

Implementation of the ECPGR European Evaluation Network (EVA) on wheat/barley and vegetable crops (carrot, lettuce and pepper)

Project funded by the German Federal Office for Agriculture and Food

Submitted by the ECPGR Secretariat 22 May 2019 – Approved 25 June 2019

Timeframe: 1 July 2019 – 30 June 2022

Budget: € 603 526

1. Background

At its 15th meeting in Thessaloniki, Greece (May 2018), the ECPGR Steering Committee approved the objectives of ECPGR for Phase X (2019-2023). Among these, objective 5 is aiming to promote the use of PGRFA and specifically the expected output 5.1 concerns the development of a European Evaluation Network for PGRFA.

Between 2017 and 2019, two ECPGR projects funded by Germany have set the basis for the formulation, consensus building and establishment of an agreed framework at ECPGR level for the implementation of a European Evaluation Network (EVA). The first project (GenR 2016-2) (Jan 2017 – May 2018), called “Private Public Partnerships (PPP) for the Use of Plant Genetic Resources for Food and Agriculture (PGRFA)”, involved representatives of the private and public breeding sectors from 18 European countries to discuss how collaboration may be improved Europe-wide to increase the utilization of plant genetic resources in plant breeding. A European Evaluation Network was considered of strategic importance for Europe as it would present an opportunity to position PGRFA at a strategic level within Europe. The Network would play a critical role in facilitating adaptation of European agriculture to climate change and would also contribute towards achieving related Sustainable Development Goals (SDGs). The importance of an Evaluation Network was seen as not only related to increase the use of genetic diversity in plant breeding, but also to increase the diversity of stakeholders in plant breeding, including private and public sectors, small and medium enterprises (SMEs) and participatory plant breeding actions. Subsequently, a Task Force developed a formal document for the establishment of the European PGRFA Evaluation Network, also including the network structure and model Letter of Commitment and Formal Cooperation Agreement. The 15th ECPGR Steering Committee meeting held in Greece 15-17 May 2018 endorsed the proposal for a European Evaluation Network and assigned to it the acronym EVA. Concomitantly, ECPGR and the European Seed Association (ESA) signed a Memorandum of Understanding for enhanced cooperation, in particular within the framework of EVA. The ECPGR Steering Committee also included the development of EVA among ECPGR objectives for Phase X (2019-2023), including the generation of evaluation data throughout the European region and inclusion of such data in EURISCO.

The second project (GenR 2018-3) (Sep 2018 – Apr 2019), was dedicated to the organization of two ECPGR workshops for the preparation of a European Evaluation Network (EVA) on wheat/barley and a vegetable crop. The main criteria identified for the selection of exemplar crops were the potential impact in an overall variety development process (perception of missing diversity) and importance of final objectives (biotic/abiotic environmental adaptation, quality, diversification of production). An essential element was also the readiness of a group of actors to get committed and participate in the

Evaluation Network, as well as the synergy with existing projects. With this regard, two workshops were held involving breeding companies, researchers and genebank representatives. The first on wheat and barley was held in Berlin, Germany, in November 2018 at the Julius Kühn-Institute (JKI), the second on vegetable crops was held in Durrës, Albania, in April 2019. At both occasions, the principles of EVA were explained and breeders and genebank managers had the opportunity to familiarize with the proposed framework. General appreciation was expressed for the advantages deriving from the implementation of an ongoing programme dedicated to systematically genotype and evaluate European genebank accessions in multiple environments, adopting common protocols and sharing the resulting data on a central documentation system. There was also agreement to make these data publicly available outside the specific crop consortia after an embargo period of three years. The cereal breeding companies were unanimous in identifying disease resistance as the most suitable and useful traits to be evaluated through the Network and agreed to carry out annual evaluation of a defined and limited amount of genebank accessions at their own cost. In the case of vegetable breeders, phenotypical, harvest and quality traits were also considered important for this exercise, together with disease resistance traits. Genebank managers agreed on the importance to provide minimum quantities of selected genebank accessions to the network for multiplication, genotyping and evaluation. It was considered a benefit for the genebanks to be able to serve users in a context that would make it possible to add genotypic and phenotypic information to their conserved accessions, at no cost for the genebanks. The Wheat and Barley workshop agreed to evaluate the same material in different environments of three macro-zones (north, centre and south Europe) and to focus on the following five crops: Spring barley, Winter barley, Spring wheat, Winter wheat, Durum wheat (only for southern region). During the vegetables workshop, three exemplar crops were selected, representing fruit (Pepper), leaves (Lettuce) and root (Carrot) products and interest was expressed towards evaluation of mainly landraces and possibly wild relatives. All materials under investigation will be pre-screened in the laboratory for susceptibility to respective critical diseases. After multiplication, the same material will then be field tested in multiple environments. All accessions of all crops are planned to be genotyped.

The potential consortium partners identified a number of items requiring external funding (see budget) and encouraged the ECPGR Secretariat to look for suitable donors. At the same time, the participants made themselves available to enter into formal consortium agreements under the coordination of the ECPGR Secretariat and welcomed the possibility to extend the consortium to a wider number of partners in order to cover all the European environments during the evaluation. The opportunity to use and further develop EURISCO as a central repository of data and information was considered appropriate and convenient.

In this context, it is proposed to start a project for the implementation of the EVA-wheat and barley and EVA-vegetables (carrot, lettuce and pepper) Networks for three years under the Coordination of the ECPGR Secretariat. As part of the project, the Evaluation Network structure will be completed, including the formal establishment of two crop consortia, through signature of Letters of Commitment and Cooperation Agreements. Overall, the concept of a European Evaluation Network will be validated and will offer an example that could be followed by other crop consortia. The implementation of this project will allow for the first time to consolidate a long-term cooperation between genebanks, research institutions and the breeding sector (public and private) within the European cooperative programme. The expected achievements will allow a leap forward in the level of efficiency and services offered by European genebanks, consolidating interaction between conservation and use of PGRFA. The latter

has been a long-standing (but to date, largely unaccomplished) goal of the European genetic resources community.

Objectives of the project

- a) Kick-start the implementation of the European Evaluation Networks on barley and wheat and on vegetables (carrot, lettuce and pepper) under the coordination of the ECPGR Secretariat
- b) Formalize the evaluation network consortia through the signature of Letters of Commitment by the partners and finalize specific Cooperation Agreements
- c) Improve the functionality of the EURISCO documentation system to enable dedicated intranet platforms for each consortium, to display and analyze data for the partners under a three years embargo
- d) Perform evaluation of:
 - a. Cereals: at least 150 European genebank accessions per year per crop (minimum 100 plots per site) in possibly 20 sites each of the three macro zones, for two years, for a total of at least 3000 cereal accessions evaluated
 - b. Vegetables:
 - i. Carrot: 20 accessions per year evaluated in possibly 10 environments with 2 replicates for each environment (including lab screening for three *Alternaria* species and *Mycocentrospora acerina*, and field traits (diseases, morphology, harvest and quality traits), for a total of 60 accessions evaluated
 - ii. Lettuce: between 20 and 50 accessions per year evaluated in possibly 10 environments (including lab screening for three *Bremia* strains and morphological characterization), for a total of between 60 and 150 lettuce accessions evaluated
 - iii. Pepper: between 100 and 200 accessions evaluated for two years in possibly 10 environments (including lab screening for TSWV, ToBRFV and *Verticillium* resistance/tolerance and field evaluation)
- e) Use jointly agreed evaluation protocols (experiment set up; scoring methodology) and data collection standards (ontologies) for data collection
- f) Genotype all the accessions selected for evaluation
- g) Include the projects derived phenotypic + genotypic data in EURISCO
- h) Facilitate inclusion of evaluated accessions into AEGIS

2. Activities

In broad terms, activities will be carried out around three growing seasons, as follows, with some difference depending on crops growing season and presence or absence of repeated evaluation of same accessions over two years (also see attached excel Table 1- cereals and Table 2-vegetables):

- Year 1 (2019-20): setting up of standards, acquisition, multiplication and redistribution of material (1st set)
- Year 2 (2020-21): first round of evaluation (1st set); second round of acquisition, multiplication and redistribution (2nd set)
- Year 3 (2021-22): second round of evaluation (1st set); first round of evaluation (2nd set); third round of acquisition, multiplication and redistribution (3rd set) [extra budget]

- Year 4 (2022-23) [extra budget]: second round of evaluation (2nd set); first round of evaluation (3rd set)

In more detail, the following activities will be carried out:

- i. Obtain signature of EVA-Letter of Commitment by the partners - expected partners are initially the following, but the list will be extended:
 - a. CEREALS: **Breeding companies** Nordic Seed (Denmark); Florimond Deprez, Limagrain, (France); BASF Agricultural Solutions Seed GmbH, GFPi, KWS, RAGT Seeds, Syngenta Seeds, WvB Eckendorf (Germany); AS.A.R. Società Semplice Agricola Randazzo, Fratelli Menzo sas, ISEA SRL, Semetica s.r.l., SIS (Italy); Agrosa, Secobra Recherches (Spain); Wiersum Plantbreeding (The Netherlands). **Research centers:** CNR, CREA Fiorenzuola d'Arda and Uni. Bologna (Italy), IPK, Gatersleben and JKI, Quedlinburg (Germany), NARDI Fundulea (Romania), John Innes Center, Norwich (UK). **Genebanks:** IPGR Sadovo (Bulgaria), IPK Gatersleben (Germany), IBBR-CNR Bari (Italy), Agroscope Nyon (Switzerland).
 - b. VEGETABLES: **Breeding companies:** Gautier Semences, Vilmorin, Rijk Zwaan, OBS, Takii (France); ISI Sementi (Italy); GFPi (Germany); Bejo, Syngenta Seeds (The Netherlands); Sementes Vivas (Portugal); Superior DOO (Serbia). **Research centers:** Agricultural University, Tirana (Albania); Institute of Genetics and Cytology National Academy of Sciences, Minsk (Belarus); Agrocampus Ouest IRHS, Angers, INRA Montfavet (France); CREA Pontecagnano (Italy); JKI, Quedlinburg (Germany); Warwick University (UK). **Genebanks:** Agricultural University of Tirana (Albania); IPGR Sadovo (Bulgaria); Agrocampus Ouest IRHS, Angers (France); CGN Wageningen (The Netherlands); Nordgen, Alnarp (Nordic Countries); INIAV, Braga (Portugal); CITA, Zaragoza (Spain); UKVGB, Warwick (UK).
- ii. Extend list of partners with the help, among others, of Nordic Seed for the Nordic zone, JKI/IPK/GFPi for the Central zone and CREA for the South zone
- iii. Annual meetings of consortium partners
- iv. Draft of the Consortium Agreement by the Secretariat, in consultation with partners and obtaining related signatures
- v. Agreement on traits to be evaluated during 2021, 2022 and 2023
- vi. Design of the evaluation experiments, coordinated by Task Forces (TF) including IPK, JKI, GFPi (cereals) and to be defined (vegetables)
- vii. Selection of genebank accessions:
 - a. Cereals: at least 200 accessions per year per crop per zone (trials repeated for 2 years)
 - b. Vegetables: at least 20 carrot accessions per year (2 replications per site); 20 to 50 lettuce accessions per year (trials repeated for 2 years); 100-200 pepper accessions (trials repeated for 2 years)
- viii. Dispatch by genebanks of agreed accessions (30-50 seeds per cereal accessions, amounts to be agreed for vegetable accessions) with SMTA to the multiplier institutes (in case of cereals: Nordic Seed, Denmark for the North zone; JKI, Germany for the Central zone; CREA, Italy for the South zone – in case of vegetables: INIAV, Portugal, CITA, Spain, Nordgen, Sweden, and Warwick, UK (carrot); ISI Sementi, Italy and Superior DOO, Serbia (pepper multiplication in kind); Gautier semences, France (lettuce multiplication in kind)

- ix. Multiplication of accessions by multipliers. In the case of pepper, 5 plants each of 200 accessions under insect-proof nets in 2020 (ISI Sementi); in case of lettuce, ca. 100 plants transplanted and ca. 80 harvested for seed, under insect-proof isolation cages.
- x. Dispatch of multiplied accessions from multipliers to lab test and field evaluators with SMTA (possibly about 20 locations in each zone in the case of cereals and possibly 10 environments in the case of vegetables) and from multipliers to genotyping institutes/companies (to be defined) – (summer 2020 and 2021 in the case of cereals; 2022 in the case of lettuce, 2021 in the case of pepper, 2021 in the case of carrot)
- xi. Agreement on evaluation protocols (e.g. JKI disease assessment sheets for cereals) and data collection standards (ontologies), coordinated by Task Forces to be defined for each crop.
- xii. Definition of genotyping methodology and selection of commercial providers (by Task Forces including CREA and others)
- xiii. Analysis of database requirements by EURISCO staff and provision of special functionalities (intranet platform for the partners, with 3 years embargo before making data widely public, etc.)
- xiv. Lab screening for disease resistance/tolerance of vegetable accessions:
 - a. Carrot: *Alternaria dauci*, *A. alternata*, *A. radicina* and *Mycocentrospora acerina* (by JKI, Quedlinburg)
 - b. Lettuce: three new candidate *Bremia* strains to be defined (by ISI Sementi, Italy – in kind), based on 200 seeds per accession
 - c. Pepper: TSWV, ToBRFV and *Verticillium* (by CREA Pontecagnao, Italy)
- xv. Carry out field evaluation in multiple locations:
 - a. Cereals: the same accessions for disease resistance traits in each of the three zones (maximum 150 plots per year per every partner per crop), during growing seasons 2020/21, 2021/22 and 2022/23
 - b. Vegetables: the same accessions in possibly 10 environments across Europe during growing seasons 2020 (where possible), 2021 and 2022, for the following traits (to be confirmed):
 - i. Carrot (same scale of symptoms with picture referential): Field traits: powdery mildew (oidium), leaf blight; virus (red leaves), bolting; Harvest traits: root cracking, nematodes, cavity spot (Pythium), root fly; Quality traits: °brix on juice (all), and optional traits such as simplified sensory evaluation (some accessions), carotenoid content or total content pigment by spectrophotometer. Characterization descriptors: Fourteen ECPGR Umbellifer WG minimum descriptors + a few others to be defined.
 - ii. Lettuce: morphological and agronomic traits to be decided
 - iii. Pepper: morphological and agronomic traits to be decided
- xvi. Dispatch of evaluation data based on agreed standard exchange formats from all the evaluation sites to the central repository (EURISCO), after harvest 2020 (where possible), 2021 and 2022
- xvii. Carry out the genotyping of selected accessions under evaluation and dispatch of genotypic data from commercial provider to consortium partners:
 - a. Cereals: each year (ca. 150 per year per crop) for two years (commercial provider)
 - b. Carrot: all accessions (ca. 60 in 2021) (commercial provider)
 - c. Lettuce: each year or all in 2022 (ca. 60-150 accessions) (commercial provider)
 - d. Pepper: all accessions (ca. 200) with genome-wide markers (commercial provider) and with trait-associated markers (IGC, Belarus) in 2021

- xviii. Data analysis (IPK-cereals; IGC-pepper for trait-associated markers; to be defined-other crops) and data display through the EURISCO Intranet platform
- xix. Promote inclusion of multiplied accessions into AEGIS
- xx. Plan for Network continuation of rolling activities after the end of the project

3. Expected outcomes

- a) EVA Networks on Wheat/Barley and vegetables (carrot, lettuce and pepper) established with Letters of Commitment and Consortium agreements signed by more than 20 partners in each of the two Networks
- b) Evaluation for disease resistance of 150 genebank accessions per cereal crop per year per two years in multiple locations in three macro-zones in Europe
- c) Evaluation for disease resistance and multiple morphological and agronomic traits of 60 carrot, 60-150 lettuce and 200 pepper accessions both through lab test and field evaluation in multiple locations across Europe
- d) Genotyping of 150 genebank accessions per cereal crop per year per zone per two years
- e) Genotyping of 60 carrot, 60-150 lettuce and 200 pepper accessions
- f) Provision of related genotypic and phenotypic data to a central repository and data made accessible through EURISCO, exclusively to consortium partners for three years, then open to the general public
- g) Increased number of project accessions entering AEGIS

4. Continuation of the EVA Network after the project

The crop specific activities initiated through this project are planned to ideally continue in the form of rolling cycles that can exercise their best effect if they remain active over multiple years, much beyond the duration of this project. For this reason, some activities that are meant to be carried out beyond the timeframe of this project have been included in the planning. Some activities will not require additional budget (e.g. second round of evaluation of 2nd set of cereals during Year 4), but will be carried out in any case to bring to completion a meaningful evaluation of the accessions over two years. Other activities will require additional budget (e.g. multiplication and redistribution of 3rd set of cereals during Year 3); in this case they have been described, since they should take place within the project timeframe, but they will only be carried out if additional budget sources can be identified by the project partners. Establishing a plan for the continuation of rolling activities after the end of the project is envisaged as a task of this project.

5. Chronogram of activities

Activity	2019		2020				2021				2022	
	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun
Obtain signature of EVA-Letter of Commitment by the partners												
Extend list of partners												
Annual meetings												
Signature of Consortium Agreement												
Agreement on traits to be evaluated												
Selection of genebank accessions	cereals/ carrot	vegetable			cereals/ carrot	vegetable			Cereals/ carrot	vegetable		
Dispatch of agreed accessions with SMTA to the multiplier institutes	cereals/ carrot	vegetable			cereals/ carrot	vegetable			cereals/ carrot	vegetable		
Multiplication of accessions by multipliers												
Lab prescreening for diseases (vegetables)												
Dispatch of multiplied accessions from multipliers to evaluators with SMTA												
Design of the evaluation experiments												
Agreement on evaluation protocols												
Definition of genotyping methodology and selection of commercial provider						vegetable						
Analysis of database requirements by EURISCO staff												
Provision of special EURISCO functionalities												
Carry out evaluation in multiple locations with same accessions												
Dispatch of evaluation data based on agreed standard exchange formats from all the evaluation sites to the central repository (EURISCO)												
Carry out the genotyping of selected accessions												
Data analysis and data display through the EURISCO Intranet platform												
Promote inclusion of multiplied accessions into AEGIS												
Plan for Network continuation of rolling activities after the end of the project												
Final Report												

