ECOBREED

solutions for organic farmer (opportunities and recommendations)

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Project coordinator

CDG on Organic Farming
On-line
24th of Oct. 2023

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Horizon 2020
Grant agreement No 771367

ECOBREED: Increasing the efficiency and competitiveness of organic crop breeding

Project duration: **5** years (till May 2023) – due to COVID prolonged for 9 months (end Feb 2024)
25 partners from **15** countries: AT, CN, CZ, DE, ES, GR, HU, IT, PL, RO, RS, SI, SK, USA, UK
14 universities & institutes, **10** private companies, **1** association
Budget: **5,815,708.40** EUR

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Consortium

25 partners from **15** countries: AT, CN, CZ, DE, ES, GR, HU, IT, PL, RO, RS, SI, SK, USA, UK
14 universities & institutes, **9** private companies, **2** associations

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ECOBREED: Background

New REGULATION (EU) 2018/848 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 May 2018 on organic production and labelling of organic products and repealing Council Regulation (EC) No 834/2007

This Regulation should provide the **basis for the sustainable development of organic production and its positive effects on the environment**, **helping farmers to achieve a fair income**, **protecting consumer interest** and encouraging short distribution channels and local production.

Having regard to the particularities of the organic production systems, the **choice of plant varieties should focus on agronomic performance, genetic diversity, disease resistance, longevity, and adaptation to diverse local soil and climate conditions**, and should respect the natural crossing barriers.

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Concept and approach

ECOBREED will use an **integrated** and **multi-disciplinary approach** to increase the competitiveness of the organic and low-input breeding and farming sectors.

ECOBREED activities will be carried out by a **multi-disciplinary** consortium involving partners from

(a) Universities (UNEW, BOKU, WSU, UNITUS, UViGO, UP) and gene banks (CRI-CZ, KIS-SI, NPPC-SK) who carry out fundamental and basic research (representing Technology Readiness Levels, TRL 1-3),

(b) **research institutes and businesses** who are more **applied** in their research (IFVC, NARDI, MTA-ATK, CAAS, IHAR, BIOMILA, NPPC, RGA, GEO), (representing TRL 4-6) and

(c) **end producers** (SMA, NATUR, SEC, SEL, SZG, PROBIO, GS) who are near market (i.e. TRL 7-9) in the application of new technologies and production of new products for the marketplace.

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The **specific objectives** to be addressed in **ECOBREED** are:

Identify genetic and phenotypic variation in morphological, abiotic/biotic tolerance/resistance and nutritional quality traits Evaluate the potential for genetic variation in enhanced nutrient acquisition

Evaluation for increased weed competitiveness and control

Optimisation of seed production/multiplication

Providing farmers the opportunity to choose and develop varieties in their own environment

Production of elite varieties for improved agronomic performance, biotic/abiotic stress resistance/tolerance and nutritional quality

Development of training programmes

Ensuring optimum and rapid utilisation and exploitation of project deliverables and innovations

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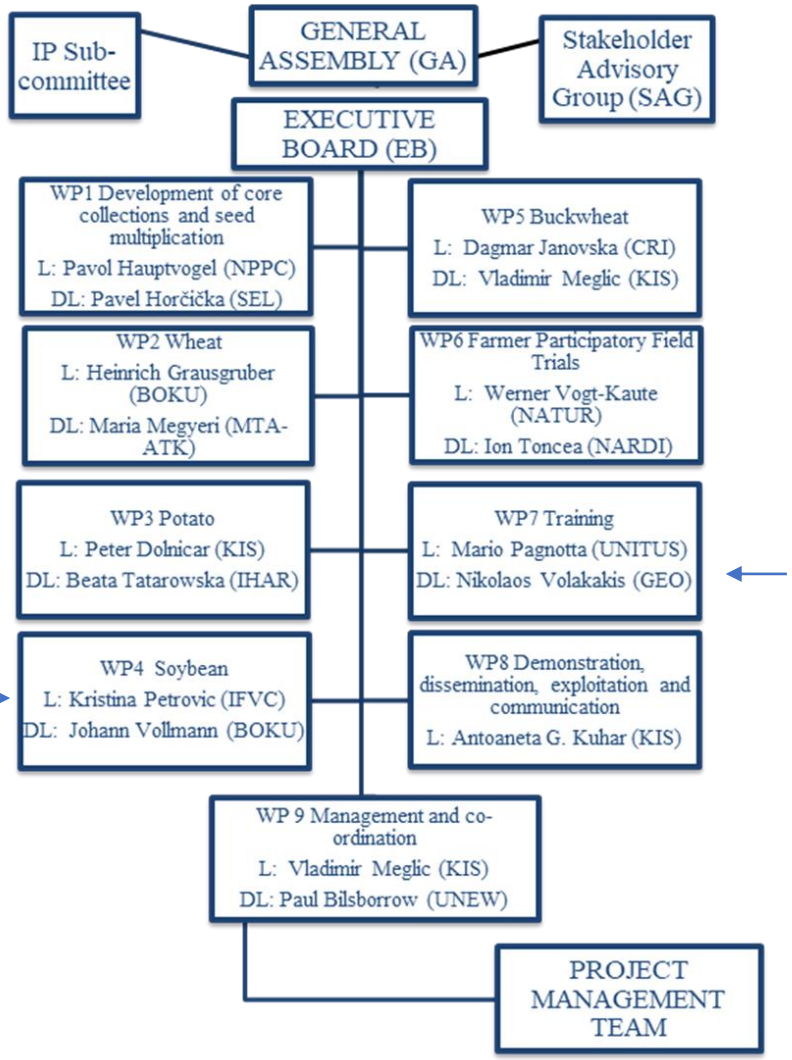
Organisation of work



Peter Miko →

Vuk Djordjević →

← Marjana Vasiljević (IFVC)

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Work completed

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Progress towards expected impact

***ECOBREED** will **increase the knowledge base required to breed/select and improve varieties for organic and low-input crop production** by:*

- ***Identifying germplasm** which can be used by breeders to produce varieties which have increased **(a)** biotic and abiotic stress resistance, **(b)** yield/yield stability and **(c)** quality (including nutritional value) traits required/desired by the organic and low-input sector.*

A huge amount of existing germplasm of all 4 crops originally derived from conventional and organic breeding programmes was tested in multi-environment trials (METs).

- ***Identifying traits and trait combinations** which allow the development of varieties that **(a)** are adapted to different pedo-climatic and agronomic background conditions and **(b)** have the robustness traits required to provide high yields and yield stability in the context of resource limitations and future climate change*

For wheat it was possible to identify genotypes with broad adaptability or regional adaptability. First analyses have shown that genotypes from different geographic origin have different strategies to cope with drought at early growth stage (i.e., tillering phase).
Late blight resistance R genes were confirmed and some new determined in late blight resistant potato cultivars using molecular markers. New Rpi and Ry gene combinations were made to pyramid R genes.
Soybean variety ideotypes will be defined based on available genetic variability. Ideotypes will be constructed for all pedo-climatic conditions.
The set of 54 buckwheat genotypes was evaluated using descriptors adapted to the needs of the breeding companies involved in phenotyping. Evaluation over three years and in different environments will help to understand the adaptation of buckwheat to different growing conditions.

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Progress towards expected impact

- *Evaluating and quantifying **novel genetic variation** for traits available but not yet used in EU germplasm and **facilitating the use of these traits in breeding programmes** (carried out by the project breeding partners) for the organic and low-input sectors*

Genes for common bunt resistance and high grain protein content were introgressed into European elite winter wheats from US sources. There were high genetic variability of canopy cover, type of growth, maturity and resistance to produce tuber malformations between tested potato cultivars. Canopy cover shows genetic variability between germplasm and can be used for facilitating soybean breeding programs for organic production. Material resistant to common bunt and better nutritional/end-use quality (i.e., Cd accumulation, high grain protein content) was identified.

ECOBREED will **increase the knowledge on relevant traits important for organic crop production** by:

- *Providing training for farmers in PPB*

Publication of training material & publication of results of Farmers Participatory Trials

- *Extensive phenotyping of species core collections under a range of differing pedo-climatic conditions, including drought/heat tolerance and cold tolerance for soybean in Southern Europe/Mediterranean and Northern Europe environments respectively.*

Multi-environment trials (i.e. Austria, Czech Republic, Germany, Hungary, Italy, Romania, Serbia, Slovakia, Slovenia) of wheat, potato, soybean and buckwheat germplasm established resulting in a detailed phenotypic description of currently commercially available varieties, advanced breeding lines and landraces and/or populations (i.e., genetic heterogeneous material). Additionally, reaction to drought stress was tested in an Advanced Phenotyping experiment in the greenhouse. Another Advanced Phenotyping experiment in the greenhouse was done with durum wheat for drought and salt tolerance.

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Progress towards expected impact

- *Identification of DNA polymorphisms (e.g. SNPs) in the putative collections of the four crop species for Molecular Assisted Selection*

Marker assisted selection (MAS) was applied for the successful transfer of bunt resistance QTL from US wheat into European elite varieties. MAS was also used to transfer a gene for high grain protein content into two winter wheat varieties provided by partners. Bulks segregating for the favourable allele were established and shared with partners for a currently ongoing MET testing. Additionally, protocols for various molecular markers were established to test the ECOBREED wheat diversity panels for resistance genes against rust diseases, cadmium accumulation in the grain, dwarfing genes, photoperiod sensitivity, as well as various genes that are related to grain yield formation under abiotic stress conditions.

A MAS programmes for selecting potato genotypes with multiple R genes for resistance to LB and PVY have been introduced in all three potato breeding programmes that will yield the new resistant cultivars suitable for organic potato production.

Cd-accumulation QTL marker assisted screening was done on sub-set of putative soybean collection. GWAS analysis for key soybean traits is ongoing.

In buckwheat GWAS was performed for 26 traits of 462 Chinese accessions and 43 traits of 96 European accessions.

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Progress towards expected impact

ECOBREED *will* ***increase the competitiveness*** *of* ***European organic and traditional low-input agriculture*** *by delivering*:

- ***Increased yields*** *(5-10%) and cost reductions in organic and low-input production for the 4 crop species, thus significantly* ***improving the economic performance*** *when compared to conventional production. This will be achieved* ***by exploiting untapped variability in genetic resources*** *and through the selection and evaluation of genetic material under organic management conditions.*

Wheat genotypes were identified with 5-15% higher yields under organic conditions compared to currently used varieties and/or available organic varieties. These genotypes are valuable alternatives to the currently used varieties by direct use or for future breeding by use as parental material for new crosses.

In three years of potato testing in four different environments big differences in yields (several fold difference between the best and the worst), quality, resistance, adaptability and capability to withstand severe growing conditions were found. Just by selecting the best cultivars could increase the average yields of organic production by at least one quarter. The improvement in yields can be even higher in wet years with severe late blight infections of potato by using resistant cultivars and newly developed germplasm.

- *Genotypes suited to increased acquisition of nutrients from organic fertiliser inputs together increased AMF activity, increased P mineralisation efficiency and increased symbiosis with N-fixing Bradyrhizobium.*

Wheat genotypes with increased AMF activity were identified in pot experiments

The present study showed low levels of natural mycorrhizal colonisation across most potato cultivars, though some cultivars (especially late ones) were significantly better than others at forming mycorrhizal associations. Variety Sarpo mira stood out as having the greatest mycorrhizal intensity and abundance across all varieties.

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Progress towards expected impact

- *Increased **global competitiveness of the European organic food industry** from the use of cultivars with enhanced content of bioactive components enabling "added nutritional or sensory quality" based marketing.*

Wheat material was developed with high grain protein content which guarantees an acceptable baking quality and nutritious bread products even under low fertility soils. In durum wheat, material with low Cd accumulation was identified which is important with respect to food safety and lower thresholds recently adopted by European legislation.
Common and Tartary buckwheat are crops rich in rutin, which is very important for people with venous insufficiency.

- *An increased range of products with enhanced nutritional benefits for promoting human health e.g. gluten-free products for those suffering from Coeliac Disease and Irritable Bowel Syndrome.*

Buckwheat is known for its gluten-free meal properties. The results of the buckwheat breeding can help promote buckwheat and its potential health benefits, thereby increasing public demand for buckwheat products.

- *Enhancing the quality and value of existing products via the identification and use of cultivars with **enhanced mineral nutrient and nutraceutical content.***

Wheat material rich in anthocyanins in the seed coat, potential antioxidants, were tested for agronomic performance. This germplasm was also studied for mineral composition, especially for Fe and Zn.
Potato cooking quality (taste, texture and discoloration of tuber flesh) were assessed. There were big differences in their vitamin C and total carotenoid content in potato tubers.
For all soybean genotypes protein and oil content was measured.
Buckwheat was evaluated for the rutin content and other compounds that may have nutraceutical effects.

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Progress towards expected impact

ECOBREED *will make a significant contribution to* ***increased availability of tools and resources for prebreeding and breeding*** *which will deliver:*

- *Efficient, ready-to-use* ***farmer participatory breeding systems*** *(PPB, CCP) that can be used by project partners and stakeholders not involved in the project, e.g. farmer groups, Co-operatives and breeders in other countries/areas of the EU.*

✓ Fields days and demonstration events are visited by farmers, advisers, bakers, processors and researchers.

✓ The number of 62 farmers in 12 countries enables to increase awareness.

✓ Distribution of CCPs and early breeding lines open possibilities for future activities and is a starting point for new communication between stakeholders.

✓ The international approach of ECOBREED increases farmers awareness of new organic breeding programmes.

- *Detailed* ***training programmes*** *in (a)* ***genomic tools/techniques****, (b)* ***PPB*** *and (c****) use and application of improved phenotyping capabilities*** *in terms of* ***digital, thermal and hyperspectral imaging*** *in terms of when, where and how these can be utilised.*

The training materials developed will remain with the trainees participated to the different ECOBREED events as future references for the topics other than the specific ones treated during the training.

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Summary

The **ECOBREED** will provide an increased availability and quality of seeds and varieties suited to the specific conditions of organic and low-input farming. It will screen and provide germplasm for use in breeding programmes for the improvement of the 4 target crop species.

Through the project we are providing extensive training, demonstration, dissemination, exploitation and communication activities to facilitate rapid technology transfer and introduction of innovations from the project into commercial practice.

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Thank you!

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