DIVERSIFOOD

Embedding crop diversity and networking for local high quality food systems

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H2020 - Research and Innovation Action

D 2.1
Inventory of underutilised crops

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Workpackage concerned: 2.1

Concerned workpackage leader: Ambrogio Costanzo (ambrogio.c@organicresearchcentre.com)

Lead Beneficiary: Luke, the partners being ITQB, IPC, PSR, INRA, ORC, FiBL, LBI, ÖMKI, RSR

Dissemination level:

- ☑ **PU:** Public (must be available on the website)
- **OBS:** The literature surveys of different crops will be available on the website http://www.diversifood.eu/Publication
- ☐ **CO:** Confidential, only for members of the consortium (including the Commission Services)
- ☐ **CI:** Classified, as referred to in Commission Decision 2001/844/EC

Abstract

The aim was to identify what is currently known about environmental, agronomic and quality aspects of selected marginal crop and their potential uses in a Europe using published results, literature surveys and interviews. In the workshop organized in Cyprus during the first annual meeting in February 2016, participants listed the information needed to be collected. The suggestions were listed and used as guidelines during the writing process. Also a working definition of underutilized and marginal crops was created. To the stories itself of different crops, the aim was to include information also on species that may become increasingly important as a result of social and climate change and local weather extremes. A description of why the crops are still underutilized and a summary of already completed projects and their associated websites were included to the stories of each of the crops.

Progress towards objectives

1. **Institutes and persons in charge of the work**

The institutes, persons in charge and the crops included were stated in the first meeting in Brittany in March 2015.

INSTITUTE	**Country**	**Persons in charge**	**Email address**	**Crops to be surveyed**
ITQB NOVA & IPC	Portugal	Carlota Vaz Patto Pedro Moreira	cpatto@itqb.unl.pt pmm@esac.pt	Maize (*Zea mays)* and common beans (*Phaseolus vulgaris)*
PSR	Switzerland	Béla Bartha Philipp Holzherr	bela.bartha@prospecierara.ch, philipp.holzherr@prospecierara.ch	Tomato (*Solanum lycopersicum*) Carrot (*Daucus carota),*
INRA	France	Véronique Chable	Veronique.chable@ inra.fr	Rivet wheat (*Triticum turgidum*), Broccoli (*Brassica oleracea* var. *italica*), Chestnuts *Castanea sativa*, Buckwheat (*Fagopyrum esculentum*)
ORC	Great Britain	Ambrogio Constanzo	ambrogio.c@organicresearchcentre.com	Definition of the minor crops
FiBL	Switzerland	Monika Messmer Arncken Christine	Monika.messmer@fibl.org christine.arncken@fibl.org	Sweet lupines (narrow-leaved lupine, L*upinus angustifolious;* white lupine, *Lupinus albus;* yellow lupine, *Lupinus luteus*)
LBI	The Netherlands	Edwin Nuijten and Boki Luske	E.Nuijten@louisbolk.nl B.Luske@Louisbolk.nl	Field bean, faba bean(*Vicia faba)*, Sweet lupines (narrow-leaved lupine, L*upinus angustifolious;* white lupine, *Lupinus albus;* yellow lupine, *Lupinus luteus*)
ÖMKI	Hungary	Dr. Drexler Dóra Dezsény Zoltán Christy den Hertog	dora.drexler@biokutatas.hu zoltan.dezseny@biokutatas.hu	Einkorn *Triticum boeoticum* or *Triticum monococcum)* also emmer (*Triticum dicoccon*)
Luke	Finland	Marjo Keskitalo	marjo.keskitalo@luke.fi	Buckwheat (*Fagopyrum esculentum*)

2. Assessment of the content of the literature survey for each crop

In the DIVERSIFOOD meeting in February in Cyprus 2016 (1st Annual meeting), the content of the literature survey was discussed. Participants have listed the issues they considered important and which should be described in the survey. It was concluded that the titles could be the same, and the content itself may vary since literature available may also vary according to the crops. The following instructions and the suggested titles were sent to the writers on the 10th of January 2017.

State of art of minor crops over all in the area/country: the report will consist of the description of the national situation of minor crops in each partner country. At least one minor crop will be selected for deeper information and literature survey from each country. The survey will target different stakeholders and the practical report will be based on published or otherwise collected information. Consider to present the results also in tables.

Description of the crop: each target crop is being addressed through more specific questions related to their 'underutilization status', depending on whether they are novel, 'outsider' species (e.g. quinoa), old, neglected species (e.g. rivet wheat) or neglected genetic resources of commonly cultivated species (e.g. vegetables as maize, broccoli, carrots and tomato). The following issues were considered important by the participants in Cyprus 2016: Culture, history, sociology origin of the crop, where does it come from, background, stories, memories, cultural heritage, history behind or linked the crop, what is the social, cultural, environmental relevance of the crop, how or why the crop has been discovered, are there still knowledge somewhere associated to the crop compare to similar, well known crop, what differences are there, who are the actor involved to the crop, limits in the development process, area of cultivation, how the crop could be improved.

Relationship between the crop and the environment: For each cases, the possible advantages of the crop in the sense of environment were described. It can be adaptation to marginal growing areas, lower need of nutrients, flowering and nectar production for the flowering insects, and other ecological services. Aspects considered important by participants in Cyprus 2016: optimum climate conditions, potential in low input conditions, adaptability to local or different growing conditions, sustainability of production, importance in crop rotation, resistance to pests and diseases, ecological benefits.

Seed management: Several aspects were considered important by participants in Cyprus 2016: genetic and phenotypic diversity, cultivars, landraces, population available preference of local vs modern seeds, self or open pollinated.

Agronomy of the crop: Information of the cultivation procedures, highlighting difficulties/challenges. A photo illustrating the agronomy or production. Aspects considered important by participants in Cyprus 2016: agronomical practices: sowing time, seed density, row spacing, harvesting, growing requirements; soil, water, photoperiod, vegetation period, temperature specific managements, equipment, machinery for production and preparation for sale difficulties, critical factors, yield level and stability, how to reproduce the seeds, where farmers can get the seeds.

Quality aspects: Information on the metabolic composition, nutrients and other quality factors had be compared to one of major crops in the area. Aspects considered important by participants in Cyprus 2016: Taste, nutritional and health properties rich in certain compounds representing present concerns, quality requirements.

Potential uses of the crop or raw materials derived from it: Information on the import/export of raw materials (can be obtained from the custom statistics. Describe how the raw materials are or have been used for food. Include an example of a recipe and photo of the dish. Aspects considered important by participants in Cyprus 2016: Uses, products, composition**:** what are the different uses including side products, alternative uses, who will use/be interesting the crop, how the crop can be used by farmers; new products, specific uses, end products; Do we need it, The need for processing; How to use with other crops, what value it has for consumers, what are consumers acceptance or willingness to pay.

An interview has been organized on one of the target groups/stakeholders in partners' region (farmer, upgrader, delivers, wholesalers, traders, advices, government, consumers, catering services…).

*Literature cited and useful links. T*he most relevant literature cited, links and webpages from previous projects, including a short description of the results.

3. **The schedule of the writing process.**

In 2017 the timetable was assessed early enough to fulfil the deliverable by the end of August 2017. It was as follows : 1st draft to be send to by 12th of February 2017 to the task leader, where the aim was to provide the overall idea of the work. The second phase was by the end of March (30th of March), and the final text was requested by the end of May (31st of May), which was later postponed to 15th of July. The aim was, that each of the writer takes care of the language proofreading, if needed.

A working definition of underutilized/marginal crops

The definition was collectively established for 'outsider species', 'old and forgotten species' and for 'neglected germplasms of common crops'.

Last call for agricultural diversity? Of a total of 250000 identified plant species, 7000 have been used in agriculture throughout human history. However, currently, 75% of the world's food comes from just 12 plant and 5 animal species, and 60% of total worldwide caloric input comes from just three plants: rice, wheat and maize (FAO, 1997). These numbers are alarming. In fact, utilisation of such a minimal diversity leads to excessive homogeneity and oversimplification of both farming and food systems, disrupting the ecological, biological and social drivers of sustainable, resilient and healthy agriculture and food.

A process-focused framework DIVERSIFOOD is focusing on the bulk of the 7000 forgotten plant species that fall into the category of Underutilised Crops. Our definition of Underutilised Crops, informed by two years of fieldwork and documentation across the DIVERSIFOOD consortium, needs to be tested over time and in different scenarios. The focus is not on the plants, but rather on the process to build opportunities across a wide range of neglected or unexplored resources.

An Underutilised Crop is:

A plant genetic resource …
Be that either a species or a germplasm, or a genetic structure

… with limited current use …
having been either forgotten or abandoned, or not yet explored

… and potential to diversify and improve
the focus is set on the advantages we expect

… cropping systems and supply chains …
both cropping systems and supply chains are target of diversification to improve sustainability, resilience and health in the field, the market and the diet

… in a given context.
the reality, in geographic, historic, social, economic terms, in which the case for the underutilised crop is embedded.

The way forward

There are different categories of Underutilised Crops. After two years' working on several case studies, during the 2nd Annual Meeting in February 2017, the DIVERSIFOOD consortium held an exercise aimed at identifying and characterising three distinct challenges:

- *introducing "outsider species"* Growing Quinoa in Europe or Chickpeas in the United Kingdom: these examples and many other have in common the challenge of *shifting a cultivation areal*. This areal shift can either (i) cross a geographical discontinuity (e.g. Quinoa from South America to Europe) or (ii) extend the borders of cultivation areal (e.g. moving Chickpeas and Buckwheat northwards). In most cases, the primary interest can arise from professional or home growers/gardeners (Kell et al. 2013), and 'outsider' plants can be primarily grown, alongside food production, for ornamental purposes.

- *reviving "old, forgotten species".* The starting point is to understand *why* these species, *e.g.* old minor cereals, have been "forgotten", and why has it been so easy to "forget" them. Although specific answers are related to specific cases, abandonment is generally an overall result of the Green Revolution, i.e. the widespread diffusion of high yielding varieties and related 'technological packages' starting from the post-World-War-2 period (Yapa, 1993). This has led to a **standardisation** of environments, cropping techniques, processing and supply chains, that most of these "abandoned" species do not fit into.

- *reviving "neglected germplasms of common crops".* A typical example is that of open-pollinated varieties (OPVs) of currently hybrid-dominated crops which went through the same process of abandonment as "forgotten species" during the Green Revolution, such as Maize, Tomatoes and Broccoli. Increasing use of OPVs would broaden the genetic diversity of these common crops aiming to specific, rather than wide, adaptation (Ceccarelli, 1994). Reviving these germplasms, as well as the old species addressed above, could help overcome agricultural standardisation, giving back marginal areas, artisanal processing and low-input farming significant chances of successful sustainable development.

Suggested readings

Ceccarelli S (1994) *Specific adaptation and breeding for marginal conditions.* Euphytica vol. 77, pp. 205–219

Food and Agriculture Organisation of the United Nations. The State of the World's Plant Genetic Resources for Food and Agriculture. Rome (IT) (1997). ftp://ftp.fao.org/docrep/fao/meeting/015/w7324e.pdf

Kell S, Rosenfeld A, Cunningham S, Dobbie S, Maxted N. *Benefits of Non-Traditional Crops Grown by Small-Scale Growers in the Midlands* – Final Report of the "Sowing New Seeds" Project. 2013, Garden Organic, Ryton, Coventry (UK). See also http://www.gardenorganic.org.uk/sns-resources

Yapa L (1993) *What are improved seeds? An epistemology of the Green Revolution*. Econ Geogr 69:254–273

Significant results

The final texts were obtained from 14 out of 15 crops or plant groups planned to be described. The titles of the text are summarized:

INSTITUTE	**Country**	**Title of the literature survey**
ITQB NOVA & IPC	Portugal	Traditional maize varieties in Portugal: Challenges and opportunities due to their underutilization status" - Literature and farmers interview survey
		Traditional beans varieties in Portugal: Challenges and opportunities due to their underutilization status - Literature and farmers interview survey
PSR	Switzerland	Tomato – an neglected genetic resource: an overview from Switzerland
		Carrots – neglected genetic resources: an overview from Switzerland
INRA	France	Rivet wheat
		Broccoli
		Chestnuts
		Buckwheat
ORC	Great Britain	Definition of underutilized crops
FiBL	Switzerland	Lupins in Switzerland
LBI	The Netherlands	Field beans in the Netherlands
		The lupin story of the netherlands
ÖMKI	Hungary	Einkorn – Reintroduction of an ancient grain into organic markets
		Emmer Rediscovering ancient grains
Luke	Finland	Story of Buckwheat in Finland

Some of the species listed in the proposal (durum wheat, chickpea, oats, bread wheat, onion) were not included. Instead, rivet wheat was included although it was not suggested in the original proposal. Presentations will be available from the DIVERSIFOOD website.

Suggestion of the most appropriate category for each crops

		A type of the new crops		
Crop species	**Country**	**outsider species**	**old and forgotten species**	**neglected germplasms of common crops'**
Broccoli	France			**x**
Buckwheat	Finland		**x**	
Buckwheat	France		**x**	
Carrots	Switzerland		**x**	
Chestnut	France		**x**	
Common bean	Portugal		**x**	
Einkorn	Hungary		**x**	
Emmer	Hungary		**x**	
Field beans	The Netherlands			**x**
Maize	Portugal		**x**	
Lupines	The Netherlands	**x**		
Lupines	Switzerland	**x**		
Rivet wheat	France		**x**	
Tomato	Switzerland			**x**

Most important observations and background for the category selected for crops.

Broccoli in France, especially in Brittany has been cultivated from ancient times. Modern F1 hybrid varieties dominates the markets and old traditional forms have been forgotten.

Buckwheat in Finland has been cultivated for hundreds of years and is one of the oldest crops in the country. About 150 years ago, the interest of cultivation decreased along the change of the cultivation practice. The old the slash-and burn cultivation methods were transferred to field culture. In slash-and-burn culture buckwheat was an important crop in the rotation.

Buckwheat in France, factors causing the neglect of the crop was mentioned to be characters such as sensitivity to lodging, intolerance to high nitrogen residues, vulnerable to frost, randomness of yields, requirements in post-harvest technology (drying and sorting) and lack of plant breeding due to its complex mechanisms for sexual reproduction.

Carrots in Switzerland have a deep and long history of cultivation. But resulting from various reasons, as market demands or the laborious seed propagation of carrots, the propagation of a rich carrot diversity is very restricted. As a result the market is dominated by carrots of the «Nantes type», originating mostly from hybrid seeds of big breeding companies. However, the available diversity of different colors and shapes among open-pollinated varieties is restricted to niche products.)

Chestnuts in France. The "civilization of the chestnut tree" came to an end in the 19th century, when cereals and potatoes replaced chestnut in the daily diet. Also the competition with more productive woody species as Pinus resulted in the general decline of the crop.

Field beans/faba beans in the Netherlands: the cultivation of field beans was marginalised due to the cheap soy import from USA. The import was a consequence of the Blairhouse trade agreement set in 1992, which protected the unlimited export of wheat in Europe and unlimited import of legumes from overseas. In addition to USA, soy bea are imported latin america. Also the utilization of artificial fertilizers reduced the need of legumes as a natural fertilizer in the crop rotations.

Common beans in Portugal, lack of competitiveness of grain legumes such as common beans has resulted continuous reduction of the production areas. The reduction of legume cultivation has recorded since 1961 and Portugal has followed the same tendency.

Einkorn in the past (Hungary). The ancient wheat, einkorn, is one of the first crops cultivated by humans and the first domestication has been recorded approximately around 7500 BC. The challenge of einkorn in modern agriculture is that, the crops does not tolerate high nutrient levels and they may be sensitive against herbicides.

Emmer in the past (Hungary). It is assumed that hunter-gatherers collected wild emmer about 23,000 years ago, on the shore of the sea of Galilee in what is today Israel, and the cultivation of the crops begun about 11 300 years ago. As it is the case with einkorn, either emmer tolerates high amount of nitrogen, which expose the crops for lodging.

Maize in Portugal. Until the World War II many land laces of maize was still cultivated in Portugal, but the country was one of the first one which allowed the testing of the American maize hybrids. Although the new hybrids were not first accepted by the Portuguese farmers due to lack of important traits for the production, eventually the hybrids have been replaces the old land races. Less than 1% of the production is covered now with the old varieties and there is risk of disappearance.

Lupins in the Netherlands. Lupin is a novel crop in the Netherlands, the introduction started in 20th century. Yellow lupinee was first introduced as a green manure for soil restoration of old heathlands, and thereafter came new sweet varieties for food consumption. Eventually came also white lupines, but the outbreak of the plant disease shifted the interests towards blue lupine.

Lupins in Switzerland may have no traditions, but rather it was introduced to the country in the late 1980's. The concern on the protein self-sufficiency rise the interest on lupins and soybean again. The problems of plant diseases in white lupin has changed the attention on blue lupins.

The disappearance of rivet wheat in France was linked to agricultural mechanization and rural exodus: modern machines had difficulties to thresh wheats with barbs as rivet.

Old varieties of tomato in Switzerland and other western countries are often neglected because they do not fulfil the mentioned requirements of modern commerce. Also producers who still try to grow old varieties, need to put in more effort in the cultivation and face a higher risk for yield loss.

Deviations

Part of the species listed in the proposal (durum and bread wheat, chickpea, oats and onion) was excluded from the working plan. In addition, rivet wheat was included and also faba beans, lupins and buckwheat were described in two different regions, since these crops were considered more important in the partner countries based on the current research.

Suggestion for corrective actions.
The work with separate text consisting variety of crops by different authors, should be continued and discussed the most appropriate way to publish it. Also a deeper analysis of the crops, characters and culture behind, might be valuable to understand the role of minor crops in Europe.