR conservation s trategy completed (D4.2) and available via the pro ject website
36	UK LR conservation s trategy completed	4	1	31/03/2014	Yes	18/07/2014	UK LR conservation s trategy completed (D4.3) and available via the pro ject website
37	LR case study strategy published	4	4	31/05/2014	Yes	06/05/2014	European specific LR conservation strategy for target crops completed (D4.4) and available via the project website
38	LR generic strategy published	4	4	31/05/2014	Yes	11/08/2014	European generic LR conservation strategy completed (D4.5) and av ailable via the project w ebsite
39	Country key-persons identified	5	2	31/05/2011	Yes	31/05/2011	Key persons identified an d list available (see App endix 1, Section 2 of the 1st periodic report)
40	Identification of stakeho lders	5	2	31/08/2011	Yes	29/02/2012	Stakeholders identified a nd lists per region avail able (see Tables 3, 4 and

							5 of Section 2 of the 1st periodic report)
41	Questionnaires sent	5	2	31/08/2012	Yes	30/09/2012	The questionnaire was made available online u sing the SurveyMonkey tool
42	Questionnaires replies	5	2	31/10/2012	Yes	15/11/2012	Responses to the que stionnaire received and d ata downloaded from SurveyMonkey for ana lysis
43	Proof of concept sta keholders locations mapping	5	2	30/06/2013	Yes	29/08/2013	Web-based map of sta keholders (‘PGR-COMN ET’) available at: w ww.pgrsecure.org/pgr -comnet
44	Feedback breeding co mpanies on usefulness material/knowledge tran sfer	5	2	30/06/2014	Yes	16/04/2013	Feedback from compan ies was integrated into D eliverable 5.3
45	European stakeholder workshop on CWR/LR diversity use and co nservation held	5	2	31/10/2013	Yes	28/11/2013	PGR Secure stakeholder workshop: ‘On the cons ervation and sustainable use of plant genetic reso urces in Europe: a stakeh older analysis’ convened 26–28 November 2013, Wageningen, NL
46	Meeting to strengthen partnerships in the CWR / LR diversity use and c onservation community	5	2	31/03/2014	Yes	28/11/2013	PGR Secure stakeholder workshop: ‘On the cons ervation and sustainable use of plant genetic reso urces in Europe: a stakeh older analysis’ convened 26–28 November 2013, Wageningen, NL
47	CWR and LR conservat ion workshops	6	1	30/06/2011	Yes	30/06/2011	Workshop held and at tended by NFPs from 38 European countries; wo rkshop report published i n website
49	Identification of TIP pot	6	3	28/02/2013	Yes	30/07/2013	List compiled and av

	ential users and contacts						ailable in the partner intranet
50	Web-enabled Europe-wide inventories of CWR and LR diversity	6	3	31/12/2013	Yes	20/07/2014	Spain, UK and Finland CWR checklists/inventories available from the search pages at: www.pgrdiversity.bioversityinternational.org
52	Dissemination of the TIP among potential users	6	3	31/01/2014	Yes	19/06/2014	PGR Diversity Gateway (formerly the TIP) was presented at the final dissemination conference, 16–20 June 2014, Cambridge, UK
53	Dissemination conference	6	3	31/08/2014	Yes	20/06/2014	Joint PGR Secure/EUCARPIA conference, 'Enhanced Genepool Utilization # Capturing wild relative and landrace diversity for crop improvement', incorporating the PGR Secure final dissemination conference, convened 16–20 June 2014, NIAB Innovation Farm and Churchill College, Cambridge, UK
54	Consortium Agreement	7	1	31/05/2011	Yes	28/11/2011	Consortium Agreement signed by beneficiaries; CA available in partner intranet, including attachment 5 updated in line with changes to the Consortium Committee
55	Kick-off consortium meeting	7	1	31/03/2011	Yes	07/06/2011	Kick-off meeting held 15-16/03/2011; meeting report available 07/06/2011; report available in partner intranet
56	1st annual consortium meeting	7	1	31/12/2011	Yes	15/12/2012	1st annual consortium meeting held 14-15/12/2011; report pending
57	2nd Annual Consortium	7	1	31/10/2012	Yes	03/12/2012	Second annual consor

	meeting						tium meeting held 23 -25/10/2012; meeting report available 03/12/2 012; report available in partner intranet
58	Mid-term review	7	1	31/10/2012	Yes	03/12/2012	Mid-term review meeting held 23-25/10/2012; m eeting report available 0 3/12/2012; report availab le in partner intranet
59	3rd annual consortium meeting	7	1	30/06/2014	Yes	16/06/2014	Third annual consortium meeting held 16/06/2014; meeting report available i n partner intranet

4. Explanation of the use of the resources

The **explanation on the use of resources** was removed from the scientific periodic reports in SESAM. These deta ils now have to be entered in the cost statement forms in FORCE instea d.

FP7 - Grant Agreement - Annex VI - Collaborative project

Summary Financial Report - Collaborative project

Project acronym	PGR Secure	Project nr.	266394	Reporting period from	01/09/2013	to	31/08/2014	Page	1/1

Funding scheme	CP

Beneficiary nr.	If 3rd Party, linked to beneficiary	Adjustment (Yes/No)	Organization Short Name	Type of activity: RTD (A)		Demonstration (B)		Management (C)		Other (D)		Total (A)+(B)+(C)+(D)			
				Total	Max EU Contribution	Total	Max EU Contribution	Total	Max EU Contribution	Total	Max EU Contribution	Total	Max EU Contribution	Receipts	Interest
1		No	UOB	212,478.35	159,358.76	0.00	0.00	45,428.66	45,428.66	79,201.20	79,201.20	337,108.21	283,988.62	0.00	0.00
1		Yes	UOB	-4,442.19	-3,331.64	0.00	0.00	0.00	0.00	0.00	0.00	-4,442.19	-3,331.64	0.00	0.00
1		Yes	UOB	-2,482.80	-1,862.10	0.00	0.00	0.00	0.00	0.00	0.00	-2,482.80	-1,862.10	0.00	0.00
2		No	DLO	467,073.14	350,304.86	0.00	0.00	25,295.52	25,295.52	20,715.71	20,715.71	513,084.37	396,316.09	0.00	0.00
2		Yes	DLO	-9,571.34	-7,178.51	0.00	0.00	-1,129.38	-1,129.38	0.00	0.00	-10,700.72	-8,307.89	0.00	0.00
2		Yes	DLO	-8,791.99	-6,593.99	0.00	0.00	-438.91	-438.91	0.00	0.00	-9,230.90	-7,032.90	0.00	0.00
3		No	BIOVER	36,903.23	27,677.42	0.00	0.00	6,750.00	6,750.00	72,061.72	72,061.72	115,714.95	106,489.14	0.00	0.00
3		Yes	BIOVER	0.00	0.00	0.00	0.00	0.00	0.00	-67.84	-67.84	-67.84	-67.84	0.00	0.00
4		No	UNIPG	26,194.61	19,645.96	0.00	0.00	0.00	0.00	12,695.09	12,695.09	38,889.70	32,341.05	0.00	0.00
5		No	JKI	160,519.35	120,389.51	0.00	0.00	0.00	0.00	12,198.21	12,198.21	172,717.56	132,587.72	0.00	0.00
6		No	NORDGEN	59,947.71	44,960.78	0.00	0.00	0.00	0.00	9,739.22	9,739.22	69,686.93	54,700.00	0.00	0.00
7		No	MTT	50,858.93	38,144.20	0.00	0.00	0.00	0.00	5,559.30	5,559.30	56,418.23	43,703.50	0.00	0.00
8		No	URJC	33,257.60	24,943.20	0.00	0.00	0.00	0.00	6,746.93	6,746.93	40,004.53	31,690.13	0.00	0.00
9		Yes	SXS	-147.63	-110.72	0.00	0.00	0.00	0.00	0.00	0.00	-147.63	-110.72	0.00	0.00
9		No	SXS	149,393.86	112,045.40	0.00	0.00	0.00	0.00	0.00	0.00	149,393.86	112,045.40	0.00	0.00
10		No	UNOT	16,155.47	12,116.60	0.00	0.00	0.00	0.00	4,490.50	4,490.50	20,645.97	16,607.10	0.00	0.00
10		Yes	UNOT	-7,912.86	-5,934.65	0.00	0.00	0.00	0.00	0.00	0.00	-7,912.86	-5,934.65	0.00	0.00
TOTAL				1,179,433.44	884,575.08	0.00	0.00	75,905.89	75,905.89	223,340.04	223,340.04	1,478,679.37	1,183,821.01	0.00	0.00

Requested EU contribution for the reporting period (in €)	1,183,821.01

Use of Resources **Overview Activity Report** Project no. **266394** Period: **01/09/2013 - 31/08/2014**

Acronym: **PGR Secure**

Beneficiary No. 1	**Legal Name: THE UNIVERSITY OF BIRMINGHAM**		**FORM C TOTAL(€) 337,108.21**
PIC: 999907526	**Short Name: UOB**	**Status: Submitted to EU**	**Version: 1**

RTD/INNOVATION

Cost Type	Work Package	Explanation	Cost
PERSONNEL	1,2,3,4	Salaries of Project Coordinator (PC) (WP1: 0.01 PM, WP2: 0.01 PM, WP3: 0.76 PM); one Project Manager (PM)/researcher (WP3: 2.47 PM, WP4: 0.01); two junior researchers (WP1: 6.50 PM, WP3: 10.46 PM).	€ 50,056.27
		RTD/INNOVATION - PERSONNEL **total (€)**	50,056.27
OTHER DIRECT	3,4	TRAVELING: PC and JR – field work (germplasm collection) associated with the Norway national CWR conservation strategy, Norway, 16–20 Sept 2013; PC – project meeting, UNIPG, February 13–14, 2013; PC – meeting to discuss UK CWR research, Defra, London, 12 Feb 2014; Training workshop, 'Ecogeographic land characterization for CWR diversity and gap analysis', 26–27 February 2014, UoB, to inform development of national and regional CWR conservation strategies. Trainers (experts from Spain and the UK) and facilitator (PGR Secure PM/Researcher); Staff member of Natural England – meeting to discuss UK CWR conservation strategy, UoB, 11 March 2014;PC and JR – meeting with Natural England to discuss UK CWR research, Purbeck, Dorset, 13 March 2014; PC – meeting to discuss network of CWR sites in the UK, PLINCK meeting, London Zoo, 19 March 2014; PC and JR – seed collection (research associated with the development of the UK CWR conservation strategy, Lizard, Cornwall, 21 August 2014.	€ 5,417.70
	3	CONSUMABLES: Catering costs for participants in the training workshop, 'Ecogeographic land characterization for CWR diversity and gap analysis', 26–27 February 2014, UoB, to inform development of national and regional CWR conservation strategies; lab consumables for sequencing genebank accessions of Medicago truncatula; AFLP (genetic diversity) analysis associated with the development of the UK CWR conservation strategy; research texts; computer consumables.	€ 77,325.00
		RTD/INNOVATION - OTHER DIRECT **total (€)**	82,742.70
INDIRECT	N/A	N/A	€ 79,679.38
		RTD/INNOVATION **total (€)**	212,478.35

MANAGEMENT

Cost Type	Work Package	Explanation	Cost
PERSONNEL	7	Salaries of PC (0.12 PM) and PM (6.86 PM).	€ 22,768.21
		MANAGEMENT - PERSONNEL **total (€)**	22,768.21
SUBCONTRACTING			€ 4,049.35
		MANAGEMENT - SUBCONTRACTING **total (€)**	4,049.35
OTHER DIRECT	7	TRAVELING: PC and PM/Researcher – Consortium Committee meeting and stakeholder workshop, Wageningen, NL, 25–28 November 2013	€ 532.03
	7	CONSUMABLES: Computer consumables; catering costs, third annual consortium meeting	€ 2,561.83
		MANAGEMENT - OTHER DIRECT **total (€)**	3,093.86
INDIRECT	N/A	N/A	€ 15,517.24
		MANAGEMENT **total (€)**	45,428.66

OTHER			
Cost Type	Work Package	Explanation	Cost
PERSONNEL	6	Salaries of PC (0.33 PM) and PM/researcher (6.85 PM).	€ 35,900.21
		OTHER - PERSONNEL **total (€)**	35,900.21
OTHER DIRECT	6	TRAVELING: PC and PM/researcher, EuroGard VI, 28–29 May 2012, to organize and facilitate CWR national conservation strategy planning training workshop (Cost of conference registration which was incurred during RP3 due to an error made by the conference organizer. Previous costs claimed for this meeting were for travel and subsistence.); PC – dissemination of PGR Secure project results to UK PGR Group, London, 16 October 2013; PC – meetings at FAO and Bioversity International, Rome, to disseminate project results, 15–16 April 2014; PC and JR – dissemination of results of UK national CWR conservation strategy at meeting with Natural England staff, Lizard, Cornwall, 12–13 May 2014; PI, PM/Researcher, Co-Investigator, two JRs, six students (presenters and conference assistants) and one member of the External Advisory Board (EAB) – Joint PGR Secure/EUCARPIA conference: 'ENHANCING GENEPOOL UTILIZATION – Capturing wild relative and landrace diversity for crop improvement', Incorporating the PGR Secure final dissemination conference, Cambridge, UK, 16–20 June 2014; PC – meeting with Syngenta to disseminate project results, Basel, Switzerland, 11–12 August 2014.	€ 11,645.02
	6	CONSUMABLES: Computer software	€ 1,955.52
		OTHER - OTHER DIRECT **total (€)**	13,600.54
INDIRECT	N/A	N/A	€ 29,700.45
		OTHER **total (€)**	79,201.20

Beneficiary No. 1	**Legal Name: THE UNIVERSITY OF BIRMINGHAM**		**FORM C TOTAL(€)**	**-4,442.19**
PIC: 999907526	**Short Name: UOB**	**Status: Submitted to EU**	**Version: 1**	**Adjustment**

RTD/INNOVATION			
Cost Type	Work Package	Explanation	Cost
PERSONNEL	1	Overpayment to staff on maternity leave	€ -5,085.05
		RTD/INNOVATION - PERSONNEL **total (€)**	-5,085.05
OTHER DIRECT	1,2,3,4	CONSUMABLES: Reversal of depreciation costs on equipment (due to revised policy) charged under 'consumables'.	€ 2,308.68
		RTD/INNOVATION - OTHER DIRECT **total (€)**	2,308.68
INDIRECT	N/A	N/A	€ -1,665.82
		RTD/INNOVATION **total (€)**	-4,442.19

Beneficiary No. 1	**Legal Name: THE UNIVERSITY OF BIRMINGHAM**		**FORM C TOTAL(€)**	**-2,482.80**
PIC: 999907526	**Short Name: UOB**	**Status: Submitted to EU**	**Version: 1**	**Adjustment**

RTD/INNOVATION			
Cost Type	Work Package	Explanation	Cost
OTHER DIRECT	1,2,3,4	DURABLE EQUIPMENT: Reversal of depreciation costs on equipment (due to revised policy) charged under 'consumables'.	€ -1,551.75
		RTD/INNOVATION - OTHER DIRECT **total (€)**	-1,551.75
INDIRECT	N/A	N/A	€ -931.05
		RTD/INNOVATION **total (€)**	-2,482.80

Beneficiary No. 2	Legal Name: STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	FORM C TOTAL(€)	513,084.37
PIC: 999547365	Short Name: DLO Status: Submitted to EU	Version: 2	

RTD/INNOVATION			
Cost Type	**Work Package**	**Explanation**	**Cost**
PERSONNEL	1	0.19 PM van Arkel (technician)	€ 1,022.58
	1	0.12 PM Capel (technician)	€ 587.71
	1	0.09 PM Davies (technician)	€ 428.75
	1	0.68 PM Henken (technician)	€ 3,196.80
	1	1.82 PM Finkers (jr. researcher)	€ 12,279.47
	1	0.15 PM Jonker (technician)	€ 690.37
	1	5.55 PM Kaauwen (technician)	€ 26,809.83
	1	0.13 PM Mumm (jr. researcher)	€ 831.50
	1	13.48 PM Pelgrom (technician)	€ 64,341.56
	1	0.55 PM van Silfhout (technician)	€ 2,622.20
	1	0.91 PM Voorrips (researcher)	€ 7,147.04
	1	0.07 PM de vos (researcher)	€ 553.37
	1	5.65 PM Vosman (sr. researcher)	€ 58,033.91
	1	4.47 PM van 't Westende (technician)	€ 21,098.46
	2	2.98 PM Bas (technician)	€ 15,009.97
	5	6.16 PM Kik (researcher)	€ 44,510.12
	1	1.44 PM Smulders (sr. researcher)	€ 13,685.89
		RTD/INNOVATION - PERSONNEL **total (€)**	272,849.53
SUBCONTRACTING	5	Subcontract payment key person France	€ 3,638.19
		RTD/INNOVATION - SUBCONTRACTING **total (€)**	3,638.19
OTHER DIRECT	1	CONSUMABLES: several consumables	€ 8,298.18
	1	OTHER: greenhouse costs	€ 40,337.93
	1	TRAVELING: costs stay Perugia Vosman 12-02-2014 till 21-02-2014 visit partner UoP	€ 173.48
	1	TRAVELING: ticket Londen Vosman 05-02-2014 visit partner UoP	€ 221.92
	1	TRAVELING: ticket Perugia Vosman 12-02-2014 visit partner UoP	€ 222.96
	1	TRAVELING: several trips by car	€ 54.74
	5	OTHER: stakeholder meeting in November 2013 in Wageningen	€ 15,765.42
		RTD/INNOVATION - OTHER DIRECT **total (€)**	65,074.63
INDIRECT	N/A	N/A	€ 125,510.79
		RTD/INNOVATION **total (€)**	467,073.14

MANAGEMENT			
Cost Type	**Work Package**	**Explanation**	**Cost**
PERSONNEL	7	0.73 PM Vosman (sr. researcher)	€ 7,480.86
	7	0.73 PM kik (researcher)	€ 5,237.70
		MANAGEMENT - PERSONNEL **total (€)**	12,718.56
SUBCONTRACTING	7	audit report CS2	€ 1,541.92
	7	audit report CS3	€ 5,184.50
		MANAGEMENT - SUBCONTRACTING **total (€)**	6,726.42
INDIRECT	N/A	N/A	€ 5,850.54
		MANAGEMENT **total (€)**	25,295.52

OTHER			
Cost Type	**Work Package**	**Explanation**	**Cost**
PERSONNEL	6	0.33 PM Kik (researcher)	€ 2,374.47
	6	0.33 PM Pelgrom (technician)	€ 1,561.53
	6	0.31 PM Voorrips (researcher)	€ 2,427.59
	6	0.36 PM Vosman (sr. researcher)	€ 3,729.92
		OTHER - PERSONNEL **total (€)**	10,093.51
OTHER DIRECT	6	TRAVELING: costs stay Vosman PGR secure Symposium and Project meeting Cambridge 16-06-2014 till 20-06-2014	€ 1,178.43
	6	TRAVELING: ticket Vosman PGR secure Symposium and Project meeting Cambridge 16-06-2014 till 20-06-2014	€ 291.63
	6	TRAVELING: costs stay Pelgrom PGR secure Symposium and Project meeting Cambridge 16-06-2014 till 20-06-2014	€ 1,203.64
	6	TRAVELING: costs stay Voorrips PGR secure Symposium and Project meeting Cambridge 16-06-2014 till 20-06-2014	€ 1,148.83
	6	TRAVELING: costs stay Kik PGR secure Symposium and Project meeting Cambridge 16-06-2014 till 20-06-2014	€ 2,012.74
	6	TRAVELING: ticket Kik PGR secure Symposium and Project meeting Cambridge 16-06-2014 till 20-06-2014	€ 143.91
		OTHER - OTHER DIRECT **total (€)**	5,979.18
INDIRECT	N/A	N/A	€ 4,643.02
		OTHER **total (€)**	20,715.71

Beneficiary No. 2	**Legal Name:**	**STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK**		**FORM C TOTAL(€)**	**-10,700.72**
PIC: 999547365	**Short Name:**	**DLO**	**Status: Submitted to EU**	**Version: 2**	**Adjustment**

RTD/INNOVATION			
Cost Type	**Work Package**	**Explanation**	**Cost**

PERSONNEL	2		€ -6,760.12
		RTD/INNOVATION - PERSONNEL	**total (€)** -6,760.12
SUBCONTRACTING	2	keyperson Greece	€ 5,000.00
	2		€ -2,228.57
		RTD/INNOVATION - SUBCONTRACTING	**total (€)** 2,771.43
OTHER DIRECT	2	OTHER:	€ -2,270.19
		RTD/INNOVATION - OTHER DIRECT	**total (€)** -2,270.19
INDIRECT	N/A	N/A	€ -3,312.46
		RTD/INNOVATION	**total (€)** -9,571.34

MANAGEMENT			
Cost Type	**Work Package**	**Explanation**	**Cost**
PERSONNEL	6		€ -757.97
		MANAGEMENT - PERSONNEL	**total (€)** -757.97
INDIRECT	N/A	N/A	€ -371.41
		MANAGEMENT	**total (€)** -1,129.38

Beneficiary No. 2	**Legal Name: STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK**	**FORM C TOTAL(€)**	**-9,230.90**
PIC: 999547365	**Short Name: DLO**	**Status: Submitted to EU**	**Version: 2 Adjustment**

RTD/INNOVATION			
Cost Type	**Work Package**	**Explanation**	**Cost**
PERSONNEL	2		€ -3,213.53
		RTD/INNOVATION - PERSONNEL	**total (€)** -3,213.53
SUBCONTRACTING	2		€ -637.85
		RTD/INNOVATION - SUBCONTRACTING	**total (€)** -637.85
OTHER DIRECT	2	OTHER:	€ -307.45
		RTD/INNOVATION - OTHER DIRECT	**total (€)** -307.45
INDIRECT	N/A	N/A	€ -4,633.16
		RTD/INNOVATION	**total (€)** -8,791.99

MANAGEMENT			
Cost Type	**Work Package**	**Explanation**	**Cost**
PERSONNEL	6		€ -294.57
		MANAGEMENT - PERSONNEL	**total (€)** -294.57

INDIRECT	N/A	N/A	€ -144.34
		MANAGEMENT total (€)	-438.91

Beneficiary No. 3	Legal Name: INTERNATIONAL PLANT GENETIC RESOURCES INSTITUTE*IPGRI	FORM C TOTAL(€)	115,714.95
PIC: 998025241	Short Name: BIOVER	Status: Submitted to EU	Version: 1

RTD/INNOVATION

Cost Type	Work Package	Explanation	Cost
PERSONNEL	2	Project Leader 0.12 PM, Scientist 0.60 PM, Scientist 0.84 PM, System Analyst and developer 2.16 PM	€ 27,814.31
		RTD/INNOVATION - PERSONNEL total (€)	27,814.31
OTHER DIRECT	2	TRAVELING: Mr. Ehsan Dulloo from Rome (Italy) to Wageningen (The Netherlands) 24.11-29.11.2013 to attend the PGR Secure stakeholder workshop.	€ 992.01
	2	TRAVELING: Ms. Sonia Dias from Rome (Italy) to Wageningen (The Netherlands) 24.11-29.11.2013 to attend the PGR Secure stakeholder workshop.	€ 1,075.81
	2	TRAVELING: Mr. Milko Skofic from Rome (Italy) to Wageningen (The Netherlands) 26.11-29.11.2013 to attend the PGR Secure stakeholder workshop.	€ 870.56
		RTD/INNOVATION - OTHER DIRECT total (€)	2,938.38
INDIRECT	N/A	N/A	€ 6,150.54
		RTD/INNOVATION total (€)	36,903.23

MANAGEMENT

Cost Type	Work Package	Explanation	Cost
SUBCONTRACTING	7	PricewaterhouseCoopers (PwC) - Grant audit as required per the grant agreement	€ 6,750.00
		MANAGEMENT - SUBCONTRACTING total (€)	6,750.00
INDIRECT	N/A	N/A	€ 0.00
		MANAGEMENT total (€)	6,750.00

OTHER

Cost Type	Work Package	Explanation	Cost
PERSONNEL	6	Project Leader 0.24 PM, Scientist 1.20 PM	€ 11,220.42
		OTHER - PERSONNEL total (€)	11,220.42
SUBCONTRACTING	6	Consultant Antonio Carella - IT development support - Symphony framework developer for the TIP	€ 2,010.28
	6	NIAB Innovation Farm - Letter of Agreement for arranging PGR Secure International Conference - For dealing with local arrangements and payments necessary for the International conference such as caterings, conference rooms, local transports and other local logistics.	€ 10,134.36
		OTHER - SUBCONTRACTING total (€)	12,144.64

OTHER DIRECT	6	CONSUMABLES: OSX Server (Software) - Updated version of OSX server	€ 18.88
	6	CONSUMABLES: 200 Eco cotton shoppers - bags for delegates - PGR Secure International Conference	€ 485.45
	6	CONSUMABLES: 200*8GB Twister Flash Drive, 200*Neck Trap, 200*Compenso per copia private - USB with conference Book of Abstracts, Programme, etc, for distribution at the PGR Secure International Conference	€ 1,364.44
	6	CONSUMABLES: Samsung 840/Evo/Pro SSD & Drive da 500 Gbyte - Hard disk replacement	€ 514.43
	6	CONSUMABLES: Top Case and keyboard - Replacement of Top Case and keyboard	€ 292.51
	6	CONSUMABLES: Easy Chair Conference Management System tool - Purchase of Easy Chair Conference Management System tool for WP6 Final Disseimination Conference	€ 204.49
	6	TRAVELING: Ms. Sonia Dias from Rome (Italy) to Cambridge (UK) 12.6-21.6.2014 to attend the PGR Secure final dissemination Conference.	€ 3,140.65
	6	TRAVELING: Mr. Milko Skofic from Rome (Italy) to Cambridge (UK) 16.6-21.6.2014 to attend the PGR Secure final dissemination Conference.	€ 1,829.62
	6	TRAVELING: Mr. Michael Halewood from Rome (Italy) to Cambridge (UK) 18.6-21.6.2014 to attend the PGR Secure final dissemination Conference.	€ 1,354.02
	6	TRAVELING: Ms. Imke Thormann from Rome (Italy) to Cambridge (UK) 16.6-21.6.2014 to attend the PGR Secure final dissemination Conference.	€ 1,901.36
	6	TRAVELING: Ms. Nora Capozio from Rome (Italy) to Cambridge (UK) 16.6-21.6.2014 to attend the PGR Secure final dissemination Conference.	€ 1,860.60
	6	TRAVELING: Ms. Sara Hutchinson from Rome (Italy) to Cambridge (UK) 12.6-21.6.2014 to attend the PGR Secure final dissemination Conference.	€ 3,268.00
	6	TRAVELING: Mr. Ehsan Dulloo from Rome (Italy) to Cambridge (UK) 13.6-20.6.2014 to attend the PGR Secure final dissemination Conference.	€ 2,371.48
	6	TRAVELING: Mr. Theodorus Johannes Leonardus from Amsterdam (The Netherlands) to Cambridge (UK) 15.6-20.6.2014 to attend the PGR Secure final dissemination Conference.	€ 1,270.98
	6	TRAVELING: Mr. Hugo Rafael Perales Rivera from Tuxtla Gutierrez (Mexico) to Cambridge (UK) 13.6-21.6.2014 to attend the PGR Secure final dissemination Conference.	€ 2,958.14
	6	TRAVELING: Ms. Lisanne Boon from Eindhoven (The Netherlands) to Cambridge (UK) 15.6-20.6.2014 to attend the PGR Secure final dissemination Conference.	€ 1,303.61
	6	TRAVELING: Mr. Jean-Christophe Glaszmann from Montpellier (France) to Cambridge (UK) 16.6-20.6.2014 to attend the PGR Secure final dissemination Conference.	€ 1,208.11
	6	TRAVELING: Mr. Abishkar Subedi from Amsterdam (The Netherlands) to Cambridge (UK) 18.6-21.6.2014 to attend the PGR Secure final dissemination Conference.	€ 679.15
	6	TRAVELING: Mr. Jose Iriondo from Madrid (Spain) to Cambridge (UK) 15.6-20.6.2014 to attend the PGR Secure final dissemination Conference.	€ 1,234.58
	6	TRAVELING: Mr. Richard Finkers from Amsterdam (The Netherlands) to Cambridge (UK) 16.6-20.6.2014 to attend the PGR Secure final dissemination Conference.	€ 1,117.08
	6	TRAVELING: Mr. Mathias Lorieux from Cali (Colombia) to Cambridge (UK) 14.6-21.6.2014 to attend the PGR Secure final dissemination Conference.	€ 3,269.71
	6	TRAVELING: Mr. Kenneth Street from Perth (Australia) to Cambridge (UK) 14.6-21.6.2014 to attend the PGR Secure final dissemination Conference.	€ 3,126.81
	6	TRAVELING: Ms. Maryam Rahmanian from Rome (Italy) to Cambridge (UK) 14.6-20.6.2014 to attend the PGR Secure final dissemination Conference.	€ 1,570.02
	6	TRAVELING: Mr. Daniel Zamir from Tel Aviv (Israel) to Cambridge (UK) 15.6-19.6.2014 to attend the PGR Secure final dissemination Conference.	€ 2,007.69
	6	TRAVELING: Ms Marleni Ramirez from Cali (Colombia) to Cambridge (UK) 14.6-21.6.2014 to attend the PGR Secure final dissemination Conference.	€ 358.67
		OTHER - OTHER DIRECT **total (€)**	38,710.48
INDIRECT	N/A	N/A	€ 9,986.18
		OTHER **total (€)**	72,061.72

Beneficiary No. 3	Legal Name: INTERNATIONAL PLANT GENETIC RESOURCES INSTITUTE*IPGRI	FORM C TOTAL(€)	-67.84
PIC: 998025241	Short Name: BIOVER	Status: Submitted to EU	Version: 1 Adjustment

OTHER			
Cost Type	Work Package	Explanation	Cost
OTHER DIRECT	6	OTHER: Setup of a list server - list server set for dissemination of the end of project conference	€ -56.53
		OTHER - OTHER DIRECT total (€)	-56.53
INDIRECT	N/A	N/A	€ -11.31
		OTHER total (€)	-67.84

Beneficiary No. 4	Legal Name: UNIVERSITA DEGLI STUDI DI PERUGIA	FORM C TOTAL(€)	38,889.70
PIC: 999846319	Short Name: UNIPG	Status: Submitted to EU	Version: 1

RTD/INNOVATION			
Cost Type	Work Package	Explanation	Cost
PERSONNEL	2,4	Wp2_t2.1,2.2: VNegri (principal scientist) mm=0.01preparing data for TraitInformationPortal WP4_t4.2,4.3,4.4: VNegri (principal scientist) mm=0.52 taking part to stakeholder meeting in Wageningen, preparing Italian, European priority genepool, generic European LR stategies, RTorricelli (highly qualified technician_scientist) mm= 0.50 preparing Italian, European priority genepool, generic European LR stategies, MBodesmo (hired staff) mm = 1.93 info collection on LR and CWR present in the same areas	€ 15,813.33
		RTD/INNOVATION - PERSONNEL total (€)	15,813.33
OTHER DIRECT	4	TRAVELING: VNegri (principal scientist) taking part to stakeholder meeting in Wageningen (nov2013)	€ 558.30
		RTD/INNOVATION - OTHER DIRECT total (€)	558.30
INDIRECT	N/A	N/A	€ 9,822.98
		RTD/INNOVATION total (€)	26,194.61

OTHER			
Cost Type	Work Package	Explanation	Cost
PERSONNEL	6	WP6 t6.6 VNegri mm =0. 34, RTorricelli mm= 0.33 Taking part to the Final dissemination conference In Cambridge	€ 4,182.95
		OTHER - PERSONNEL total (€)	4,182.95
SUBCONTRACTING			€ 0.00
		OTHER - SUBCONTRACTING total (€)	0.00
OTHER DIRECT	6	TRAVELING: VNegri (principal scientist) taking part to the final dissemination conference in Cambridge (June 2014)	€ 1,622.17
	6	TRAVELING: RTorricelli (highly qualified technician_scientist) taking part to the final dissemination conference in Cambridge (June 2014)	€ 1,457.19
	6	CONSUMABLES: PGR secure poster and brochure printing for dissemination activities at annual 'Società Italiana di Genetica Agraria' congress (Foggia, Italy, September 2013)	€ 108.60
	6	CONSUMABLES: CD Rom printing + etiquettes (NEGRI V., PACICCO L., BODESMO M., TORRICELLI R. 2013 - The first Italian inventory of in situ maintained landraces. On CD ROM. ISBN 978-88-6074-279-7. Morlacchi Editrice, Perugia)	€ 563.52
		OTHER - OTHER DIRECT total (€)	3,751.48

INDIRECT	N/A	N/A	€ 4,760.66
		OTHER total (€)	12,695.09

Beneficiary No. 5	Legal Name: JULIUS KUHN INSTITUT BUNDESFORSCHUNGSINSTITUT FUR KULTURPFLANZEN		FORM C TOTAL(€) 172,717.56
PIC: 998890578	Short Name: JKI	Status: Submitted to EU	Version: 1

RTD/INNOVATION

Cost Type	Work Package	Explanation	Cost
PERSONNEL	5	Scientist Bülow 11.75 PM	€ 57,776.82
	5	Permanent Staff Frese 3.56 PM	€ 21,864.00
		RTD/INNOVATION - PERSONNEL total (€)	79,640.82
SUBCONTRACTING	5	Work contract between JKI and consultant in Slovenia (assistance in preparation and implemention of interviews as well as reports)	€ 3,178.33
		RTD/INNOVATION - SUBCONTRACTING total (€)	3,178.33
OTHER DIRECT	5	TRAVELING: TRAVELLING: Frese, L., Laon, France, 26-270913 - IIRB Meeting Beta stakeholder group	€ 266.86
	5	TRAVELING: TRAVELLING: Frese, L. and Bülow, L., Bonn, Germany, 05-061113 - PGR Secure Breeders' Committee Final Meeting	€ 762.42
	5	TRAVELING: TRAVELLING: Frese, L. and Bülow, L., Wageningen, Netherlands, 25-291113 - participation as organizers of the PGR Secure stakeholder workshop 'On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis', cost for workshop hosting and travel reimbursement for 28 participants of the workshop	€ 17,437.69
	5	TRAVELING: TRAVELLING: Frese, L., Bonn, Germany, 060614 - participation at a BfN Meeting on in situ management	€ 230.35
		RTD/INNOVATION - OTHER DIRECT total (€)	18,697.32
INDIRECT	N/A	N/A	€ 59,002.88
		RTD/INNOVATION total (€)	160,519.35

OTHER

Cost Type	Work Package	Explanation	Cost
PERSONNEL	6	Scientist Bülow 0.25 PM	€ 1,185.30
	6	Permanent staff Frese 0.47 PM	€ 2,886.54
		OTHER - PERSONNEL total (€)	4,071.84
OTHER DIRECT	6	TRAVELING: TRAVELLING: Frese, L. and Bülow, L., Cambridge, United Kingdom, 15-210614 - participation at the Joint PGR Secure/EUCARPIA conference: 'ENHANCED GENEPOOL UTILIZATION - Capturing wild relative and landrace diversity for crop improvement'	€ 3,552.04
		OTHER - OTHER DIRECT total (€)	3,552.04
INDIRECT	N/A	N/A	€ 4,574.33
		OTHER total (€)	12,198.21

Beneficiary No. 6	Legal Name: NORDISKT GENRESURSCENTER		FORM C TOTAL(€) 69,686.93
PIC: 986317147	Short Name: NORDGEN	Status: Submitted to EU	Version: 1

RTD/INNOVATION			
Cost Type	Work Package	Explanation	Cost
PERSONNEL	5	Salary for 1 senior scientist, PM's 2,71	€ 19,097.49
		RTD/INNOVATION - PERSONNEL total (€)	19,097.49
OTHER DIRECT	5	TRAVELING: Travel expenses for 1 senior scientist attending: Breeders committee meeting in Bonn 5-6 Nov, 2013. Consortium-meeting and workshop "On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis Workshop in Wageningen, November 25–29, 2013"	€ 695.25
	5	OTHER: Documents sent by DHL	€ 72.40
	5	OTHER: Travel expenses for 18 participants in workshop: "On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis Workshop in Wageningen, November 25–29, 2013"	€ 4,724.63
	5	OTHER: Part of workshop expenses for: "On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis Workshop in Wageningen, November 25–29, 2013"	€ 12,877.55
		RTD/INNOVATION - OTHER DIRECT total (€)	18,369.83
INDIRECT	N/A	N/A	€ 22,480.39
		RTD/INNOVATION total (€)	59,947.71

OTHER			
Cost Type	Work Package	Explanation	Cost
PERSONNEL	6	Salary for 1 senior scientist, PM's 0,68	€ 4,801.11
		OTHER - PERSONNEL total (€)	4,801.11
OTHER DIRECT	6	TRAVELING: Travel expenses for 1 senior scientist attending: PGR-Secure and EUCARPIA conference in Cambridge 15-20 June, 2014 "ENHANCED GENEPOOL UTILIZATION – Capturing wild relative and landrace diversity for crop improvement"	€ 1,189.40
	6	OTHER: Poster to PGR-Secure and EUCARPIA conference in Cambridge 15-20 June, 2014	€ 96.50
		OTHER - OTHER DIRECT total (€)	1,285.90
INDIRECT	N/A	N/A	€ 3,652.21
		OTHER total (€)	9,739.22

Beneficiary No. 7	Legal Name: MAA JA ELINTARVIKETALOUDEN TUTKIMUSKESKUS		FORM C TOTAL(€) 56,418.23
PIC: 999467825	Short Name: MTT	Status: Submitted to EU	Version: 1

RTD/INNOVATION			
Cost Type	Work Package	Explanation	Cost
PERSONNEL	2,3,4	WP2: collating descriptors of in situ inventoried landraces of Finland (0.9 pm), 1 resercher. WP3: negotiations for implementing the Finnish CWR strategy (0.05 pm), 1 researcher. WP4: in situ landrace inventories, european nand national landrace conservation strategies (2.93 pm),1 researcher	€ 24,782.22
		RTD/INNOVATION - PERSONNEL total (€)	24,782.22

SUBCONTRACTING	3	Finnish CWR strategy: collating descriptors of inventories CWR to database; negotiations for implementing the Finnish CWR strategy (University of Helsinki, 1 researcher)	€ 5,842.58
		RTD/INNOVATION - SUBCONTRACTING **total (€)**	5,842.58
OTHER DIRECT	4	TRAVELING: 1) national meeting aiming to implement the Finnish landrace strategy, Finland, 13/11/2013, 1 researcher, 89,9 e; 2) PGR Secure Consortium Committee meeting; PGR Secure stakeholder workshop, The Netherlands, 21-28/11/2013, 1 researcher, 982,21 e; 3) preparing European landrace strategies (with WP4 leader), Italy, 5-14/4/2014,1 researcher, 1469,22 e	€ 2,541.33
		RTD/INNOVATION - OTHER DIRECT **total (€)**	2,541.33
INDIRECT	N/A	N/A	€ 17,692.80
		RTD/INNOVATION **total (€)**	50,858.93

MANAGEMENT			
Cost Type	**Work Package**	**Explanation**	**Cost**
PERSONNEL			€ 0.00
		MANAGEMENT - PERSONNEL **total (€)**	0.00
INDIRECT	N/A	N/A	€ 0.00
		MANAGEMENT **total (€)**	0.00

OTHER			
Cost Type	**Work Package**	**Explanation**	**Cost**
PERSONNEL	6	Dissemination: Joint PGR Secure / EUCARPIA conference, UK (0.17 pm), 1 researcher	€ 1,023.73
		OTHER - PERSONNEL **total (€)**	1,023.73
OTHER DIRECT	6	TRAVELING: 1) PGR Secure final dissemination conference: Joint PGR Secure /EUCARPIA conference 'Enhanced genepool utilization', UK, 16-20/6/2014; 1917.06 e, 1 researcher 2) presenting landrace in situ inventory results of Finland at NJF seminar 474 'Nordic heritage varieties of cereals', Mariehamn, Finland, 15-17/7/2014, Finland, 655.56 e, 1 researcher 3) presenting landrace in situ inventory results of Finland at EUCARPIA Genetic Resources section meeting 'Pre-breeding: fishing in the gene pool', 10-13/6/2013, Sweden, 1187.75 e, 1 researcher	€ 3,760.37
		OTHER - OTHER DIRECT **total (€)**	3,760.37
INDIRECT	N/A	N/A	€ 775.20
		OTHER **total (€)**	5,559.30

Beneficiary No. 8	**Legal Name: UNIVERSIDAD REY JUAN CARLOS**	**FORM C TOTAL(€)**	**40,004.53**
PIC: 999886283	**Short Name: URJC**	**Status: Submitted to EU**	**Version: 1**

RTD/INNOVATION			
Cost Type	**Work Package**	**Explanation**	**Cost**
PERSONNEL	2	0.4 PM PhD student/ researcher Mª Luisa Rubio	€ 723.90
	2	0.1 PM Full Prof. Jose Maria Iriondo (PI)	€ 549.70

	3	8,2 PM PhD student/ researcher Mª Luisa Rubio	€ 14,840.03
	3	0.75 PM Full Prof. Jose Maria Iriondo (PI)	€ 4,122.77
		RTD/INNOVATION - PERSONNEL total (€)	20,236.40
OTHER DIRECT	3	TRAVELING: PGR Secure Consortium Committee meeting, 25 November 2013, Wageningen, the Netherlands Travel expenses (plane tickets), allowances and accommodation for Prof. Iriondo (PI).	€ 549.60
		RTD/INNOVATION - OTHER DIRECT total (€)	549.60
INDIRECT	N/A	N/A	€ 12,471.60
		RTD/INNOVATION total (€)	33,257.60

OTHER			
Cost Type	**Work Package**	**Explanation**	**Cost**
PERSONNEL	6	0.4 PM PhD student/ researcher Mª Luisa Rubio	€ 723.90
	6	0.4 PM Full Prof. Jose Maria Iriondo (PI)	€ 2,198.81
		OTHER - PERSONNEL total (€)	2,922.71
OTHER DIRECT	6	TRAVELING: PGR Secure final dissemination conference. Joint PGR Secure/EUCARPIA conference: 'ENHANCING GENEPOOL UTILIZATION – Capturing wild relative and landrace diversity for crop improvement' , 16–20 June 2014, NIAB Innovation Farm, Cambridge, UK	€ 1,294.12
		OTHER - OTHER DIRECT total (€)	1,294.12
INDIRECT	N/A	N/A	€ 2,530.10
		OTHER total (€)	6,746.93

Beneficiary No. 9	**Legal Name: ServiceXS BV**	**FORM C TOTAL(€)**	**-147.63**
PIC: 996183987	**Short Name: SXS**	**Status: Submitted to EU**	**Version: 1 Adjustment**

RTD/INNOVATION			
Cost Type	**Work Package**	**Explanation**	**Cost**
PERSONNEL	1	Correction of calculated wages	€ -92.27
		RTD/INNOVATION - PERSONNEL total (€)	-92.27
INDIRECT	N/A	N/A	€ -55.36
		RTD/INNOVATION total (€)	-147.63

Beneficiary No. 9	**Legal Name: ServiceXS BV**	**FORM C TOTAL(€)**	**149,393.86**
PIC: 996183987	**Short Name: SXS**	**Status: Submitted to EU**	**Version: 1**

RTD/INNOVATION			
Cost Type	**Work Package**	**Explanation**	**Cost**
PERSONNEL	1	6,26 Person-months (Senior researcher), and 1,11 Person-months (Technician)	€ 57,111.33
		RTD/INNOVATION - PERSONNEL total (€)	57,111.33
OTHER DIRECT	1	CONSUMABLES: 3 288 Axxiom arrays+reagents (WP task 1.5), 3 High seq runs (WP task 1.3), sample prep kits and 4 harddisks	€ 34,423.49

	1	TRAVELING: PGR Secure Third Annual Consortium meeting 16 June 2014	€ 1,804.17
	1	OTHER: Shipping costs data	€ 32.17
		RTD/INNOVATION - OTHER DIRECT total (€)	36,259.83
INDIRECT	N/A	N/A	€ 56,022.70
		RTD/INNOVATION total (€)	149,393.86

Beneficiary No. 10	**Legal Name:**	**THE UNIVERSITY OF NOTTINGHAM**		**FORM C TOTAL(€)**	**20,645.97**
PIC: 999976978	**Short Name:**	**UNOT**	**Status: Submitted to EU**	**Version: 1**	

RTD/INNOVATION			
Cost Type	**Work Package**	**Explanation**	**Cost**
PERSONNEL	1	Salary costs for 1 researcher, 2.5PMs	€ 7,237.61
		RTD/INNOVATION - PERSONNEL total (€)	7,237.61
OTHER DIRECT	1	TRAVELING: Consortium Committee meeting 25th November 2013. Dorskampzaal 1, Hof van Wageningen, the Netherlands. 25 November 2013 - S May	€ 492.56
	1	CONSUMABLES: Chemicals used in connection to WP1	€ 2,367.00
		RTD/INNOVATION - OTHER DIRECT total (€)	2,859.56
INDIRECT	N/A	N/A	€ 6,058.30
		RTD/INNOVATION total (€)	16,155.47

OTHER			
Cost Type	**Work Package**	**Explanation**	**Cost**
OTHER DIRECT	6	OTHER: Conference registration fees S May and Marcos Castellanos	€ 1,311.79
	6	TRAVELING: Travel costs for S May and Marcos Castellanos. PGR Secure final dissemination conference ENHANCED GENEPOOL UTILIZATION – Capturing wild relative and landrace diversity for crop improvement 16–20 June 2014 NIAB Innovation Farm, Cambridge, UK. Poster presentation and a session chaired by S May.	€ 1,494.77
		OTHER - OTHER DIRECT total (€)	2,806.56
INDIRECT	N/A	N/A	€ 1,683.94
		OTHER total (€)	4,490.50

Beneficiary No. 10	**Legal Name:**	**THE UNIVERSITY OF NOTTINGHAM**		**FORM C TOTAL(€)**	**-7,912.86**
PIC: 999976978	**Short Name:**	**UNOT**	**Status: Submitted to EU**	**Version: 1**	**Adjustment**

RTD/INNOVATION			
Cost Type	**Work Package**	**Explanation**	**Cost**
OTHER DIRECT	1	OTHER: VAT removed from Consumable purchase €29,672.63 claimed in Period 2	€ -4,945.54
		RTD/INNOVATION - OTHER DIRECT total (€)	-4,945.54
INDIRECT	N/A	N/A	€ -2,967.32
		RTD/INNOVATION total (€)	-7,912.86

Costs details' TOTAL for this period (€)	1,478,679.37

	EUROPEAN COMMISSION RESEARCH AND INNOVATION DG	Final Report

Project No: 266394

Project Acronym: PGR Secure

Project Full Name: Novel characterization of crop wild relative and landrace resources as a basis for improved crop breeding

Final Report

Period covered: from 01/03/2011 **to** 31/08/2014

Date of preparation: 16/09/2014

Start date of project: 01/03/2011

Date of submission (SESAM): 31/10/2014

Project coordinator name:
Dr. Nigel Maxted

Project coordinator organisation name:
THE UNIVERSITY OF BIRMINGHAM

Version: 1

Final Report

PROJECT FINAL REPORT

Grant Agreement number:	266394
Project acronym:	PGR Secure
Project title:	Novel characterization of crop wild relative and landrace resources as a basis for improved crop breeding
Funding Scheme:	FP7-CP-FP
Project starting date:	01/03/2011
Project end date:	31/08/2014
Name of the scientific representative of the project's coordinator and organisation:	Dr. Nigel Maxted THE UNIVERSITY OF BIRMINGHAM
Tel:	+441214145571
Fax:	+441214145925
E-mail:	N.Maxted@bham.ac.uk
Project website address:	http://www.pgrsecure.org

Final Report

Please note that the contents of the Final Report can be found in the attachment.

4.1 Final publishable summary report

Executive Summary
See attached pdf document, 'Final_Report_Section_4.1'
Summary description of project context and objectives
See attached pdf document, 'Final_Report_Section_4.1'
Description of main S & T results/foregrounds
See attached pdf document, 'Final_Report_Section_4.1'
Potential impact and main dissemination activities and exploitation results
See attached pdf document, 'Final_Report_Sections_4.1_and_4.2'
Address of project public website and relevant contact details
See attached pdf document, 'Final_Report_Section_4.1'

www.pgrsecure.org

Project acronym: PGR Secure

Project Full Name: Novel characterization of crop wild relative and landrace resources as a basis for improved crop breeding

Final Report

Section 4.1: Final publishable summary

Contents

4.1.1 Executive summary

The PGR Secure action, 'Novel characterization of crop wild relative and landrace resources as a basis for improved crop breeding' was undertaken to address the pressing need for greater genetic diversity in European crops to mitigate the potentially devastating impacts of climate change on the agri-environments in which they grow. Extreme weather events resulting from climate change have already resulted in significant economic losses in the EU agricultural sector amounting to billions of euros. There is an urgency to breed more resilient crops and to find ways of speeding up the plant breeding process to provide a buffer against unpredictable climatic changes.

The particular value of crop wild relatives (CWR – plant species closely related to crops) and landraces (LR – locally adapted, genetically diverse crop varieties) for crop improvement has long been recognized. However, their conservation has been largely neglected and their full utilization has been hampered by insufficient knowledge of their diversity; lack of characterized germplasm collections; unavailability of information on potentially useful material and specific traits; difficulties associated with the time taken to breed uniform and stable crops utilizing wild species; and problems of access to plant material due to the political issues of sovereignty and benefit-sharing.

Like other wild species, CWR are threatened by a range of human-induced pressures on their native habitats, including climate change. Historically, many LR varieties have been lost (and continue to be lost) due to replacement with high yielding varieties, changing consumer preferences and expectations, and socio-economic circumstances impacting on LR growers. Without a systematic strategy for conserving CWR and LR diversity, many populations will continue to suffer genetic erosion (loss of unique traits) and may even face extinction. There is an imperative to conserve these resources *in situ* (i.e., in their native habitats or where they have adapted to local conditions) to allow continuing natural evolution through adaptation to changing environmental conditions. There is also the need for safety *ex situ* storage in gene banks where they can be characterized and made available for crop improvement programmes.

Actions undertaken by the PGR Secure consortium have resulted in the development of an integrated approach to the conservation of these important resources which combines national and regional conservation strategies. However, conservation is only one part of the story. In order to overcome the obstacles to their effective utilization, the complexity of procedures for breeders obtaining material and the barriers to the use of exotic diversity (i.e., plant material that is more difficult to utilize in conventional breeding programmes) need to be addressed. PGR Secure brought the European PGRFA stakeholder community (genebanks, public research institutes, commercial plant breeding companies, agro-NGOs and governmental bodies) together to better understand their needs and to identify ways to improve the links between conserved CWR and LR resources and their use in crop improvement. The project also developed novel tools and methods to identify traits of interest to plant breeders and to speed up the breeding process, as well as to improve access to CWR and LR conservation and utilization data.

Achieving effective conservation and use of European CWR and LR diversity as a means to promote food and economic security requires coherent, regionally coordinated policy and the appropriate resources for their conservation, characterization and evaluation. The PGR Secure consortium has taken the first steps towards achieving this aim by providing a solid scientific and technological foundation to underpin policy development, the maintenance of food security and to safeguard Europe's agricultural economy.

4.1.2 Project context and objectives

Introduction

Our food depends on the continued availability of novel sources of genetic variation to breed new varieties of crops which will thrive in the rapidly evolving agri-environmental conditions we are now faced with as a result of climate change. Wild plant species closely related to crops (crop wild relatives, or CWR) and traditional, locally adapted crop varieties (landraces, or LR) are vital sources of such variation, yet these resources are themselves threatened by the effects of climate change, as well as by a range of other human-induced pressures and socio-economic changes. Further, while the value of CWR and LR for food security is widely recognized, there is a lack of knowledge about the diversity that exists and precisely how that diversity may be used for crop improvement. This is despite the importance of these resources being recognized in a number of policy instruments, including the FAO Global Plan of Action for the conservation and sustainable use of PGRFA[1] (GPA), FAO International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), CBD Global Strategy for Plant Conservation, CBD Strategic Plan for Biodiversity 2011–2020, and European Strategy for Plant Conservation. PGR Secure aimed to address these issues by: a) developing fast and economic methods to identify and make available genetic material that can be used by plant breeders, for example to confer resistance to new strains of pests and diseases and tolerance to extreme environmental conditions such as drought, flooding and heat stress – the biotic and abiotic pressures which are rapidly evolving and having an increasingly detrimental effect on crop productivity; and b) developing a Europe-wide systematic strategy for the conservation of the highest priority CWR and LR resources to secure the genetic diversity needed for crop improvement; and c) ensuring that conserved diversity is made available to users in a manner that facilitates their ease of use.

PGR Secure context: a step change in agrobiodiversity conservation and use

The EC Biodiversity Action Plan for Agriculture (www.epbrs.org/PDF/EPBRS-IR2004-BAP%20Agriculture.pdf) highlighted the need for a step change in crop cultivar production in Europe to ensure food security across the continent, particularly in light of the adverse impacts of climate change on crop yields, as well as to respond to rapidly changing consumer demands. If these requirements are to be met, plant breeders need a broader pool of diversity to supply the necessary range of traits, as well as greater efficiency in characterization and evaluation techniques to locate the desired traits and speed up the production of new varieties. The Action Plan also argued that maintaining the *status quo* for agrobiodiversity conservation and use is no longer tenable and that a step change in systematic conservation and use is also required. The two major components of agrobiodiversity that offer the broadest range of diversity for breeders are CWR and LR, but there is currently a gap between their conservation and their use and they remain under-exploited by the user community. In order to meet the needs of future generations, there are four key areas that need to be addressed: 1) development of novel approaches to characterization and evaluation to replace traditional resource intensive phenotypic methods; 2) systematic active *in situ* and *ex situ* CWR and LR conservation; 3) understanding the needs of the user communities and current constraints in the use of CWR and LR in crop improvement programmes; and 4) improved CWR and LR information management and accessibility.

[1] Plant genetic resources for food and agriculture

PGR Secure: answering the call

The overarching goal of PGR Secure was to underpin European food security in the face of climate change by advancing CWR and LR diversity conservation and use. To achieve this goal PGR Secure had four research themes: 1) novel characterization techniques, 2) CWR and LR conservation, 3) improved use of CWR and LR by breeders, and 4) informatics (see Figure 1). The objectives of themes 1 and 3 were to improve breeders' use of conserved CWR and LR diversity by a) applying novel characterization techniques such as genomics, transcriptomics, metabolomics, high-throughput phenotyping and GIS-based predictive characterization, and b) engaging the plant breeding community in a dialogue to identify exactly what is needed to bridge the conservation/use gap and to facilitate the flow of material from conservation facilities to breeders. The objectives of themes 2 and 4 were to enhance CWR and LR species and genetic diversity conservation through the development of CWR and LR inventories and systematic conservation strategies, and to improve the management and accessibility of CWR and LR conservation and trait data.

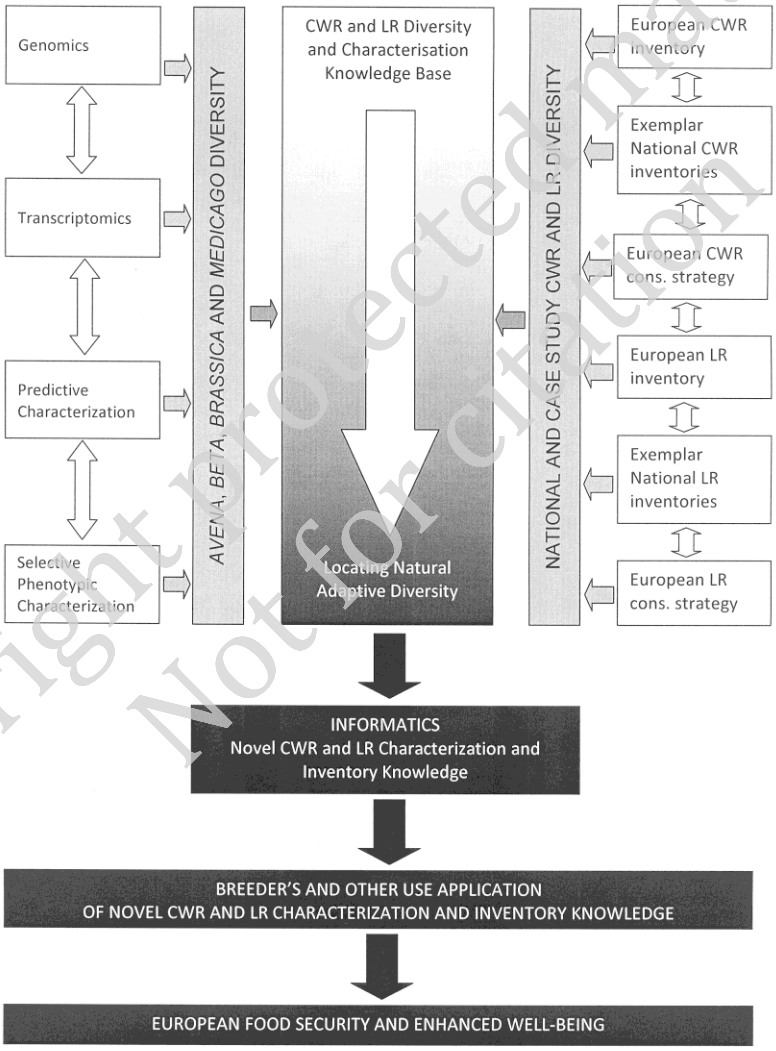

Figure 1. Schematic diagram of interrelated project themes

4.1.3 Main scientific and technological results/foregrounds

The scientific and technological results of the project fall under four themes: 1) Novel characterization techniques; 2) CWR and LR conservation; 3) Improved use of CWR and LR by breeders; and 4) Informatics.

Theme 1: Novel characterization techniques

Actions undertaken under Theme 1 have resulted in enhanced techniques to identify useful adaptive traits to support plant breeding. The research involved two components: a) phenomics and genomics and b) predictive characterization.

Phenomics and genomics

Brassica crops, in particular Brussels sprout, kale and Savoy cabbage suffer from a range of insect pests, including the cabbage aphid (*Brevicoryne brassicae* – Figure 2) and whitefly (*Aleyrodes proletella*), which are difficult to control and growers would therefore benefit strongly from resistant varieties. In the PGR Secure project we aimed to: 1) identify novel sources of host plant resistance to the cabbage whitefly and cabbage aphid; 2) elucidate the resistance mechanism; and 3) provide tools to breeders that will facilitate resistance breeding.

Figure 2. Susceptible brassica leaf with heavy infestation of cabbage aphid. Photo: J. Pritchard

Novel sources of resistance

The application of a novel high throughput method for phenotyping genebank accessions of *Brassica* species has led to the identification of accessions resistant to the cabbage aphid and the cabbage whitefly. Accessions resistant to whitefly were identified among *B. oleracea* var. *capitata* (heading cabbage) landraces and their wild relatives, *B. villosa* (Figure 3), *B. incana* and *B. montana*. Whereas in heading cabbage the resistance is only expressed in plants of at least ten–twelve weeks old, some wild relatives were already starting to express resistance at six weeks. Since farmers plant these crops at an age of 5–6 weeks this earlier expression of resistance is of great practical importance. Some level of resistance to the cabbage aphid was observed in *B. fruticulosa* and in *B. villosa*. With the resistant accessions identified, plant breeders now have a resource that can be used to develop high yielding varieties that are resistant to the cabbage whitefly and aphid.

Figure 3. *Brassica villosa* subsp. *bivoniana* pictured with clip cage containing whiteflies in field trials for plant host resistance, Wageningen, The Netherlands. Photo: K. Pelgrom

Resistance mechanism

Host plant resistance to phloem-feeding insects can be mediated by several mechanisms. Plants can defend themselves against phloem-feeding insects by means of physical and chemical barriers. Resistance components can be present in the form of morphological adaptations, such as trichomes (leaf hairs) or wax layers on the surface of the leaf, but may also be present in deeper cell layers or in the phloem itself. The Electrical Penetration Graph (EPG) technique was used to obtain information on the presence and location of resistance factors. From the EPG readings it is possible to determine the time an insect needs to reach the phloem and where on the way to the phloem they encounter resistance from the plant. EPG readings also contain information on how long aphids are actually taking up phloem sap. Using this technique we could show large differences in feeding behaviour of cabbage aphids on different *Brassica* accessions. Aphids had difficulties to reach the phloem on some accessions of *B. villosa*, *B. incana* and *B. montana*, whereas they had no problems doing this on some *B. oleracea* accessions. All accessions of *B. villosa* and one *B. incana* accession were densely covered with trichomes, which may explain at least some of the resistance observed.

Secondary metabolites can also play an important role in the defence against herbivores. To identify metabolites possibly involved in the resistance against whitefly we performed metabolomics analysis on two sets of plant material with contrasting levels of whitefly resistance (resistant vs. susceptible). One set consisted of cabbage landraces and another set of heading cabbage genotypes derived from a segregating population. Two complementary metabolomics platforms were used to identify compounds related to susceptibility and resistance—Gas Chromatography-Mass Spectrometry (GC-MS) and Liquid Chromatography-Mass Spectrometry (LC-MS)—in both negative and positive ionization modes. Both the GCMS and LCMS data showed no significant differences in metabolites between the resistant and susceptible groups. Based on this result it is unlikely that the resistance in heading cabbage is based on a metabolite. Other mechanisms which may be based on a protein are more likely, although it cannot be excluded that a metabolite not detected by any of the platforms used is the causal agent.

We also studied differential gene expression in different landraces and species of *Brassica* to obtain information about candidate genes underpinning resistance factors, which may also help to identify resistance mechanisms. Differences in gene expression were seen in the sets of material previously classified as resistant or susceptible to aphids based on EPG or field evaluation of resistance. The gene expression analysis was carried out on plant materials with or without prior infestation with the cabbage aphid. In the plants that received an infestation, genes that are induced by aphid infestation will also show up. Differentially expressed genes were seen in almost every grouping of resistant and susceptible plants that were considered (e.g., based on the field evaluation or on the different EPG parameters). Different sets of genes were revealed by the different groupings, which may point to the different mechanisms active during the various phases in an aphid infestation. The differentially expressed genes are considered candidate genes for resistance. Some of them have already been implicated in resistance to aphids in the literature, but most of them are new (i.e., not previously associated with aphid resistance). Further research will be needed to establish and validate their exact role in resistance and to identify the alleles that contribute most to the resistance.

Tools to facilitate resistance breeding

Molecular markers are an indispensable tool for modern plant breeders. They are used to make early selection of plant material possible, for the introgression of genes/alleles without a clear phenotype, for stacking several alleles with a positive effect, and to facilitate recurrent parent selection. The marker type most widely used today is the Single Nucleotide Polymorphism (SNP) marker. We obtained SNP markers that are informative in *B. oleracea* and its wild relatives by sequencing the leaf RNA of 15 selected plants, resulting in the identification of c. 2 million SNPs. From these SNPs a selection was made based on the position of the SNP on the *B. oleracea* reference genome and their origin. Finally a 90k Affymetrix Axiom array was produced which contains c. 40,000 SNPs selected from a set of broccoli varieties, 21,000 polymorphic SNPs from a set of heading cabbages, 4200 already validated *B. oleracea* SNPs and approx. 5000 SNPs that are polymorphic between *B. oleracea* and the wild relative *B. incana,* as well as 5000 that are polymorphic between *B. oleracea* and *B. montana.* The array also contains c. 5000 SNPs that are polymorphic within *B. fruticulosa.* The array will be very useful in a number of applications including QTL mapping in *B. oleracea* and its wild relatives, association mapping in *B. oleracea*, as well as relationship analysis among (sub)species, varieties and landraces. The array is expected to significantly decrease the time needed to develop a new variety in a range of brassica crops.

To facilitate an efficient use of the novel sources of resistance that were identified, we studied the genetics of the resistance. Quantitative trait loci (QTL) and linkage disequilibrium (LD) mapping were used to identify chromosomal regions involved in whitefly resistance. In an F2 population based on a cross between the whitefly susceptible cultivar 'Christmas Drumhead' and the resistant 'Rivera', we measured whitefly adult survival and oviposition rate as well as some morphological characteristics possibly involved in the resistance (time of head formation, leaf wax layer and leaf toughness). QTLs were found for the whitefly resistance parameters 'adult survival' and 'oviposition rate', explaining 14% and 13% of the variance, respectively. A strong QTL was found for 'wax layer', explaining 64% of the variance. None of the QTLs identified for the morphological traits co-localized with the QTLs for adult survival and oviposition rate. Therefore it is unlikely that these morphological traits contribute to the resistance observed. Although a strong resistance towards the cabbage whitefly was observed in the heading cabbage cultivar 'Rivera', no major QTL was detected for survival and oviposition rate. The resistance in this variety is probably based on the interaction of several genes or different resistance mechanisms. Further support for this came from the LD-mapping experiment in which we genotyped cabbage accessions using the 90k Axiom array that was developed within the project, and phenotyped them for 'adult survival' and 'oviposition rate'. Significant associations between these whitefly resistance related traits and markers were found on chromosomes 1, 2, 4, 5, 6, 7 and 9, showing that several chromosomal regions contribute to whitefly resistance observed in heading cabbage accessions. Markers linked to these QTLs are now available and may be used by breeding companies for indirect selection of genomic regions that contribute to whitefly resistance.

We also used a fully whitefly resistant plant of the brassica wild relative *B. incana*. This plant is densely covered with trichomes which may contribute to resistance. The resistant *B. incana* plant was crossed with a susceptible *B. oleracea* cultivar and the resulting F1 was backcrossed with the *B. incana* parent. In this cross we mapped whitefly resistance to a single locus explaining 57% of the variance for whitefly adult survival and 82% for oviposition rate. At the same locus we also mapped the presence/absence of trichomes. There was a strong correlation between the presence of trichomes and whitefly adult survival (-0.71) and oviposition rate (-0.89). The presence of the trichomes is likely responsible for the resistance observed. Again, information on markers co-segregating with the resistance is now available, thus facilitating resistance breeding.

In conclusion the PGR Secure project has identified novel sources of resistance against the cabbage whitefly and cabbage aphid in landrace accessions of *B. oleracea* var. *capitata* as well as in wild relatives of *B. oleracea.* This resistance is likely based on different mechanisms and markers linked to the genes involved in the resistance are now available to the brassica breeding community. The PGR Secure project also enriched the brassica community with a 90k Axiom array that will show its value for a range of applications. The phenomics and genomics approach used within the PGR Secure project may also serve as an example for other crops.

Predictive characterization

Conventionally, to identify desirable traits in germplasm collections, all the plant materials need to be grown out in field trials, characterized (i.e., finding the desired characters) and evaluated. This can be expensive and time-consuming. A better approach is to predict which accessions contain the desired traits using geographic and environmental data along with Geographic Information Systems (GIS) analysis. This so-called predictive characterization approach builds on the hypothesis that different environments exert divergent selective pressures on plant populations, increasing the probability of finding specific traits under certain circumstances (for example, we might expect to find traits of saline tolerance in plants growing in areas where salt levels are high) and represents a more cost-effective method.

One of the first systematic applications of using a predictive link between a specific resistance trait and a set of environmental parameters, named the Focused Identification of Germplasm Strategy (FIGS) used biotic and abiotic matching techniques. FIGS was developed at the International Centre for Agricultural Research in the Dry Areas (ICARDA) based on early work by Michael Mackay in the 1980s and 1990s. The first FIGS studies used a series of filters based on scientific expert knowledge for matching environmental profiles that were known to be suitable for adaptations leading to the target trait properties in landraces growing in such locations.

FIGS studies so far have mainly been applied to major crops, in particular wheat and barley, and recently also to faba bean. Building upon the foundation of the FIGS approach, further studies that use ecogeographical information or previously recorded characterization and evaluation (C&E) data have been developed and were tested for their applicability to CWR and LR within the context of the

PGR Secure project. These additional predictive characterization studies on CWR and LR material have explored the methods called ‘ecogeographical filtering’ and ‘calibration’ (Figure 4).

The ecogeographical filtering method combines the spatial distribution of the target taxon with an ecogeographical land characterization (ELC) map that characterizes the environments that are likely to impose selection pressure for the adaptive trait investigated, to identify accessions or populations that are likely to contain the trait of interest. In the predictive characterization context it uses a taxon-specific ELC map that is developed based on the variables most relevant for adaptation and for determining the species’ distribution. This map aims to represent the adaptive scenarios that are present over the territory studied.

As a first step in this method, the ecogeographical categories from the ELC map are assigned to each occurrence record according to its coordinates and the records are then grouped according to their ELC map category. After all georeferenced occurrences have been ecogeographically characterized, the second step is to select occurrences from each group that comply with specific environmental requirements related to the traits of interest: the specific ecogeographical variables (geophysical, edaphic or bioclimatic) that best describe and delimit the environmental profile likely to impose selection pressure for the adaptive trait of interest. These are then used for further filtering to obtain a final subset of occurrences.

The calibration method uses existing C&E data for the trait of interest, together with eco-geographical data specific to the environment at collecting sites from which these accessions were collected, to identify existing relationships between the trait and the environment. Based on these relationships, it calibrates a prediction model. This prediction model is then applied to other non-evaluated accessions to identify those that, according to this model, are likely to have a higher probability of genetic adaptation for a target trait property. The model therefore aims to identify a subset that is more likely to show the target trait property than a subset merely selected randomly. The calibration method can be used when availability of evaluation data is not a limiting factor. The use of the calibration method has been described in recent studies on morphological and agricultural traits in barley and wheat stem rust.

The traits that we identified—based on an expert consultation and literature reviews—as important for the four target genera of the PGR Secure project, as well as variables and thresholds that were used within the ecogeographical filtering method to identify and select the environments likely to favour the development of tolerance or resistance traits, are summarized in Table 1.

The ecogeographical filtering method was applied to CWR and LR of all four genera and eight sets of accessions were produced containing those that are expected to have a higher likelihood of containing genetic diversity for the selected adaptive traits. The application of the calibration method requires the availability of evaluation data for the respective genera. The evaluation data that we managed to compile from public sources, direct contacts with curators and through the PGR Secure consortium, both for LR and CWR, proved to be too few to be able to implement the method on these four genera. The R-scripts developed for that method have therefore been tested on a wheat dataset made available by one of the external experts that collaborated in the predictive characterization activities. Both methods have been documented in the document, ‘Predictive characterization of crop wild relatives and landraces. Technical guidelines version 1’ which will be published by Bioversity International and freely downloadable from the Bioversity website.

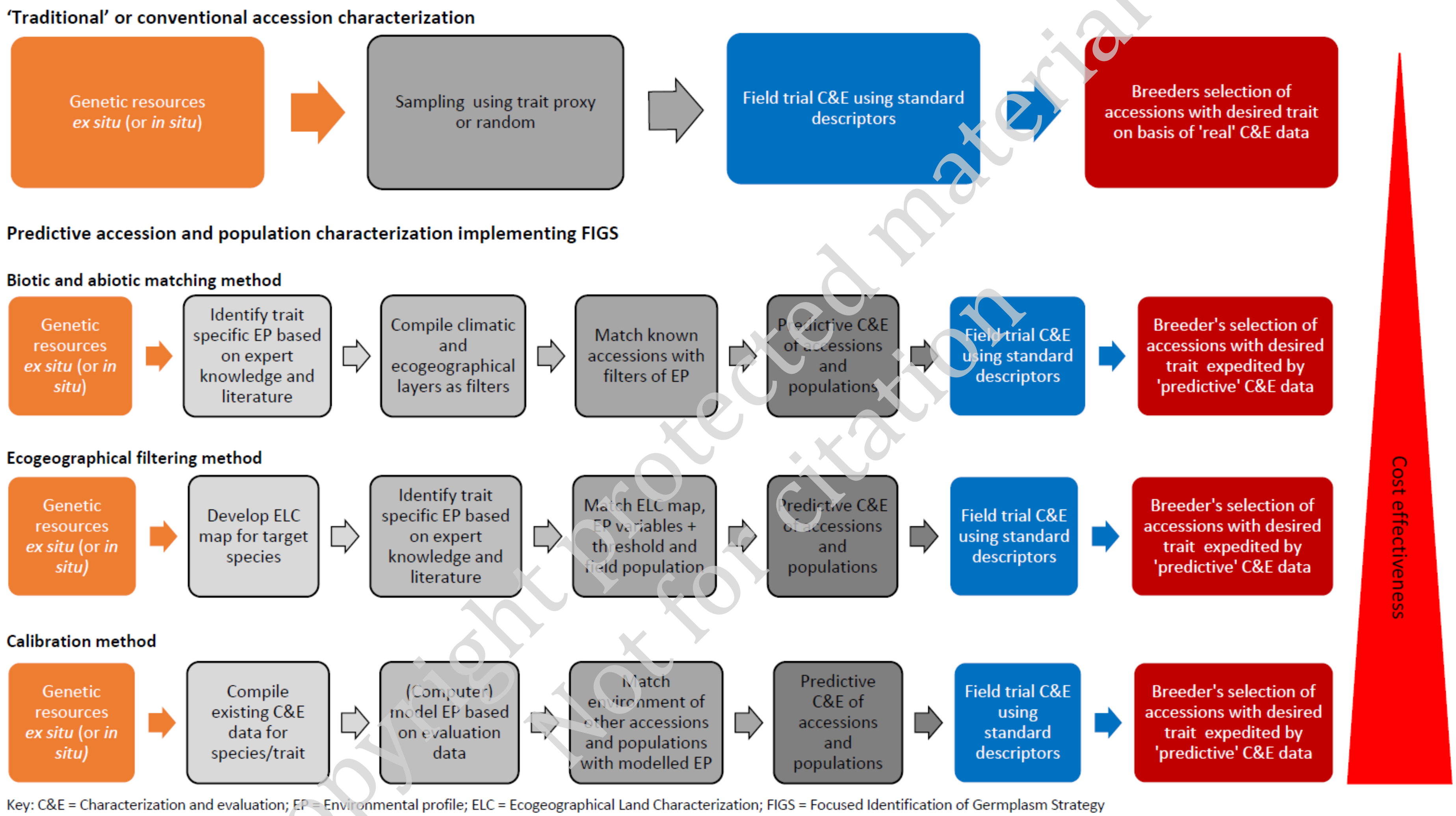

Figure 4. Schematic representation of approaches to predictive characterization

Table 1. Traits and variables for the project's target genera *Avena*, *Beta*, *Brassica* and *Medicago*

Genus	Identified abiotic trait	Identified variable(s)	Threshold value
Avena	Aluminium toxicity	Soil pH; Soil organic carbon content T_OC	< pH 5.5 < 1.2% T_OC
Beta	Drought	De Martonne aridity index (De Martonne, 1926), calculated based on temperature and precipitation of the three driest months (July, August and September in the Northern Hemisphere).	< 10
Brassica	Drought Salinity	De Martonne aridity index Topsoil salinity (TSS) measured as electrical conductivity in dS/m (deciSiemens/metre) Mean temperature values for the driest months	< 10 > 4 dS/m Highest values in records with TSS > 4
Medicago	Frost	BIOCLIM 11	< -2°C

Theme 2: Crop wild relative and landrace conservation

Actions undertaken under Theme 2 have resulted in the development of national and Europe-wide conservation strategies for high priority European CWR and LR resources. The research involved two components: a) CWR conservation and b) LR conservation.

CWR and LR conservation training

The joint PGR Secure/ECPGR[2] workshop, 'Conservation strategies for European crop wild relative and landrace diversity' (the Palanga workshop), was convened in Palanga, Lithuania from 7–9 September 2011 to discuss and agree a strategic approach to European and national CWR and LR conservation with the aim of ensuring the systematic conservation of European PGRFA which are important for food security and the European economy. The workshop addressed five primary topics: 1) production of National Inventories (NIs), 2) taxon prioritization, diversity and gap analysis, and threat assessment, 3) data collection, management and exchange, 4) linking conservation to use, 5) development and implementation of national CWR and LR conservation strategies by the ECPGR Network members. The workshop comprised a series of presentations and discussion sessions on the state of the art of CWR and LR conservation in Europe, available approaches and methods for their conservation, and discussion on their practical application. Participants shared knowledge on current national activities, discussed the practicalities of developing national CWR and LR conservation strategies, and agreed on the way forward. The workshop was attended by 101 participants from 38 European countries and one from the United States of America. Participants included members of the ECPGR *In Situ* and On-farm Conservation Network (Wild Species Conservation in Genetic Reserves and On-farm Conservation Working Groups) and Documentation and Information Network, as well as Consortium and External Advisory Board Members of the EU Framework 7 project, PGR Secure. A review of progress in national CWR and LR conservation in each European country is available via the online conservation Helpdesk (www.pgrsecure.org/helpdesk).

[2] European Cooperative Programme for Plant Genetic Resources

Conservation helpdesk

A CWR and LR conservation helpdesk has been active throughout the project in providing assistance to national programmes in the development of national CWR and LR conservation strategies through one to one contact by email and in-country visits, as well as by the provision of online resources (www.pgrsecure.org/helpdesk). Regular communication has also been maintained with all European national PGR programmes to offer support for the development of their national conservation strategies.

The online helpdesk includes an introductory page providing background information, and an explanation of the role of the helpdesk and how to use it. Links to two additional pages are provided which contain a range of resources to aid and inform the national CWR (www.pgrsecure.org/helpdesk_cwr) and LR (www.pgrsecure.org/helpdesk_lr) conservation strategy planning process, as well as links to email addresses for one-to-one support.

Crop wild relative conservation

European CWR inventory

The CWR Catalogue for Europe and the Mediterranean, which is a comprehensive list of CWR taxa in the region and their occurrences in geographical units (countries or sub-national units) related to cultivated plants of all types (including food, fodder, forage, industrial plants, ornamentals and medicinal plants) has been revised using the latest data provided by the Euro+Med PlantBase Secretariat. The Catalogue provides an overview of the breadth of crop and CWR diversity in the European region and the baseline data for conservation planning at regional scale. National CWR checklists were extracted from the original version of the Catalogue and provided to each European country for use in the national PGR programmes to form the basis of national checklists, inventories and subsequently, national CWR conservation strategies and action plans. The data were provided to the countries prior to the PGR Secure project and again at the Palanga workshop, as well as being made available via the online conservation helpdesk. The revised CWR Catalogue data are available via the PGR Diversity Gateway where they are searchable and from where national checklists can be generated to form the basis of national inventories and conservation strategies. A peer-reviewed publication describing the process of creating the CWR Catalogue is in preparation.

National CWR conservation strategies

Seven European countries have to date completed national CWR checklists and inventories: Cyprus, Czech Republic, Finland, Italy, Norway, Spain and the United Kingdom (UK). The data have been web-enabled via the PGR Diversity Gateway and the Italy and Spain CWR checklists and inventories are also available via the case study websites of those countries.

National CWR conservation strategies for the three project case study countries Finland, Italy and Spain, as well as for Cyprus, have been completed and published and significant progress has also been made in Albania, Bulgaria, the Czech Republic, Norway, Sweden and the UK. Each strategy follows a similar general model but has been adapted according to factors such as the number of native CWR present, the economic use of the related crops, and national conservation and utilization priorities.

European CWR conservation strategy: from conservation planning to conservation practice

Europe is an important centre of diversity of many crops and their wild relatives and these CWR are potential genetic resources for crop improvement. Europe's CWR diversity is therefore an important resource for the maintenance of food security and for safeguarding the substantial economic gains to Europe through crop production in the region. We have developed an integrated European CWR conservation strategy which combines national CWR conservation strategies and a regional CWR conservation strategy for priority taxa at European level (Figure 5). A list of priority CWR species native to Europe in more than 20 priority crop gene pools has been produced and ecogeographic data analysed to identify high priority populations for conservation action.

Recent advances in our understanding of CWR diversity in the region, as well as in planning for their complementary conservation, provides a solid foundation for the development of a strategic approach to their conservation in Europe based on a range of commonly agreed and widely tested scientific concepts and techniques. However, the perceived value and impact of the integrated CWR conservation strategy for Europe ultimately depends on successfully channelling conserved germplasm from *in situ* and *ex situ* conservation facilities to the user community for crop improvement. It is essential that the strategy meets the interests and needs of the stakeholder community (public and private plant breeding research institutes, breeding companies, plant genebanks, farmers and agro-NGOs). To this end, we have identified four key challenges to enhancing the utilization of conserved plant germplasm:

1. Strengthening the interface between *in situ* and *ex situ* conservation;
2. Increasing efforts to characterize and evaluate conserved germplasm;
3. Improving the availability of conservation, characterization and evaluation data to end users;
4. Addressing issues of access by the user community to *in situ* and *ex situ* conserved germplasm.

Achieving effective conservation and utilization of European CWR diversity will require a coherent, regionally coordinated policy and the appropriate resources to fund their conservation, characterization and evaluation. Therefore, to achieve sustainable conservation of CWR and maximize their sustainable exploitation in Europe, there is an imperative to develop an EU-led policy to harmonize their conservation, characterization and evaluation with existing biodiversity conservation and agricultural initiatives, and to develop new initiatives where necessary. The preparation and publication of 'A concept for *in situ* conservation of crop wild relatives in Europe' (www.pgrsecure.org/documents/Concept.pdf), which was led by members of the PGR Secure consortium, is a landmark in CWR conservation in Europe and will be utilized to lobby for the required action and European and national levels.

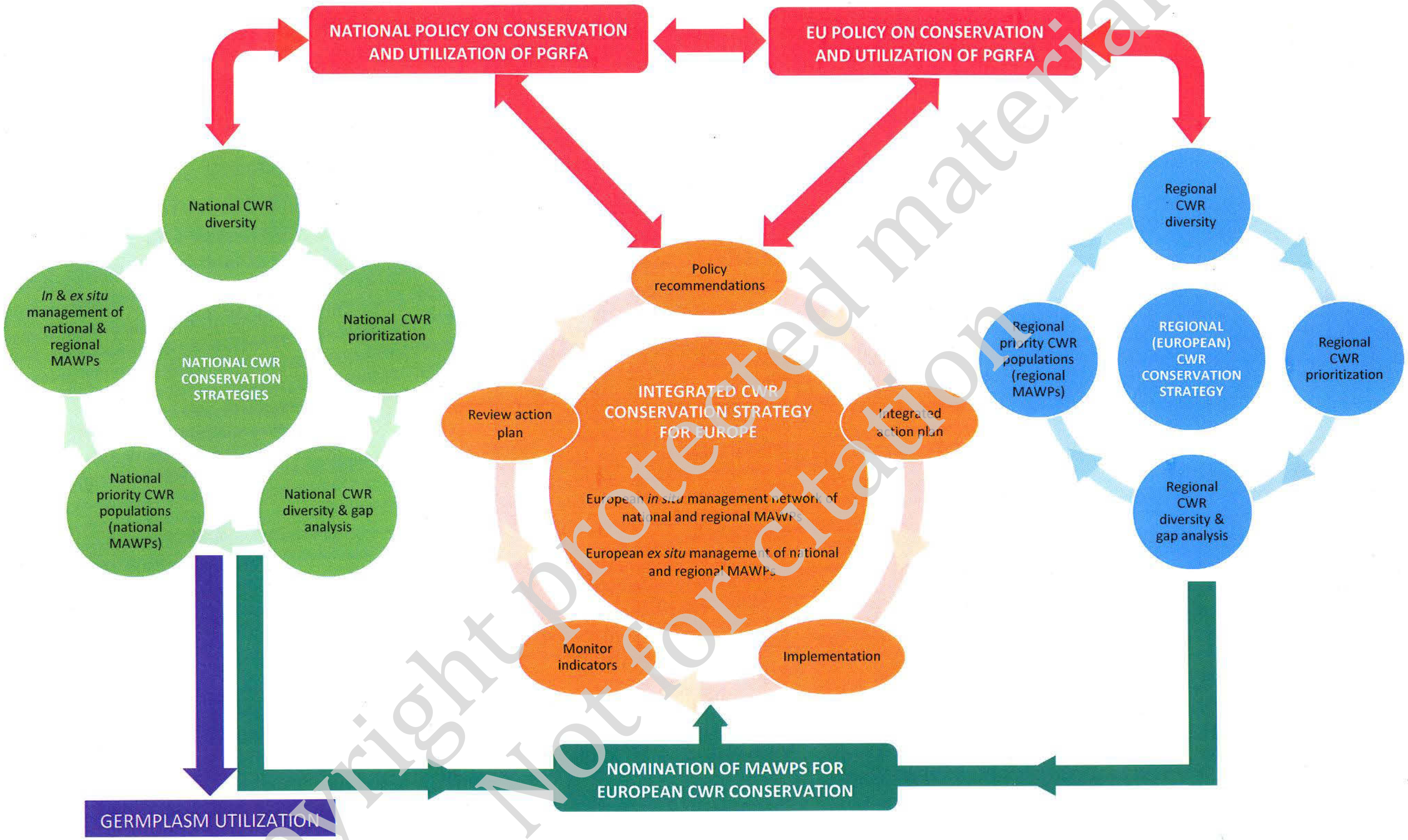

Figure 5. Schematic representation of the concept for *in situ* conservation of CWR in Europe[3]

[3] Kell, S., Maxted, N., Ford-Lloyd, B.V. *et al.* (in prep.) A methodological approach to complementary conservation of priority European CWR

Landrace conservation

A major step forward in LR conservation in Europe was the publication of a set of descriptors for collecting, recording and making available data for LR that are maintained *in situ* (on-farm). This set of descriptors will be adopted by the ECPGR and used to manage national LR inventories throughout Europe. Data standards and a tool for recording LR data have been developed and are available via the online conservation helpdesk, LR resources page (www.pgrsecure.org/helpdesk_lr) (Figure 6).

Figure 6. Data standards and a tool for recording LR data are available via the online conservation helpdesk: www.pgrsecure.org/helpdesk_lr

LR conservation strategies have been published for the project case study countries Italy and the UK at: www.pgrsecure.org/publications and the LR conservation strategy for Finland will be published in the MTT Agrifood Research Finland report series, as well as being available via a link from the PGR Secure website. Progress in the development of LR conservation strategies for three case study countries will inform a model for national LR conservation across Europe.

A European LR priority gene pool (*Avena*, *Beta*, *Brassica* and *Medicago*) strategy has also been published on the project website. The strategy highlights the lack of conservation actions for LR of target crops that are maintained *in situ* (on-farm) and the need to compile inventories as a basis for their implementation.

Finally, based on the above-mentioned strategies and other documents, a generic European LR conservation strategy has been published that focuses on both conservation and enhancement of use priority actions. The further priority conservation actions needed are:

1. Compile a comprehensive European LR inventory;

2. Collect and conserve germplasm samples of priority LR populations in *ex situ* collections;

3. Promote LR reintroduction from genebanks to on-farm sites;

4. Increase European coordination in developing and implementing measures for LR conservation;

5. Make available adequate funds for LR *in situ* (on-farm) and *ex situ* conservation actions and for carrying out research on LR diversity in the context of climate change and unpredictability.

In particular, the compilation of a European inventory of LR that are maintained *in situ* (on-farm) is seen as the principal means to carry out efficient and effective conservation. This is because such an inventory, when made public, ensures the possibility of:

- Collecting materials not already present in *ex situ* collections;
- Promoting the direct use of LR in agriculture (and in doing so achieving their *in situ* (on-farm) conservation);
- Promoting the use of LR in conventional and participatory plant breeding;
- Identifying research case studies useful to deepen knowledge on LR (within- and among- genetic diversity level, *in situ* genetic diversity evolution under changed climatic conditions, level of genetic diversity that can be maintained under different agro-ecosystems, different management systems, socio-economic factors that drive conservation);
- Identifying agrobiodiversity hot spots for conservation activities.

The compilation of a European LR inventory will also allow the assessment of overall progress on implementation and related follow-up processes of the GPA, facilitate cooperation among European countries, and will be a useful example to develop *in situ* conservation actions at global level.

In terms of LR use, the most important required actions are:

1. Promote the use of home garden LR in community and home gardens;
2. Register LR as 'conservation varieties' and award quality marks for typical, local products derived from LR;
3. Carry out campaigns aimed to promote local economies based on locally sourced products from LR;
4. Facilitate cooperation among the formal sector, farmer networks and farmer organizations;
5. Stimulate the use of LR in plant breeding programmes aimed at creating heterogeneous (i.e., genetically diverse) varieties suitable for environmentally friendly agronomic systems.

The European LR conservation strategy will have practical and policy implications beyond the lifetime of the PGR Secure project, although requiring further development and promotion by the relevant players, most notably the ECPGR On-farm Working Group.

Theme 3: Improved use of CWR and LR by breeders

Actions undertaken under Theme 3 have resulted in greater awareness amongst the plant breeding community of the breadth of genetic material available from CWR and LR and of the enhanced access to these resources for crop improvement, as well as improved communication between the conservation and end user communities.

Understanding and improving the PGR system in Europe

Understanding the needs of the European CWR and LR user community, including genebanks, public research institutes, commercial plant breeding companies, agro-NGOs (non-governmental organizations) and government, is fundamental to improve the links between conserved CWR and LR resources and their use in plant breeding programmes for crop improvement. To this end an elaborate study has been carried out to analyse PGR conservation and use in Europe to date. During the study, representatives of the five interest groups: genebanks, public research institutes, plant breeders, agro-NGOs, and governments, were interviewed. In total, 20 countries were visited and around 130 semi-structured interviews took place with the various PGR stakeholders concerned. An online survey was also conducted which was answered by 226 respondents.

The interim results of the study were discussed during the workshop, 'On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis' which was convened in Wageningen in November 2013 to discuss the constraints in the conservation and use of PGR in Europe. Eighty participants from 21 European countries attended, representing the five stakeholder groups (Figure 7). This was a landmark meeting as it was the first time that these diverse stakeholder groups had come together to discuss a common issue of concern to all groups.

Figure 7. Participants at the PGR Secure stakeholder workshop, 'On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis', Wageningen, November 2013

The results of the semi-structured interviews, the online questionnaire and input from the workshop were integrated into the final report 'On the sustainable use and conservation of plant genetic resources in Europe'. In this report a SWOT (strengths, weaknesses, opportunities and threats) analysis of these data is presented together with a vision of an ideal European PGR system (i.e., a system in which PGR are adequately conserved and easily available for utilization for crop improvement) and recommendations on how we can improve the current system and move towards this ideal system.

There are many notable strengths and competences within the PGR system in Europe today and also several promising opportunities coming from outside the system. Perhaps most importantly, there is today a general consensus that genetic resources are important and should be protected through conservation measures. In the same vein, member states have accepted the international legal obligations for conservation of PGRFA, which puts ethical pressure on policy- makers. Within the current system the conservation sector does conserve a substantial amount of genetic resources *ex situ*. There are also public funds available for conservation, evaluation, PGR research and pre-breeding and there is an interest among the stakeholders to cooperate within such projects. A large knowledge base and high competence, in combination with innovative thinking among the stakeholders, leads to successful projects and development of efficient new tools that can be used in conservation and breeding.

However, there are several major problems that need to be addressed if we are to secure reliable conservation of essential genetic resources and make it possible to use these resources efficiently in future efforts to assure food security. A central problem is that genetic resource issues often have a low priority, both at the European and national governmental levels, which leads to insufficient support of conservation activities and a lack of implementation of conservation and use policies. *Ex situ* conservation is the most well established conservation approach for PGRFA, but most of the European genebanks are still not independent units with regard to funding or programmes, and under-funding frequently puts genetic resources at risk. In addition, most genebanks do not follow defined standards to assure transparency and a minimum quality of the work. The visibility and access to the *ex situ* collections are often limited and there is a lack of relevant evaluation data available in the collection databases.

Another issue affecting several stakeholders is the prevalence of short-term funding and instabilities of policies. Both conservation and breeding are long-term efforts that demand long-term commitments. For example, pre-breeding projects are crucial to bridge the gap between genetic resources and conventional breeding, but they need funding over a long period of time to be successful.

A range of problems are also associated with on-farm and *in situ* conservation. At the heart of the problem is perhaps uncertainty regarding responsibility. At the governmental level, the responsibility for *in situ* conservation is often shared between authorities and the terms of cooperation and responsibility are not always clear. Genebanks have traditionally worked with *ex situ* conservation and have not risen to the challenge to take a leading role in development of *in situ* and on-farm conservation strategies. In many countries inventories of LR and CWR are still missing and so are conservation strategies targeted at these important genetic resources. Clarification over the national lead responsibility for implementing on-farm and *in situ* conservation would alleviate much of the inertia associated with active complementary conservation.

In this study we have identified a long list of weaknesses and threats. However, our main message is that these can be overcome, but actions are needed both on the national and European level. To this end we have put forward 12 recommendations for improving the European PGR system:

- Establish a European Plant Germplasm System;
- Establish a technical EU infrastructure for the organization of conservation of PGRFA measures;
- Establish a EU information infrastructure for conservation of PGRFA;
- Disentangle genebank tasks from plant breeding research and plant breeding tasks at the national level;
- Establish a legal basis for *in situ* and *ex situ* conservation of PGRFA in the EU;
- Carry out an inventory of financial means available to genebanks and estimation of financial means needed for a fully functioning European network of genebanks;
- Increase the visibility of genebanks on the internet;
- Clear uncertainties concerning access and benefit sharing (ABS) rules, so that breeding companies can take economic decisions on a safe legal basis;
- Strengthen research to better understand the amount and geographic distribution of genetic diversity present in priority crop gene pools;
- Develop a European infrastructure for long-term crop specific pre-breeding programmes;
- Strengthen the European agro-NGOs sector;
- Establish a European Network of Private-Public-Partnership programmes for evaluation of PGR in Europe.

At the centre of the recommendations is the development of a legal and infrastructure framework for the conservation of PGR in Europe. The final report, its annexes and a policy paper based on this report can be downloaded from www.nordgen.org/index.php/en/Plants/Innehaall/WorkshopsConferences/Plant-Genetic-Resource-Workshop-2013/Final-report.

A draft of the policy paper was sent to members of the Executive Committee of the ECPGR with a request for comments and feedback. The final downloadable version will be sent to the ECPGR Secretariat and to the European Commission Directorate-General for Agriculture and Rural Development, Directorate E.4, 'Evaluation and studies' (under Directorate E, 'Economic analysis, perspectives and evaluation; communication'). The policy paper is an important input for the 'Preparatory action on EU plant and animal genetic resources agriculture' (www.geneticresources.eu) and will also be announced by a short communication in Agra-Europe (www.agra-europe.de) to reach a wider public.

Facilitating greater communication within the European PGR system

To facilitate European PGR stakeholders to establish contacts, which in turn will promote the use of CWR and LR through improved cooperation, two approaches were used. First, a web-based map of PGR stakeholders in Europe was established. The web-application PGR-COMNET (www.pgrsecure.org/pgr-comnet) currently visualizes more than 460 stakeholders on a map. Secondly, a stakeholder market day was organized at the stakeholder workshop in Wageningen with the aim of establishing new or renewed partnerships and potential future cooperation among the participants. After the sessions, the participants gave feedback on the stakeholder market day by providing information on their partnerships or potential cooperation established. The replies were categorized into six clusters of interests: 1) *ex situ* conservation (eight consortia, each representing two to five partners); 2) *in situ* conservation (two consortia, each representing two to four partners); 3) on-farm management (three consortia, each representing three to four partners); 4) characterization and evaluation (five consortia, each representing two to three partners); 5) pre-breeding (five consortia, each representing two to four partners); and 6) knowledge transfer (five consortia, each representing two to five partners). The clusters were further analysed according to the specific subjects, methods and species the partners are interested in. About three months after the workshop, the stakeholder market day participants were asked to give further feedback on the status of their partnerships. Out of 26 partnerships proposed, replies from 13 consortia were collected. There was generally positive feedback on the stakeholder market, and many respondents stated that they had been able to establish contacts with colleagues through this event. Since then, most respondents have been in contact with their partners or will soon meet at upcoming workshops or conferences. Some of the respondents are already planning future collaborations like the preparation of joint Horizon 2020 project proposals.

Channelling potential interesting germplasm into breeding programmes
Online databases were screened for agronomically interesting accessions of *Avena* and *Beta* species and the results were circulated to private breeding companies and public research institutes. Further, information on germplasm resistant to cabbage aphid and molecular markers for whitefly resistance identified under Theme 1, 'phenomics and genomics' was sent to European companies involved in brassica crop improvement. Responses have been received to both communications from a number of breeders interested in obtaining further information and material.

Theme 4: Informatics
Actions undertaken under Theme 4 have resulted in the availability of a resource base for access to CWR and LR conservation and trait data for use by the full range of stakeholders—the Plant Genetic Resources Diversity Gateway (PGR Diversity Gateway).

What is the Plant Genetic Resources Diversity Gateway?
The PGR Diversity Gateway (http://pgrdiversity.bioversityinternational.org) is an online information system that provides the PGR community—including breeders, conservation scientists and protected area managers—with information on CWR and LR diversity and the capacity to upload their own data. The PGR Diversity Gateway is public and provides free access to:

- A portal and visualization map service;
- A means to maintain, access and share germplasm conservation and use data;
- An advanced communication and information tool to facilitate country reporting and policy decision-making on PGRFA;
- An infrastructure for storing and linking CWR and LR conservation, characterization and trait data;
- A central point for linking national, regional and global CWR and LR information.

Data have been uploaded to the system, both from the project (CWR and LR checklists and inventories, national and regional CWR and LR conservation strategies, trait data for *Avena*, *Brassica*, *Beta* and *Medicago*) and from other existing sources (e.g., EURISCO, USDA). The data already in the system include:

- 531,982 plant germplasm accession records;
- CWR checklists containing 14,860 taxon records;
- CWR inventories containing 4,791 taxon records;
- Forest gene conservation units comprising 3,110 taxon records;
- Organizations (contact details/location map): 20,644 records.

Various adaptive trait data records have been uploaded to the system. For all records that have coordinates (830,452 records), data for 19 climatic variables, soil types, human footprints and land cover can be extracted from available services. The data inferred enables identification and characterization of landscapes where material was either collected or a population exists. The Gateway also has a map service that displays every record that has geo-coordinates. Records are displayed in group by proximity including the additional inferred environmental information on the observation or point. The system has the functionality to download the data searched.

The PGR Diversity Gateway has a simple platform architecture and includes three different entry points—trait information, CWR inventories and LR inventories—allowing users to choose their entry point to the information they require, while maintaining the capacity to link to existing online sources of information. The data that they can access via the system includes national inventories, national crop and CWR checklists, national and European conservation strategies, adaptive trait summary data linking to other data resources, *ex situ* and *in situ* conservation data, mapping services and environmental layers. Not all users are technically minded, so a simple interface is provided. In addition, since the incoming data are constantly increasing and new sources and domains are impossible to predict in advance, the system has the power to expand in a flexible way.

What is the design behind the PGR Diversity Gateway?

The PGR Diversity Gateway is designed using an ontology approach. An ontology is a description of the concepts and relationships that can exist for a community. Rather than relating concepts to each other through the structure of the database, an ontology relates concepts through their associated metadata. This allows great flexibility and potentially infinite growth. For example, if the user would like to access data by region but only country data are available, by using an ontology it is simple to search the database through regions without the concept of 'regions' being directly related to the data.

In order to accommodate this flexibility and manage large quantities of data, we decided to move away from a traditional relational model to embrace new technologies and workflows. The system is implemented by using two main kinds of databases: the *document* database and the *graph* database (*MongoDB* and *Neo4j* respectively). The combination of these two data storage engine types allows us to handle very large quantities of data with dynamic structures, providing extremely fast response times both for the data and the metadata and implementing inference algorithms to make the system a very powerful portal.

The ontology component was developed using internationally agreed standards, some of which were developed during the project phase and thus are community-agreed standards with templates. The system is capable of producing and retrieving useful information, storing and retrieving many diverse data types and discovering relations between them. It includes over 17,000 defined concepts. The standards ensure that the most important information is collected and that data are provided in a common format allowing for interoperability between datasets. Examples of standards used are:

- FAO/IPGRI Multi-Crop Passport Descriptors (MCPD) used generically for genebank information and documentation;
- Descriptors for Web-Enabled National *In Situ* Landrace Inventories for on-farm conservation data;
- Standard for National Checklists, National Inventories and Conservation Strategies, v1 for national CWR checklists, inventories and conservation strategies;
- Standards for adaptive trait description.

In addition, linked to these the system ontology uses over 30 other standards: Agrobiodiversity household assessments; EEC CORINE Land Cover (CLC) nomenclature; EEC EUNIS habitat type nomenclature; FAO Land use 1990; FAO/WIEWS Institutes; Forest genetic resources (FGR) inventories in Europe (EUFGIS); Global Environment Stratification (GENS); Global land cover type (ESA-GlobCover 2009 project); FAO Harmonized world soil database 2009; Human Foot Print; ISO 15924-alpha4; ISO 15924-numeric; ISO 3166-1; ISO 3166-2; ISO 3166-3; ISO 4217-A; ISO 4217-H; ISO 639-1; ISO 639-2; ISO 639-2B; ISO 639-2T; ISO 639-3; ISO 639-5; IUCN category; IUCN conservation; IUCN criteria; IUCN habitat; IUCN habitat score; IUCN threat; MCPD; NatureServe threat; World Bank Institute (WBI) income classification; World Bank Institute (WBI) lending classification; WORLDCLIM.

If geo-coordinates are available, these standards and services extract environmental (bioclimatic variables), soil type, land cover and human footprint information that is added to the dataset and can be seen when searched. The datasets are automatically enriched by the system and these additional data not only increase the dataset quality and quantity but also provide users with detailed information on the environmental characteristics (environmental profiles) for the sample(s) or observation(s) being looked at.

4.1.4 Potential impacts of the PGR Secure action

Socio-economic impact and wider societal implications of the action

The potential impacts of the project action are: a) better access to and wider take-up of conserved CWR and LR resources in plant breeding programmes; b) increased capacity and options for crop improvement to support European farming and to back-stop food security; c) systematic national level action on conservation of European CWR and LR resources; and d) improved knowledge to inform coherent planning of plant breeding and agrobiodiversity conservation policy in Europe—all of which will ultimately result in greater European food security. Tables 2–7 detail the specific potential scientific, technological, economic, competitive and social impacts of the project under each of its four themes.

The project results will benefit a range of stakeholders including: a) small and large plant breeding companies; b) scientists and policy-makers in public and private research institutes; c) farmers and others working in the agricultural sector; d) genebank and protected area managers, and the broader conservation community; e) government agencies and NGOs involved in plant conservation, plant breeding and national or local nutrition and food supply issues; f) the European Commission; and ultimately g) the European farm product consumer. However, it is the improved use of CWR and LR by plant breeders and farmers that will have the greatest economic and social impact in Europe. A critical issue currently hindering the wider use of these resources was highlighted in FAO's Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture (www.fao.org/agriculture/crops/core-themes/theme/seeds-pgr/sow/sow2/en/) which stated that: "Considerable opportunities exist for strengthening cooperation among those involved in the conservation and sustainable use of Plant Genetic Resources for Food and Agriculture (PGRFA), at all stages of the seed and food chain. Stronger links are needed, especially between plant breeders and those involved in the seed system, as well as between the public and private sectors". Recognizing that the success of the initiative hinges on bridging the gap between the conservation and use communities, the PGR Secure project sought to strengthen these links and therefore involved collaboration between European policy, conservation and breeding sectors throughout Europe.

Exploitation of project results: breaking through the scientific and industrial state of the art

The results of the action outlined in section 4.1.3 are major breakthroughs in the scientific and industrial state of the art of conservation and utilization of PGRFA in Europe. Specifically:

1. Under Theme 1, the accessions that have been found to be resistant to whitefly and/or aphids will undoubtedly be further investigated by breeding companies in order to develop resistant varieties. The same will apply to markers linked to resistance genes. The development of new predictive characterization models has great potential for improved targeting of CWR and LR populations for molecular characterization, thus reducing the number of populations that need to be analysed.

2. Under Theme 2a, the Consortium has implemented and enhanced concepts and methodologies initiated and published in the context of earlier EU-funded projects. The results and products of the action will fundamentally change the state of the art of CWR conservation in Europe because for the first time, a Europe-wide conservation strategy for a selection of high priority crop gene pools and national CWR conservation strategies for four countries (Cyprus, Finland, Italy and Spain) have been published. The practical implementation of the conservation strategies will provide greater security in terms of maintaining potentially useful germplasm, as well as the baseline knowledge required for its characterization and to make this information freely and easily available. Improved systematic CWR conservation will increase options for the use of germplasm in crop improvement programmes, leading to enhanced food security in Europe.

   Under Theme 2b, the Consortium has developed concepts and methodologies that were never applied before in a continental context. Therefore, the results and products of the action will fundamentally change the scientific state of the art of LR conservation in Europe and elsewhere.

The tools generated in the project (i.e., the 'Descriptors for Web-Enabled National *In Situ* Landrace Inventories' and the related database for LR *in situ* data recording) will significantly improve cooperation in *in situ* conservation activities at European level. For the first time, Europe-wide and national LR conservation strategies for at least three countries (Finland, Italy and the UK) have been published. The practical implementation of the conservation strategies will provide greater security of maintaining useful LR populations, as well as the baseline knowledge required for their characterization, wider use and *in situ* conservation actions at local level. In addition, to make LR related information freely and easily available will enhance options for the use of LR in agriculture and in crop improvement programmes. All the above-mentioned points not only strengthen the relationships between European countries, but potentially have positive fallout on the entire world conservation community.

3. The main result of research undertaken under Theme 3 is a policy paper that addresses the limitations of the European PGRFA conservation and use context, and how the limitations might best be overcome to enhance European crop production competition and improve food and nutritional security. If the results and recommendations of this paper are used by decision-makers at all policy levels within the EU to organize a comprehensive, efficient and effective common programme for the conservation and use of PGR, as well as for the establishment of the durable infrastructures required for the long-term operation of such a programme, a framework for science will come into existence allowing the much better exploitation of genetic resources for the benefit of all European citizens.

4. Sharing information on CWR and LR (Theme 4) has the potential to influence the way breeders conduct their activities. In addition, the free and wide accessibility of the information in a portal can stimulate more research in the area of genetic diversity (CWR and LR) to adapt to biotic and abiotic stresses caused by climate change.

Dissemination activities

Dissemination activities and the project products user communities are detailed in Tables 2–7 under each of the four project themes. A summary of the project dissemination activities is provided below.

Project website

The project website (www.pgrsecure.org) provides a general introduction to the project, its component work packages, a list of project collaborators and partner contact details, and a number of specific pages for disseminating the project results. Dissemination is primarily via the publications (www.pgrsecure.bham.ac.uk/publications) and conservation helpdesk (www.pgrsecure.bham.ac.uk/helpdesk) pages (project newsletters and factsheets, CWR and LR conservation strategies, project reports and other products arising from the work packages); a page hosted by NordGen dedicated to the stakeholder workshop and products associated with Theme 3, 'Improved use of CWR and LR by breeders' (www.nordgen.org/index.php/en/content/view/full/2481/); PGR-COMNET (www.pgrsecure.org/pgr-comnet – hosted by JKI and embedded in the PGR Secure website); pages dedicated to providing access to presentations given at, and the report of the CWR and LR conservation training workshop, 'Conservation strategies for European crop wild relative and landrace diversity' (www.pgrsecure.bham.ac.uk/palanga_workshop); and pages dedicated to dissemination of information about the project’s final dissemination conference (www.pgrsecure.bham.ac.uk/conference), including access to the conference book of abstracts, programme and oral presentations (note, registration, abstract submission and logistical information now disabled).

Final dissemination conference

The project’s final dissemination conference, ‘ENHANCED GENEPOOL UTILIZATION: capturing wild relative and landrace diversity for crop improvement’ (www.pgrsecure.bham.ac.uk/conference) was attended by 140 participants from 42 countries, of which half were from outside Europe, making it a truly international conference. The conference comprised twelve sessions organized within four themes:

- **Characterization techniques**: ‘omics’ techniques and predictive tools to identify traits and expedite plant breeding;
- **Conservation strategies**: national, regional and global CWR and LR conservation strategy development; targeted conservation to meet the needs of the plant breeding community; integration of CWR and LR diversity into existing biodiversity conservation programmes;
- **Facilitating CWR and LR use**: pre-breeding; meeting breeders’ needs; integrating the conservation and user communities; policy enhancement;
- **Informatics development**: characterization, trait and conservation data management and accessibility; inter-information system operability.

Fifty-nine oral presentations and 56 posters were shared under these themes. The full conference programme and book of abstracts are available online and a summary of the conference will be published in *Crop wild relative* Issue 10 in November 2014 (www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_10.pdf).

Publications

Conference proceedings

A text based on the final dissemination conference but with additional invited authors will be published by CAB International (CABI) early in 2015 under the title ‘Enhancing Crop Genepool Utilization: Capturing Wild Relative and Landrace Diversity for Crop Improvement’. Edited by Dr. Nigel Maxted (PGR Secure Project Coordinator) and Prof. Brian Ford-Lloyd (UoB), and Dr. Ehsan Dulloo (BIOVER), the contents of the book will be broadly synonymous with the conference themes. The text has a global market and is primarily targeted at agrobiodiversity conservation and use professionals, postgraduate students and public bodies.

Peer-reviewed publications

Four peer-reviewed publications arising directly from the project research have been published and a number of others are in press and in preparation (see section 4.2).

Project newsletters and factsheet

Two issues of *Crop wild relative* and its sister newsletter *Landraces* have been published and one further issue of each newsletter will be published before the end of 2014 (see www.pgrsecure.bham.ac.uk/publications). A project factsheet (www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/PGR_Secure_factsheet_opt imized.pdf) targeted towards different audiences (plant breeders, agrobiodiversity conservationists, policymakers and the general public) was published in seven languages and is available from the project home and publications pages.

Other publications

A range of other publications arising from the project are available for download from the project website or via links to pages hosted by partner institutions. These include: CWR and LR checklists, inventories and conservation strategies; project reports and other publically available deliverables; other products arising from the work packages such as the LR descriptors and tool for recording *in situ* LR data and final report and policy paper 'On the sustainable use and conservation of plant genetic resources in Europe' associated with Theme 3, 'Improved use of CWR and LR by breeders'; presentations given at the CWR and LR conservation training workshop and final dissemination conference; and the conference book of abstracts. Two PhD theses related to Themes 1a (phenomics and genomics) and 3a (CWR conservation) by students of the coordinating institute, the University of Birmingham, are approaching completion.

Dissemination at associated conferences, workshops and meetings

The project partners have taken every opportunity to disseminate the project results at relevant conferences, workshops and meetings other than those organized in the context of the project. A list of oral and poster presentations given at these events is provided in section 4.2.

Other dissemination activities

Project news and events have regularly been circulated by email, discussion fora, blogs, Facebook and Twitter. Public posters, TV and radio were used by MTT Agrifood Research Finland to disseminate news about the project research on LR conservation and to gather information from farmers and other LR maintainers. An infographic on the importance of CWR has been produced by Bioversity International and published on their website (http://visual.ly/importance-crop-wild-relatives).

Sustainability of project results

Sustainability of the results is critical to the success of the project. Thus, the project was initiated by and involves members of the existing ECPGR *In Situ* and On-farm Conservation Network (www.ecpgr.cgiar.org/networks/in_situ_and_on_farm.html) from 39 European countries who will be actively involved in planning, promoting and implementing national CWR and LR conservation strategies post-PGR Secure. Further, the Consortium itself included members of plant breeding and conservation research institutes, a SME specializing in the field of molecular genetics and applied genomics, as well as Europe's primary plant breeding research network, the European Association for Research in Plant Breeding (EUCARPIA), all of which have an interest in utilizing and taking forward the project results to benefit the wider conservation and use communities. In turn, and to further improve the dissemination and uptake of the results, the Consortium was supported by an External Advisory Board which involved senior researchers in plant breeding and PGRFA conservation and policy, as well as a Breeders' Committee comprising plant breeders and pre-breeders of major European food crops.

Table 2. Potential impacts of the PGR Secure action – Theme 1a: Novel characterization techniques – phenomics and genomics

IMPACT CATEGORY	PROJECT PRODUCTS AND POTENTIAL IMPACTS				
	Phenotyping data	**Transcriptomics data**	**Sequencing data**	**Molecular markers**	**Metabolomics data**
Scientific	Insight into morphological traits that may be causal to resistance	• Insight into genes that may be causal to resistance • Insight into resistance mechanism	• Insight into variation in gene content • SNPs	• QTLs for resistance • Insight into resistance mechanism	• Insight into role of metabolites in resistance • Insight into resistance mechanism
Technological	Evaluation techniques	–	Axiom SNP array	–	–
Economic	Basis for new varieties	–	More efficient breeding	Basis for new varieties	–
Competitive	Faster breeding	–	–	Faster breeding	–
Social	Less pesticides	–	–	Less pesticides	–
Means of dissemination	Scientific paper, PGR Diversity Gateway	Scientific paper, NCBI database	Scientific paper, NCBI database	Scientific paper, PGR Diversity Gateway	Scientific paper
User community(ies)	Genebanks, breeders, scientists	Scientists	Scientists/breeders	Scientists, breeders	Scientists

Table 3. Potential impacts of the PGR Secure action – Theme 1b: Novel characterization techniques – predictive characterization

IMPACT CATEGORY	PROJECT PRODUCTS AND POTENTIAL IMPACTS
	Technical guidelines for predictive characterization of CWR and LR
Scientific	• First guidelines for predictive characterization of CWR and LR using different methodological approaches implementing FIGS • Provides knowledge for targeted selection of CWR and LR accessions and populations for breeding
Technological	Provides a powerful methodology for predictive characterization and thus for the use of target CWR
Economic	More efficient selection of accessions with potential traits of interest for breeding programmes, leading to an economic advantage for the European plant breeding and farming industries
Competitive	More rapid selection of potential traits of interest for breeding programmes than with traditional screening methods
Social	Increased options for crop improvement through enhanced selection of breeding material; greater climate change resilience, food security and enhanced choice
Means of dissemination	Via the Bioversity and PGR Secure project website and a peer-reviewed publication
User community(ies)	• National PGR programmes • Plant genebanks • Breeders

Table 4. Potential impacts of the PGR Secure action – Theme 2a: Crop wild relative conservation

IMPACT CATEGORY	PROJECT PRODUCTS AND POTENTIAL IMPACTS			
	European crops and CWR inventory	**CWR National Inventories (NIs)**	**National CWR conservation strategies**	**European CWR conservation strategy**
Scientific	• Enhanced comprehensive inventory of European crop and CWR taxa • Published methodology for creation of the inventory to act as a model for use in other regions of the world	• First CWR NIs for most European (and non-European) countries • Provides baseline data for CWR conservation planning at national level • Model that can be used in other countries	• First national CWR conservation strategies for most European (and non-European) countries • Provides the knowledge needed for conservation action at national level • Model that can be used in other countries	• First comprehensive regional conservation strategy for high priority CWR • Provides the knowledge needed for conservation action at regional level • Model that can be used in other regions of the world
Technological	Provides: • The nomenclatural anchor onto which conservation and use data are attached • A baseline for future conservation prioritization, threat and utilization assessment at European level • Baseline national CWR checklists for each European country	Provide a baseline for future conservation prioritization, threat and utilization assessment at national level	Provide the strategic planning and scientific baseline data required for practical implementation of complementary conservation of national CWR diversity	Provides the strategic planning and scientific baseline data required for practical implementation of complementary conservation of European CWR diversity
Economic	Improved accessibility to baseline data required for European and national conservation planning	Improved accessibility to baseline data required for national conservation planning	Better focusing of conservation action leading to improved knowledge of CWR diversity for eventual exploitation in crop improvement programmes	
Competitive	This will be the only fully comprehensive regional crop and CWR inventory available; therefore, its existence gives Europe a clear competitive advantage over other regions and non-European countries	Better access to potential exploitation materials than competitor countries such as the USA, Canada, Australia, Russia, Brazil, India and China		
Social	Baseline knowledge of European CWR taxonomic diversity required for conservation and utilization leading to increased options for crop improvement	• Conservation of European CWR diversity leading to increased utilization options for crop improvement • Greater climate change resilience, food security and enhanced choice		

Table 4 cont'd. Potential impacts of the PGR Secure action – Theme 2a: Crop wild relative conservation

IMPACT CATEGORY	PROJECT PRODUCTS AND POTENTIAL IMPACTS			
	European crops and CWR inventory	**CWR National Inventories (NIs)**	**National CWR conservation strategies**	**European CWR conservation strategy**
Means of dissemination	Web-enabled (via the PGR Diversity Gateway)		• Partially web-enabled via the PGR Diversity Gateway • Reports for use by national PGR programmes, the European Commission and other stakeholders (see list of user communities below) • Peer-reviewed publications	
User community(ies)	• National PGR programmes • Government agencies and NGOs involved in plant conservation • Plant gene banks • Protected area managers • Plant breeding companies • Scientists and policy-makers in public and private research institutes • The European Commission			

Table 5. Potential impacts of the PGR Secure action – Theme 2b: Landrace conservation

IMPACT CATEGORY	PROJECT PRODUCTS AND POTENTIAL IMPACTS			
	European LR inventory	**National LR Inventories (NIs)**	**National LR conservation strategies**	**European LR conservation strategies**
Scientific	• Descriptors for *in situ* LR data recording (onto which conservation and use data are attached) and the tool for their recording were created that allow the compilation of the European inventory and act as a model for use in other regions of the world	• First LR NIs for three exemplar European countries • Provide baseline data for LR conservation planning at national level • Provide models that can be used in other countries	• First national LR conservation strategies for three exemplar European countries • Provide the knowledge needed for conservation action at national level • Provide models that can be used in other countries	• First comprehensive regional conservation strategies for general LR and for LR of high priority species • Provide the knowledge needed for conservation action at regional level • Model that can be used in other regions of the world

Table 5 cont'd. Potential impacts of the PGR Secure action – Theme 2b: Landrace conservation

IMPACT CATEGORY	PROJECT PRODUCTS AND POTENTIAL IMPACTS			
	European LR inventory	**National LR Inventories (NIs)**	**National LR conservation strategies**	**European LR conservation strategies**
Technological	• The Descriptors for *in situ* LR data recording (onto which conservation and use data are attached) and the tool for their recording provide a baseline for creating national LR checklists in each European country	Provide a baseline for future conservation prioritization, threat and utilization assessment at national level	Provide the strategic planning and scientific baseline data required for practical implementation of complementary conservation of national LR diversity	Provide the strategic planning and scientific baseline data required for practical implementation of complementary conservation of European LR diversity
Economic	Improved accessibility to baseline data required for European and national conservation planning	Improved accessibility to baseline data required for national conservation planning	Better focusing of conservation action leading to improved knowledge of LR diversity for eventual exploitation in crop improvement programmes and for direct use in agriculture	
Competitive	Descriptors for *in situ* LR data recording (onto which conservation and use data are attached) and a tool for their recording were created for the first time which gives Europe a clear competitive advantage over other regions and non-European countries	Better access to materials of potential use than competitor countries such as the USA, Canada, Australia, Russia, Brazil, India and China		
Social	Baseline knowledge of European LR diversity required for conservation and utilization (i.e., leading to increased options for crop improvement based on LR and direct use of LR in agriculture)	• Conservation of European LR diversity leading to increased utilization options for crop improvement • Greater climate change resilience, food security and enhanced choice		

Table 5 cont'd. Potential impacts of the PGR Secure action – Theme 2b: Landrace conservation

IMPACT CATEGORY	PROJECT PRODUCTS AND POTENTIAL IMPACTS			
	European LR inventory	**National LR Inventories (NIs)**	**National LR conservation strategies**	**European LR conservation strategies**
Means of dissemination	• Descriptors and the related data recording tool are both available for download from the PGR Secure website for use by national PGR programmes, the European Commission and other stakeholders (see list of user communities below)	• Web-enabled for Italy via http://vnr.unipg.it/PGRSecure/ • CD distribution to relevant governmental and regional agencies of Italy • Reports for use by national PGR programmes, the European Commission and other stakeholders	• National strategies available from the PGR Secure website (Italy, UK) and from https://portal.mtt.fi/portal/page/portal/mtt_en/mtt/publications (Finland) • European conservation strategies available from PGR Secure website • Related peer-reviewed and other publications • Conference presentations and posters	
User community(ies)	• National PGR programmes • Government and Regional agencies involved in LR diversity conservation • Farmers and farmer associations involved in LR diversity conservation • Plant gene banks • Protected area managers • Plant breeding companies • Scientists and policy-makers in public and private research institutes • The European Commission			

Table 6. Potential impacts of the PGR Secure action – Theme 3: Improved use of CWR and LR by breeders

IMPACT CATEGORY	**PROJECT PRODUCTS AND POTENTIAL IMPACTS**							
	Report on identification and discussions with stakeholders	**Transfer of selected material and associated knowledge to breeding companies**	**List and seeds of interesting accessions for breeding companies**	**Preliminary SWOT**	**Publication on trends in CWR/LR use in breeding**	**Web-based map of stakeholders**	**List of new partnerships**	**Transfer of linked markers to pests information to breeders**
Scientific	This interim report provides data on the constraints of PGR conservation and use in the EU	–	–	This interim report will provide more detailed data on PGR conservation and use constraints in the EU	This report will give an up-to-date detailed overview of the constraints of PGR use in the EU and provide action points to overcome these problems	This map will provide one of the first geographical overviews of PGR stakeholders in the EU	–	–
Technological	–	–	Provides an overview of *Avena*/*Beta* material of possible interest for breeders	–	Report provides a baseline for future research/activitie s	Provides an easy to handle web-based overview of EU PGR stakeholders	–	Use of linked markers improves the speed and efficiency in the development of new cultivars
Economic	–	Higher turnover through improved varieties	Users can benefit from this knowledge in their breeding programmes	–	Better exploitation of PGR from *ex situ* collections	Better exploitation of cooperation	Better exploitation of resources through cooperation	Use of pest resistance markers shortens the time to market entrance of a cultivar

Table 6 cont'd. Potential impacts of the PGR Secure action – Theme 3: Improved use of CWR and LR by breeders

IMPACT CATEGORY	PROJECT PRODUCTS AND POTENTIAL IMPACTS							
	Report on identification and discussions with stakeholders	**Transfer of selected material and associated knowledge to breeding companies**	**List and seeds of interesting accessions for breeding companies**	**Preliminary SWOT**	**Publication on trends in CWR/LR use in breeding**	**Web-based map of stakeholders**	**List of new partnerships**	**Transfer of linked markers to pests information to breeders**
Competitive	–	Better competitive position of breeding companies with headquarters in the EU	Being first on the market with improved cultivars can be profitable	–	Improved PGR use will lead to competitive advantage	Cooperation might bring competitive advantage to the partners concerned	Cooperation might bring competitive advantage to the partners	Being first on the market with improved cultivars can be profitable
Social	Promoting cooperation between PGR stakeholders within and between EU countries	–	–	–	Will contribute to improved food security	–	–	–
Means of dissemination	Via PGR Secure website and via the national consultants involved in WP5	Via identification of users; material and knowledge is sent to users	Via sending reports to stakeholders concerned; discussions during meetings with breeders	Via PGR Secure website and sending the report to specific stakeholders	Publication in scientific and popular context	Via internet and via sending reports to stakeholders	Via internet	Via identification of users. Material and knowledge is sent to users
User community(ies)	Government, genebanks, agro-NGOs, breeders, research institutes	Breeders, research institutes, agro-NGOs	Breeders, agro-NGOs and research institutes	Government, genebanks, agro-NGOs, breeders, research institutes	Government, genebanks, agro-NGOs, breeders, research institutes	Government, genebanks, agro-NGOs, breeders, research institutes	Government, genebanks, agro-NGOs, breeders, research institutes	Breeders, research institutes, agro-NGOs

Table 7. Potential impacts of the PGR Secure action – Theme 4: Informatics

IMPACT CATEGORY	PRODUCTS AND POTENTIAL IMPACTS
	Plant Genetic Resources Diversity Gateway
Scientific	This development is an outreach product resulting from research on CWR and LR conservation and use
Technological	• The technology being used is not a closed database but can be changed when new data are made available by using a non-structured database and making use of ontologies in the backbone making it more robust and easy to bring together the various data types (traits, organizations, geo-referencing, threat status, conservation status, environment, taxonomy) and different domains (*in situ* /*ex situ*, conservation strategies, inventories) • The 'Descriptors and templates for data management and monitoring of CWR conservation and utilization for checklists, inventories and conservation strategies (v1)' • 'Descriptors and template for Web-Enabled Quantitative Trait Locus (QTL) Data, v1' • Download of information is available to promote wider scientific use
Economic	Better access to traits that are important to breeders can improve the whole breeding process with clear economic benefits for the EU
Competitive	This will be the first web portal dedicated to providing open access to information on European CWR, LR and traits, and facilitating access to materials for crop improvement; it will also be a source of information to better inform decision-makers about conservation needs and strategies and potential material for crop improvement
Social	Enhanced knowledge about CWR, LR and traits of interest to improve crops in the face of climate change; the PGR Diversity Gateway can also serve as a platform to raise awareness about these crops and can contribute to better decision-making on policy for CWR and LR
Means of dissemination	Web, conferences, workshops, press, factsheets and papers
User community(ies)	• National PGR programmes • Government agencies and NGOs involved in plant conservation • Plant genebanks • Protected area managers • Plant breeding companies • Scientists and policymakers in public and private research institutes • The European Commission • Farmers

4.1.5 Project website and contact details

The project website is available at www.pgrsecure.org and it is anticipated that the content will remain available until 2017.

Partner contact details

The main partner contacts and primary roles in the project are listed below. A full list of collaborators is available at: www.pgrsecure.bham.ac.uk/collaborators.

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Project Coordinator, WP3 and WP7 leader

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www.pgrsecure.org

Project acronym: PGR Secure

Project Full Name: Novel characterization of crop wild relative and landrace resources as a basis for improved crop breeding

Final Report

Section 4.2: Use and dissemination of foreground

Contents

PGR Secure dissemination and exit strategies

An initial plan for use and dissemination of foreground was detailed in Annex I, Description of Work (www.pgrsecure.bham.ac.uk/sites/default/files/documents/contract_reporting/DOW_PGR_Secure_(266394)_2013-04-04.pdf). At the project's kick-off meeting in March 2011, dissemination and exit strategies per work package and per deliverable were drafted and these were updated during the project lifetime, as well as being reviewed and amended at each project consortium meeting. These documents are available in the partner intranet at: www.pgrsecure.bham.ac.uk/sites/default/files/documents/deliverables/Dissemination_strategy.pdf and www.pgrsecure.bham.ac.uk/sites/default/files/documents/deliverables/Exit_strategy.pdf.

Scientific publications and dissemination activities arising from the project are detailed in sections A1 and A2 below. A list of publications and presentations is also provided per work package in Appendix 1 of the third periodic report, as well as a list of publications and presentations per partner institute that are closely related to the project research.

Section A1: Scientific publications

Peer-reviewed journal papers

Garkava-Gustavssona, L., Mujajub, C., Sehic, J., Zborowska, A., Backes, G.M., Hietaranta, T. and Antonius, K. (2013) Genetic diversity in Swedish and Finnish heirloom apple cultivars revealed with SSR markers. *Scientia Horticulturae* 162, 43–48. DOI: 10.1016/j.scienta.2013.07.040

Landucci, F., Panella, L., Lucarini, D., Gigante, D., Donnini, D., Kell, S., Maxted, S., Venanzoni, R. and Negri, V. (2014) A prioritized inventory of crop wild relatives and wild harvested plants of Italy. *Crop Science* 54, 1628–1644. DOI: 10.2135/cropsci2013.05.0355.

Phillips, J., Kyratzis, A., Christoudoulou, C., Kell, S.P. and Maxted, N. (2014) Development of a national crop wild relative conservation strategy for Cyprus. *Genetic Resources and Crop Evolution* 61(4), 817–827. DOI: 10.1007/s10722-013-0076-z

Spataro, G. and Negri, V. (2013) The European seed legislation on conservation varieties: focus, implementation, present and future impact on landrace on farm conservation. *Genetic Resources and Crop Evolution* 60, 2421–2430. DOI: 10.1007/s10722-013-0009-x

Peer-reviewed journal papers in preparation or submitted

Kell, S., Maxted, N., Ford-Lloyd, B.V. *et al*. (in prep.). A methodological approach to complementary conservation of priority European CWR. *Journal to be decided.*

Landucci, F., Panella, L., Gigante, D., Donnini, D., Lucarini, D., Venanzoni, R. and Negri, V. Towards an *in situ* conservation strategy for wild plants of socio-economic interest: an example from Italy. *Genetic Resources and Crop Evolution*, submitted.

Rubio Teso, M.L., Parra-Quijano, M., Torres Lamas, E. and Iriondo, J.M. (in prep.) *In situ* and *ex situ* conservation status of CWR in Spain. Implications for conservation. *Genetic Resources and Crop Evolution*.

Rubio Teso, M.L., Thormann, I., Parra-Quijano, M., Dias, S., Van Etten, J. and Iriondo, J.M. (in prep.) An ecogeographical approach to optimizing focused identification germplasm strategy in crop wild relatives. *BMC Bioinformatics*.

Taylor, N.G., Kell, S., Holubec, V., Parra-Quijano, M., Chobot, K. and Maxted, N. (in prep.) A crop wild relative conservation strategy for the Czech Republic. *Journal to be decided.*

Books

Maxted, N., Ford-Lloyd, B. and Dulloo, M.E. (eds.) (2015) *Enhancing Crop Genepool Utilization: Capturing Wild Relative and Landrace Diversity for Crop Improvement*. CAB International, Wallingford, in prep.

Book chapters

Dias, S. et al. (2015) Plant Genetic Resources Diversity Gateway – a way forward. In: Maxted, N., Ford-Lloyd, B.V. and Dulloo, M.E. (eds.), *Enhancing Crop Genepool Utilization: Capturing Wild Relative and Landrace Diversity for Crop Improvement*. CAB International, Wallingford, in prep.

Dias, S. et al. (2015) Thoughts and experiences building an *in situ/ex situ* information system. In: Maxted, N., Ford-Lloyd, B.V. and Dulloo, M.E. (eds.), *Enhancing Crop Genepool Utilization: Capturing Wild Relative and Landrace Diversity for Crop Improvement*. CAB International, Wallingford, in prep.

Fielder, H. *et al*. (2015) Developing methodologies for the genetic conservation of UK crop wild relatives. In: Maxted, N., Ford-Lloyd, B.V. and Dulloo, M.E. (eds.), *Enhancing Crop Genepool Utilization: Capturing Wild Relative and Landrace Diversity for Crop Improvement*. CAB International, Wallingford, in prep.

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Maxted, N. *et al*. (2015) Joining up the dots: a systematic perspective on crop wild relative conservation and use. In: Maxted, N., Ford-Lloyd, B.V. and Dulloo, M.E. (eds.), *Enhancing Crop Genepool Utilization: Capturing Wild Relative and Landrace Diversity for Crop Improvement*. CAB International, Wallingford, in prep.

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Heinonen, M. and contributors (2014) *Landrace* In Situ *Conservation Strategy for Finland*. MTT Report 163. 44 pp. ISBN 978-952-487-570-7. http://urn.fi/URN:ISBN:978-952-487-570-7

Heinonen, M., Fitzgerald, H., Veteläinen, M. and Korpelainen, H. (2014) Suomalaisten maatiaiskasvien ja viljelykasvien luonnonvaraisten sukulaisten *in situ* -suojelustrategioiden valmisteleminen [Towards *in situ* conservation strategies of landraces and crop wild relatives in Finland] In: Kiviharju, E. (ed.), *Viljelykasvien Geenivarat Talteen ja Käyttöön – Suomen Kansallisen Asvigeenivaraohjelman 10-Vuotisseminaarin* (29.8.2014) satoa. MTT Raportti 139. Pp. 68–69. https://portal.mtt.fi/portal/page/portal/www/Tietopaketit/Kasvigeenivarat/mttraportti139.pdf

Heinonen, M., Kinnanen, H., Valo, R., Antonius, K. and Ala-Kaarre, J. (2014) Nurkkapuut kansan sydämessä [Seed born apple trees in Finland]. In: Kiviharju, E. (ed.), *Viljelykasvien Geenivarat Talteen ja Käyttöön – Suomen Kansallisen Asvigeenivaraohjelman 10-Vuotisseminaarin* (29.8.2014) satoa. MTT Raportti 139. Pp. 40–43. https://portal.mtt.fi/portal/page/portal/www/Tietopaketit/Kasvigeenivarat/mttraportti139.pdf

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Maxted, N., Avagyan, A. Frese, L., Iriondo, J.M., Magos Brehm, J., Singer, A. and Kell, S.P. (2013) *Preserving Diversity: A Concept for In Situ Conservation of Crop Wild Relatives in Europe.* Rome, Italy: *In Situ* and On-farm Conservation Network, European Cooperative Programme for Plant Genetic Resources, Rome, Italy. www.pgrsecure.org/documents/Concept.pdf

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Thormann, I., Parra-Quijano, M., Iriondo, J.M., Rubio-Teso, M.L., Endresen, D.T., Dias, S., van Etten, J. and Maxted, N. (2014) *Predictive Characterization of Crop Wild Relatives and Landraces. Technical Guidelines Version 1.* Bioversity International, Rome, Italy, in press.

Newsletters

Kell, S., Maxted, N. and Fielder, H. (eds.) (2012) *Crop wild relative Issue 8, April 2012.* 44 pp. www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_8.pdf

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Kell, S. and Maxted, N. (eds.) (2014, in press) *Crop wild relative Issue 10, November 2014.* www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/CWR_Issue_10.pdf

Negri, V., Torricelli, R. and Maxted, N. (eds.) (2012) *Landraces Issue 1, October 2012.* 31 pp. www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/Landraces_Issue_1.pdf

Negri, V., Torricelli, R. and Maxted, N. (eds.) (2013) *Landraces Issue 2, October 2013.* 24 pp. www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/Landraces_Issue_2.pdf

Negri, V., Torricelli, R. and Maxted, N. (eds.) (2014 in press) *Landraces Issue 3, December 2014.* www.pgrsecure.bham.ac.uk/sites/default/files/documents/newsletters/Landraces_Issue_3.pdf

PhD theses

Fielder, H. (2015) *Developing methodologies for the genetic conservation of UK crop wild relatives*. PhD Thesis. University of Birmingham, UK, in prep.

Sharma, G. (2015) *Novel approaches for evaluating* Brassica *germplasm for insect resistance*. PhD Thesis. University of Birmingham, UK, in prep.

Section A2: Dissemination activities

Conferences and workshops

Joint PGR Secure/ECPGR workshop, 'Conservation strategies for European crop wild relative and landrace diversity', 7–9 September 2011, Hotel Palangos vėtra, Palanga, Lithuania. www.pgrsecure.bham.ac.uk/palanga_workshop

PGR Secure stakeholder workshop: 'On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis', 26–28 November 2013, Wageningen, the Netherlands. www.nordgen.org/index.php/en/content/view/full/2481/

Joint PGR Secure/EUCARPIA conference, 'Enhanced Genepool Utilization – Capturing wild relative and landrace diversity for crop improvement', incorporating the PGR Secure final dissemination conference, 16–20 June 2014, NIAB Innovation Farm and Churchill College, Cambridge, UK. www.pgrsecure.org/conference

Dias, S., Dulloo, E., Maxted, N., Kell, S., Thörn, E., Smith, L., Preston, J. and Hutchinson, S. (eds.) (2014) *International Conference on Enhanced Genepool Utilization – Capturing wild relative and landrace diversity for crop improvement, Cambridge, United Kingdom, 16–20 June 2014. Book of Abstracts.* Bioversity International, Rome, Italy. www.pgrsecure.bham.ac.uk/sites/default/files/documents/public/PGR_Secure_conference_abstracts.pdf

Oral communications

Broekgaarden, C., Riviere, P., Steenhuis, G., Del sol Cuenca, M., Kos, M., Pelgrom, K., Voorrips, R. and Vosman, B. (2013) *Phloem-specific resistance in* Brassica oleracea *against the whitefly* Aleyrodes proletella*.* Oral communication, 6th meeting of the IOBC-WPRS Working Group 'Induced resistance in plants against insects and diseases', June 10–13 2013, Avignon, France.

Dias, S. (2013) *EURISCO, GENESYS and the TIP: an update*. Oral communication, UK PGR Group meeting, London, UK, 13 March 2013. Available at: http://ukpgrg.org/01-SDias_UKPGR_13March2013.pdf

Dias, S. and Skofic, M. (2014) *Thoughts and experiences building an* in situ/ex situ *information system*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Dias, S., Skofic, M., Dulloo, E. and Maxted, N. (2014) *Plant Genetic resources Diversity gateway – a way forward*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Fielder, H., Hosking, J., Brotherton, P., Woodman, J., Smith, S., Hopkins, J., Ford-Lloyd, B. and Maxted N. (2014) *Developing methodologies for the genetic conservation of UK crop wild relatives*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Frese, L. (2011) *Conservation and use of crop wild relatives*. Oral communication, IIRB Study Group meeting 'Genetics and Breeding', AIMCRA, Valladolid, Spain, 22–23 September 2011.

Frese, L., Kik, C. and Palmé, A. (2013) *On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis*. Oral communication, IV Symposium International: Gestion des Ressources et Applications Biotechnologiques en Aridoculture et Cultures Oasiennes, Djerba, Tunisia, 17–19 December 2013.

Frese L., Palmé A., and Kik C. (2014) *On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis*. Oral communication, 'Enhanced genepool utilization – capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Frese L., Palmé A., Bülow, L. and Kik, C. (2014) *Towards an improved European plant germplasm system*. Oral communication, 'Enhanced genepool utilization – capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Heinonen, M., Kinnanen, H., Valo, R., Antonius, K. and Ala-Kaarre, J. (2013) *Nurkkapuut Kansan Sydämessä*. Keynote oral communication at Finnish national plant genetic programme's 10th anniversary seminar, 29 August 2013, Jokioinen, Finland. www.mtt.fi/kasvigeenivarat

Heinonen, M. (2014) *Heritage varieties* ex situ *and* in situ *in Finland*. Keynote oral presentation at NJF seminar 474 'Nordic heritage varieties of cereals', Mariehamn, Finland, 15-17 July 2014.

Heinonen, M., Antonius, K., Kinnanen, H. and Valo, R. (2014) *Landrace inventories and conservation strategy making in Finland*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Iriondo, J.M. (2014) *Origen silvestre de las plantas cultivadas: ¿por qué resulta tan importante ahora?* Oral communication (invited speaker), Conferences of the Jardin Atlántico Botanical Garden, Gijón, Spain, 26 June 2014.

Iriondo, J.M., Parra-Quijano, M., Rubio-Teso, M.L., Torres, E. and García, R. (2013) *Ecogeographical approaches to characterize CWR adaptive traits useful for crop adaptation*. Oral communication, EUCARPIA Genetic Resources section meeting, 'Pre-breeding – fishing in the gene pool', June 10–13 2013, Alnarp, Sweden.

Iriondo, J.M., Kell, S.P., Fitzgerald, H., Negri, V., Magos Brehm, J. and Maxted, N. (2014) *National strategies for the conservation of CWR*. Keynote oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Kell, S., Iriondo, J., Magos Brehm, J., Ford-Lloyd, B., Harris, C. and Maxted, N. (2014) *Europe's crop wild relative diversity: from conservation planning to conservation action*. Oral communication. 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Maxted, N., Dias, S., Fielder, H., Fitzgerald, H., Iriondo, J.M., Landucci, F., Negri, V.,Rubio, L., Taylor, N. and Kell, S. (2013) *Nurturing the gene pool: National strategies for crop wild relative conservation and use.* Oral communication, EUCARPIA Genetic Resources section meeting, 'Pre-breeding–fishing in the gene pool', 12 June 2013, Alnarp, Sweden.

Maxted, N., Amri, A., Castañeda Álvarez, N., Dias, S., Dulloo, M.E., Fielder, H., Ford-Lloyd, B.V., Iriondo, J.M., Magos Brehm, J., Nilsen, L-B., Thormann, I., Vinvent, H. and Kell, S. (2014) *Joining up the dots: a systematic perspective on crop wild relative conservation and use*. Keynote oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Negri, V., Gigante, D., Donnini, D., Torricelli, R., Landucci, F., Panella, L. and Venanzoni, R. (2013) *Attività del DBA_UNIPG per la salvaguardia dei progenitori selvatici delle piante coltivate nell'ambito del progetto EC FPVII PGR Secure*. Oral communication, Banche di germoplasma e conservazione *in situ* scientific meeting, Orto Botanico, Rome, 23 April 2013.

Negri, V., Heinonen, M., Mendes Moreira, P., Torricelli, R. and Maxted, N. (2013) *Developing a European on farm conservation strategy for landraces.* Oral communication, EUCARPIA Genetic Resources section meeting, 'Pre-breeding – fishing in the gene pool', 10–13 June 2013, Alnarp, Sweden. www.nordgen.org/ngdoc/nordgen/Eucarpia/oral_presentations/Valeria_Negri.pdf

Negri, V., Heinonen, M., Moreira Mendes, P., Torricelli, R. and Maxted N. (2013) *Developing a European in situ (on farm) conservation strategy for landraces (LR).* Oral communication, EUCARPIA Genetic Resources section meeting, 'Pre-breeding – fishing in the gene pool', 10–13 June 2013, Alnarp, Sweden.

Negri, V., Maxted, N., Torriceli, R. and Heinonen, M. (2014) *Towards a European on-farm conservation strategy for landraces.* Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Negri, V., Torricelli, R., Maxted, N. and Heinonen, M. (2014) European landrace conservation. *Landraces* 3, in press.

Palmé, A. (2012) *Utilizing crop wild relatives in the Baltic sea region: some initial findings in the EU project PGR Secure*. Oral communication, 'Diversity in plant breeding and agriculture: strategies for healthy lifestyle', State Stende Cereals Breeding Institute, Latvia, May 30–June 01 2012.

Parra-Quijano, M., López, F., Torres, E. and Iriondo, J.M. (2014) *CAPFITOGEN tools. Facilitated spatial and ecogeographical germplasm analysis for efficient PGR conservation and utilization*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Pelgrom, K. (2012) *Host plant resistance to cabbage whitefly in Brassica oleracea and wild relatives*. Oral communication, NWO-ALW meeting 'Experimental Plant Sciences', Lunteren, The Netherlands, 03 April 2012.

Pelgrom, K., Sharma, G., Voorrips, R., Broekgaarden, C., Pritchard, J., May, S., Adobor, S., Janssen, B., van Workum, W., Ford-Lloyd, B. and Vosman, B. (2014) *Using phenomics and genomics to unlock landrace and wild relative diversity for crop improvement*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Rubio-Teso, M.L., Parra-Quijano, M. and Iriondo, J.M. (2013) *Finding the most drought-resistant plant populations. Evaluation of the FIGS methodology.* Oral communication, XI National Congress of the Spanish Association of Terrestrial Ecology. Pamplona/Iruña 6–10 May 2013.

Rubio Teso, M.L., Parra-Quijano, M., Ronquillo-Ferrero, C., Nebreda, A., Torres, E. and Iriondo, J.M. (2013) *Hacia la estrategia de conservación de parientes silvestres de cultivos. Diversidad genética de valor adaptativo en espacios naturales protegidos.* Oral communication, XI Congress of Plant Conservation Biology, Murcia, Spain, 15–18 October 2013.

Rubio Teso, M.L., Ronquillo Ferrero, C., Torres Lamas, E., Parra Quijano, M. and Iriondo Alegría, J.M. (2013) *Evaluación del estado de conservación* in situ *y diversidad de parientes silvestres de cultivos para la alimentación y forraje*. Oral communication, IV Congress of Biodiversity, Bilbao, Spain, 6–8 February 2013. http://congresobiodiversidad.com/comunicaciones-orales/

Rubio Teso, M.L., Kinoshita-Kinoshita, K. and Iriondo, J.M. (2014) *Optimized site selection for the* in situ *conservation of forage and fodder CWRs: a combination of community and genetic level perspectives*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Thormann, I., Parra-Quijano, M., Iriondo, J.M., Rubio-Teso, M.L., Endresen, D.T., Dias, S., van Etten, J. and Maxted, N. (2014) *New predictive characterization methods for accessing and using CWR diversity*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Torricelli, R., Pacicco, L., Bodesmo, M., Raggi, L. and Negri, V. (2014) *Assessment of Italian LR density and species richness: useful criteria for developing in situ conservation strategies*. Oral communication, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Vosman, B. (2013) *High throughput screening of plant collections for increased resistance towards phloem feeding insects*. Oral communication, annual meeting of the Entomological Society of America. 10–13 November 2013, Austin, USA.

Vosman, B. (2013) *Breeding for insect resistant crops*. Oral communication, mini-symposium on novel technologies to study plant/herbivore interactions. Arkansas State University, 8 November 2013, Jonesburo, USA.

Vosman, B. (2013) *Novel characterization techniques: the phenomics and genomics approach*. Oral communication, PGR Secure workshop, 'On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis', Wageningen, The Netherlands, 25–29 November 2013.

Vosman, B. (2014) *Insect resistance in vegetable crops*. Oral communication, Applied Vegetables Genomics Conference, Vienna, 19–20 February 2014.

Poster presentations

Fitzgerald, H., Heinonen, M., Korpelainen, H. and Veteläinen, M. (2013) *Towards the Finnish LR and CWR conservation strategies.* Poster presented at the EUCARPIA Genetic Resources section meeting, 'Pre-breeding – fishing in the gene pool', 10–13 June 2013, Alnarp, Sweden.

Fitzgerald, H., Korpelainen, H. and Veteläinen, M. (2014) *Developing a crop wild relative conservation strategy for Finland*. Poster presentation, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Frese L., Palmé A. and Kik C. (2014) *Towards an improved European plant germplasm system*. Poster presented at the Third Nordic International Conference on Climate Change Adaptation: Adapting to Change: From Research to Decision-making, Copenhagen, Denmark, 25–27 August 2014.

Heinonen, M., Fitzgerald, H., Veteläinen, M. and Korpelainen, H. (2013) *Suomalaisten Maatiaiskasvien ja Viljelykasvien Luonnonvaraisten Sukulaisten in situ Suojelustrategioiden Valmisteleminen*. Poster and abstract at Finnish national plant genetic programme's 10th anniversary seminar, 29 August 2013, Jokioinen, Finland. www.mtt.fi/kasvigeenivarat

Pacicco, L., Bodesmo, M., Torricelli, R. and Negri, V. (2013) *The First Italian Inventory of In Situ Maintained Landraces.* Poster presented at the 57th Annual Congress of Societa' Italiana di Genetica Agraria, Foggia, 16–19 September 2013.

Palmé, A., Solberg, S.Ø., Ottosson, F., Poulsen, G., Frese, L. and Kik, C. (2013) *Constraints in the Utilization of Plant Genetic Resources in the Nordic Countries*. Poster presented at the EUCARPIA Genetic Resources section meeting: 'Pre-breeding – fishing in the gene pool', 10–13 June 2013, Alnarp, Sweden.

Panella, L., Donnini, D., Gigante, D., Negri, V. and Venanzoni, R. (2011) Crop Wild Relatives of *Apium*, *Avena*, *Beta*, *Brassica* and *Prunus* genera in Umbria. Poster presented at the 106° Società Botanica Italiana Congress, Genova (I) 21–24 September 2011.

Panella, L., Landucci, F., Gigante, D., Donnini, D., Lucarini, D., Venanzoni, R., Torricelli, R. and Negri, V. (2013) *Crop wild relatives and wild harvested plants of Italy*. Poster presented at the 57th Annual Congress of Societa' Italiana di Genetica Agraria, Foggia, Italy, 16–19 September 2013.

Pelgrom, K., Broekgaarden, C., Voorrips, R. and Vosman, B. (2014) *Mapping and validation of QTLs for resistance to whitefly in cabbage*. Poster presentation, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Phillips, J., Asdal, Å. and Maxted, N. (2014) *National implementation of the conservation of plant genetic resources within Norway.* Poster presentation, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Raggi, R., Panella, L., Landucci, F., Gigante, D., Venanzoni, R. and Negri, V. (2013) *Brassica crop wild relatives in central Italy*. Poster presented at the VI International Symposium on Brassicas and XVIII Crucifer Genetics Workshop, Catania, Italy, 12–16 November 2013.

Raggi, R., Panella, L., Landucci, F., Torricelli, R., Venanzoni, R. and Negri, V. (2014) *A gap analysis for* Brassica incana *Ten. and* B. montana *Pourr. Present in Italy.* Poster presentation, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Sharma, G., Pritchard, J. and Ford-Lloyd, B. (2014) *Looking for insect resistance in brassicas: combining physiology with plant transcriptomics to identify new sources of resistance and candidate genes*. Poster presentation, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Suojala-Ahlfors, T., Heinonen, M., Antonius, A., Heinonen, A., Mattila P. and Pihlava, J-M. (2013) *Ryvässipuli – Perinnekasvi Takaisin Viljelyyn ja Käyttöön*. Poster at Finnish national plant genetic programme's 10th anniversary seminar, 29 August 2013, Jokioinen, Finland. www.mtt.fi/kasvigeenivarat

Thormann, I., Rubio Teso, M.L., Parra Quijano, M. and Iriondo, J.M. (2014) *Predictive characterization of* Beta *CWR using the ecogeographical filtering method*. Poster presentation, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Torricelli, R., Landucci, F., Panella, L. Donnini, D., Gigante, D., Venanzoni, R., Raggi, L. and Negri, V. (2014) *First steps towards and Italian conservation strategy for crop wild relatives and wild harvested plants.* Poster presentation, 'Enhanced genepool utilization – Capturing wild relative and landrace diversity for crop improvement', Cambridge, UK, 16–20 June 2014.

Vosman, B., Pelgrom, K., Voorrips, R. and Broekgaarden, C. (2013) *Breeding for cabbage whitefly resistance in* Brassica oleracea. Poster presented at the conference 'Future IPM in Europe', 19–21 March 2013, Riva del Garda, Italy.

Calls for landraces (related to WP4, Landrace conservation): Posters and other material (in Finnish and Swedish)

Heinonen, M. (2012) Valtavan rakas / Hugely loved / Högt älskade fruktträd. MTT elo-blog 14 January 2012, mttelo.mtt.fi

Heinonen, M. and Kinnanen, H. (2012) Paikalliset hedelmälajikkeet. [Call for LR apples and pears in Finland]

Heinonen, M. and Kinnanen, H. (2012) Missä kasvaa hämäläisiä vanhoja omenalajikkeita? [Call for LR apples in southern Finland]

Heinonen, M. and Kinnanen, H. (2012) Missä kasvaa savolaisia vanhoja omenalajikkeita? [Call for LR apples in central Finland]

Heinonen, M. and Kinnanen, H. (2012) Missä kasvaa lounaissuomalaisia vanhoja omenalajikkeita? [Call for LR apples in southwest Finland]

Heinonen, M. and Kinnanen, H. (2012) Missä kasvaa lounaissuomalaisia vanhoja päärynälajikkeita? [Call for LR pears in southwest Finland]

Heinonen, M. and Kinnanen, H. (2012) Inhemska äpplen och päron vid Finska viken [Call for LR apples and pears in coastal Finland]

Heinonen, M. and Kinnanen, H. (2013) Missä kasvaa uusmaalaisia vanhoja omenalajikkeita? [Call for LR apples in south Finland]

Kinnanen H. and Mäkinen K. (2013) Omenakalenteri 2013. Suomalaisia maatiaislajikkeita [Native Apple Annual Calendar 2013]

Field exhibits

NIAB Innovation Farm was host institute and sponsor of the joint PGR Secure/EUCARPIA conference, 'ENHANCED GENEPOOL UTILIZATION – capturing wild relative and landrace diversity for crop improvement' convened in Cambridge, UK, 16–20 June 2014. NIAB has a particular strength in practical translation of research to products and Innovation Farm forms the user interface between growers, industry and the research community by working to improve knowledge exchange and to facilitate practical and profitable relationships in order to harness the full potential of plant genetic innovations. One of NIAB Innovation Farm's main facilities is 2 ha of land devoted to exhibiting plant genetic resources in field plots and in glasshouses adjacent to a visitor centre containing seminar and networking facilities. The PGR Secure consortium took advantage of this opportunity to display crop wild relative (CWR) and landrace material to raise awareness of the value of these plant genetic resources for food and agriculture (PGRFA) and to provide a means of attracting users of the material. A series of information sheets were prepared and provided to visitors to the NIAB Innovation Farm.

Information sheets

Frese, L. (2014) *The sugar beet crop gene pool*. PGR Secure information sheet to accompany field exhibit, NIAB Innovation Farm, Cambridge, UK. www.pgrsecure.org/sites/default/files/documents/public/Exhibits/sugarbeet.pdf

Heinonen, M. (2014) *Landrace potato onions in Finland*. PGR Secure information sheet to accompany field exhibit, NIAB Innovation Farm, Cambridge, UK. www.pgrsecure.org/sites/default/files/documents/public/Exhibits/potato_onion.pdf

Heinonen, M., Timonen, A. and Kell, S. (2014) *Landrace hulless barley 'Jorma'*. PGR Secure information sheet to accompany field exhibit, NIAB Innovation Farm, Cambridge, UK. www.pgrsecure.org/sites/default/files/documents/public/Exhibits/hulless_barley.pdf

Solberg, S. Ø. and Palmé, A. (2014) *Forages from the Nordic countries*. PGR Secure information sheet to accompany field exhibit, NIAB Innovation Farm, Cambridge, UK. www.pgrsecure.org/sites/default/files/documents/public/Exhibits/Nordic_forages.pdf

Solberg, S. Ø. and Palmé, A. (2014) *Vegetables and herbs from the Nordic region*. PGR Secure information sheet to accompany field exhibit, NIAB Innovation Farm, Cambridge, UK. www.pgrsecure.org/sites/default/files/documents/public/Exhibits/Nordic_vegetables.pdf

Vosman, B. (2014) *Breeding insect-resistant brassica crops*. PGR Secure information sheet to accompany field and glasshouse exhibits, NIAB Innovation Farm, Cambridge, UK. www.pgrsecure.org/sites/default/files/documents/public/Exhibits/brassicas.pdf

Videos

Crop wild relatives – a key asset for sustainable agriculture. Bioversity International, Rome, Italy. www.bioversityinternational.org/news/detail/new-video-on-crop-wild-relatives/; www.youtube.com/watch?feature=player_embedded&v=Ah7RruMZ9CU

4.3 Report on societal implications

B. Ethics

1. Did your project undergo an Ethics Review (and/or Screening)?	Yes
If Yes: have you described the progress of compliance with the relevant Ethics Review/Screening Requirements in the frame of the periodic/final reports?	Yes

2. Please indicate whether your project involved any of the following issues :

RESEARCH ON HUMANS

Did the project involve children?	No
Did the project involve patients?	No
Did the project involve persons not able to consent?	No
Did the project involve adult healthy volunteers?	No
Did the project involve Human genetic material?	No
Did the project involve Human biological samples?	No
Did the project involve Human data collection?	No

RESEARCH ON HUMAN EMBRYO/FOETUS

Did the project involve Human Embryos?	No
Did the project involve Human Foetal Tissue / Cells?	No
Did the project involve Human Embryonic Stem Cells (hESCs)?	No
Did the project on human Embryonic Stem Cells involve cells in culture?	No
Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos?	No

PRIVACY

Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	No
Did the project involve tracking the location or observation of people?	No

RESEARCH ON ANIMALS

Did the project involve research on animals?	No
Were those animals transgenic small laboratory animals?	No
Were those animals transgenic farm animals?	No
Were those animals cloned farm animals?	No
Were those animals non-human primates?	No
RESEARCH INVOLVING DEVELOPING COUNTRIES	
Did the project involve the use of local resources (genetic, animal, plant etc)?	No
Was the project of benefit to local community (capacity building, access to healthcare, education etc)?	No
DUAL USE	
Research having direct military use	No
Research having potential for terrorist abuse	No

C. Workforce Statistics

3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).

Type of Position	Number of Women	Number of Men
Scientific Coordinator	0	1
Work package leaders	1	6
Experienced researchers (i.e. PhD holders)	11	21
PhD student	3	2
Other	22	15

4. How many additional researchers (in companies and universities) were recruited specifically for this project?	12
Of which, indicate the number of men:	4

D. Gender Aspects

5. Did you carry out specific Gender Equality Actions under the project ?	No

6. Which of the following actions did you carry out and how effective were they?	
Design and implement an equal opportunity policy	Not Applicable
Set targets to achieve a gender balance in the workforce	Not Applicable
Organise conferences and workshops on gender	Not Applicable
Actions to improve work-life balance	Not Applicable
Other:	

7. Was there a gender dimension associated with the research content - i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?	No
If yes, please specify:	

E. Synergies with Science Education

8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?	Yes
If yes, please specify:	Science festival at University of Birmingham and we undertook joint project with national conservation agencies

9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?	No

F. Interdisciplinarity

10. Which disciplines (see list below) are involved in your project?	
Main discipline:	4.1 Agriculture, forestry, fisheries and allied sciences (agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects)
Associated discipline:	1.5 Biological sciences (biology, botany, bacteriology, microbiology, zoology, entomology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences)
Associated discipline:	

G. Engaging with Civil society and policy makers

11a. Did your project engage with societal actors beyond the research community? (if 'No', go to Question 14)	Yes
11b. If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?	Yes, in communicating /disseminating / using the results of the project
11c. In doing so, did your project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?	No
12. Did you engage with government / public bodies or policy makers (including international organisations)	Yes - in implementing the research agenda
13a. Will the project generate outputs (expertise or scientific advice) which could be used by policy makers?	Yes - as a primary objective (please indicate areas below multiple answers possible)
13b. If Yes, in which fields?	
Agriculture	Yes
Audiovisual and Media	No
Budget	No
Competition	No
Consumers	No
Culture	No
Customs	No
Development Economic and Monetary Affairs	No
Education, Training, Youth	No
Employment and Social Affairs	No
Energy	No
Enlargement	No
Enterprise	No
Environment	No
External Relations	No
External Trade	No
Fisheries and Maritime Affairs	No
Food Safety	No
Foreign and Security Policy	No
Fraud	No

Humanitarian aid	No
Human rightsd	No
Information Society	No
Institutional affairs	No
Internal Market	No
Justice, freedom and security	No
Public Health	No
Regional Policy	No
Research and Innovation	No
Space	No
Taxation	No
Transport	No
13c. If Yes, at which level?	European level

H. Use and dissemination

14. How many Articles were published/accepted for publication in peer-reviewed journals?	4
To how many of these is open access provided?	0
How many of these are published in open access journals?	0
How many of these are published in open repositories?	0
To how many of these is open access not provided?	0
Please check all applicable reasons for not providing open access:	
publisher's licensing agreement would not permit publishing in a repository	No
no suitable repository available	No
no suitable open access journal available	Yes
no funds available to publish in an open access journal	Yes
lack of time and resources	No
lack of information on open access	No
If other - please specify	
15. How many new patent applications ('priority filings') have been made? ("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).	0

16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).	
Trademark	0
Registered design	0
Other	0

17. How many spin-off companies were created / are planned as a direct result of the project?	0
Indicate the approximate number of additional jobs in these companies:	0

18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:	Difficult to estimate / not possible to quantify, None of the above / not relevant to the project

19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (FTE = one person working fulltime for a year) jobs:	0Difficult to estimate / not possible to quantify

I. Media and Communication to the general public

20. As part of the project, were any of the beneficiaries professionals in communication or media relations?	No

21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?	No

22. Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?	
Press Release	No
Media briefing	No
TV coverage / report	Yes
Radio coverage / report	Yes
Brochures /posters / flyers	Yes
DVD /Film /Multimedia	Yes
Coverage in specialist press	No
Coverage in general (non-specialist) press	No
Coverage in national press	No
Coverage in international press	No
Website for the general public / internet	Yes

Event targeting general public (festival, conference, exhibition, science café)	Yes

23. In which languages are the information products for the general public produced?	
Language of the coordinator	No
Other language(s)	Yes
English	Yes

Attachments	PGR_Secure_266394_Periodic_Report_3_Section_1.pdf, PGR_Secure_266394_Periodic_Report_3_Section_2.pdf
Grant Agreement number:	266394
Project acronym:	PGR Secure
Project title:	Novel characterization of crop wild relative and landrace resources as a basis for improved crop breeding
Funding Scheme:	FP7-CP-FP
Project starting date:	01/03/2011
Project end date:	31/08/2014
Name of the scientific representative of the project's coordinator and organisation:	Dr. Nigel Maxted THE UNIVERSITY OF BIRMINGHAM
Period covered - start date:	01/09/2013
Period covered - end date:	31/08/2014
Name	
Date	31/10/2014

This declaration was visaed electronically by Shelagh KELL (ECAS user name nkellksh) on 31/10/2014

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