Innovations in Organic Seed Systems for diverse seeds and practices

LiveSeeding

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Introduction

The European Union has set the objective of achieving full use of organic plant reproductive material in organic farming by 2036 in Regulation (EU) 2018/848. Reaching this objective requires more than increasing the supply of organic seed: it depends on seed systems that can provide high-quality seed across a wide range of cultivars, adapted to different climates, soils, farming practices and uses.

In a context of climate uncertainty, evolving pest and disease dynamics, increasing vulnerability to external supply chains, and growing demands for more sustainable agriculture and greater strategic autonomy in seed supply, **organic seed systems face a double challenge**. They must **provide reliable seed for immediate crop establishment**, while also **supporting the diversity and adaptive capacity needed for resilient farming systems over time**. This means addressing seed quality and health in a broad sense: not only germination and purity, but also diversity, sanitary status, biological interactions and practical conditions for production, storage and use.

To respond to these challenges, LiveSeeding brought together researchers, breeders, seed companies, advisors and other actors involved in organic seed systems across Europe. Through their combined work, the project contributed to improving knowledge, tools and practices related to organic seed quality and health, while taking into account the diversity of actors and contexts in which organic seed is produced and used.

This booklet presents three examples that illustrate the practical impact of LiveSeeding's work on organic seed systems.

The first focuses on **Organic Heterogeneous Material (OHM)**, a new category recognised under EU organic regulation. OHM offers important opportunities for diversity and resilience, but it also raises practical questions for seed propagation, quality management and traceability.

The second focuses on **seed health, vigour and microbiota**. Seeds carry microbial communities that may influence germination and early plant development, yet these interactions remain poorly understood in organic systems. LiveSeeding explored this topic through experiments on wheat and soybean seeds produced under different farming systems.

The third focuses on **innovative seed treatments for organic agriculture**. Seed-borne pathogens remain a significant constraint for organic seed production, and effective alternatives to synthetic chemical treatments are needed. LiveSeeding worked with seed companies and research partners to identify and validate promising treatment options under practical conditions.

Together, these three topics show that strengthening organic seed systems requires action at several levels: better management of seed diversity, a deeper understanding of biological processes linked to seed performance, and practical solutions to improve seed health in production. They also show that innovation in organic seed systems is not only about new products or techniques, but also about making knowledge usable for different actors.

These activities were complemented by the development of **training materials and self-paced e-learning modules for different audiences**, from small-scale seed producers and seed networks to breeders, seed companies and public authorities. A selection of these outputs is presented at the end of this booklet.

Taken together, the results presented here contribute to building organic seed systems that are more robust, more diverse and better able to meet the needs of farmers and society. LiveSeeding has helped create practical knowledge, tools and connections that can continue to support this transition beyond the lifetime of the project.

Managing Diversity and Quality in OHM Seed Production

In a context of growing climate uncertainty and increasing demand for more resilient cropping systems, a novel legal cultivar category named Organic Heterogeneous Material (OHM) was introduced by Regulation (EU) 2018/848. Unlike uniform varieties, **OHM is characterised by high genetic and phenotypic diversity and by the capacity to evolve over time**. This makes it particularly relevant for organic systems, where adaptation, diversity and resilience are central. At the same time, the development of OHM raises practical questions: how can such diverse material be multiplied while preserving both seed quality and the dynamic nature of the population?

To address this challenge, LiveSeeding focused on the practical management of OHM seed propagation. The project sought to improve understanding of how breeders and seed propagators can plan multiplication, monitor diversity, manage seed quality and ensure traceability in ways that are both technically feasible and consistent with the specific nature of OHM (Figure 1).

Researchers, breeders, seed propagators and other development actors worked together through workshops, surveys and technical exchanges to identify the main issues faced in practice. Their work covered the full process of OHM seed propagation, from defining multiplication objectives and choosing suitable sites, to field monitoring, harvest, seed cleaning, testing and storage.

Figure 1: Variability in durum wheat population EPO (Hungary, ÖMKi)

These activities produced practical results: LiveSeeding developed guidance (Figure 2) for breeders and seed propagators showing that OHM seed production can rely largely on existing organic seed production infrastructure, but requires adapted management practices at certain critical steps. The work highlighted the importance of defining the objective of multiplication from the start, choosing a multiplication area that matches this objective, documenting seed lots carefully, and monitoring the population during multiplication in order to preserve its identity without unnecessarily restricting its diversity.

Practical Guidelines for OHM actors (Breeders, Seed Propagators)

1. Planning

a) Definition of aims
b) Information Gathering
c) Technical Requirements
d) Multiplication site

2. Pre-harvest processes

a) Field Conditions
b) Monitoring and Field Inspections
c) Harvest of OHM Seed

3. Post-harvest processes

a) Quality Management
b) Seed Processing

Figure 2: Recommended practical steps for OHM breeders and seed propagators

The project also showed that **seed quality requirements for OHM remain largely aligned with those of other seeds, especially for physical purity, germination and seed health**. At the same time, some post-harvest practices, especially cleaning and sorting, may need to be less strict in order to preserve the heterogeneity that defines OHM.
Traceability also emerged as a key issue in OHM seed production. To support transparency and continuity across multiplication cycles, LiveSeeding developed and promoted digital tools such as OHMTrack, which enable the documentation and tracking of seed lots, production sites and population histories throughout the propagation process. This helps maintain the identity of evolving populations while supporting quality management and regulatory compliance.

OHMTrack

OHMTrack is an open-source digital tool that supports the notification process and the traceability of OHM seed lots, ensuring transparent and harmonised tracking across the EU (ohmtrack.liveseeding.eu).

OHM cultivation is expanding across Europe, and actors now have clearer reference points and practical tools for managing multiplication and traceability. The work also helped to **position OHM not as a technical exception, but as a cultivar category that can be integrated into existing seed systems with appropriate adjustments.**
Through the uptake of these results by breeders, seed producers, farmers and authorities, the project is expected to contribute to broader impacts in the longer term: greater confidence among breeders, seed producers and farmers; more transparent and reliable OHM seed production; wider use of diverse crop populations; and, ultimately, more resilient and adaptive organic farming systems.

What organically produced seeds deliver: evidence from seed health, vigour and microbiota experiments

In a context where organic farming depends heavily on strong crop establishment and resilient plant-soil interactions, seed quality cannot be reduced to germination rate alone. Seeds also carry microbial communities that may influence germination, early seedling growth and stress response. This is especially relevant in organic systems, where biological interactions play a major role and where farmers rely less on corrective inputs after sowing.

LiveSeeding investigated whether seeds produced under different farming systems differ in vigour, germination behaviour and associated microbiota, and whether these differences translate into better resilience under stress. The objective was not only to describe seed microbiota, but also to better understand what organically produced seeds may deliver in practice.

Researchers and development partners worked with wheat and soybean seeds from the long-term DOK trial in Switzerland (Figure 3), which compares biodynamic, organic and conventional farming systems.

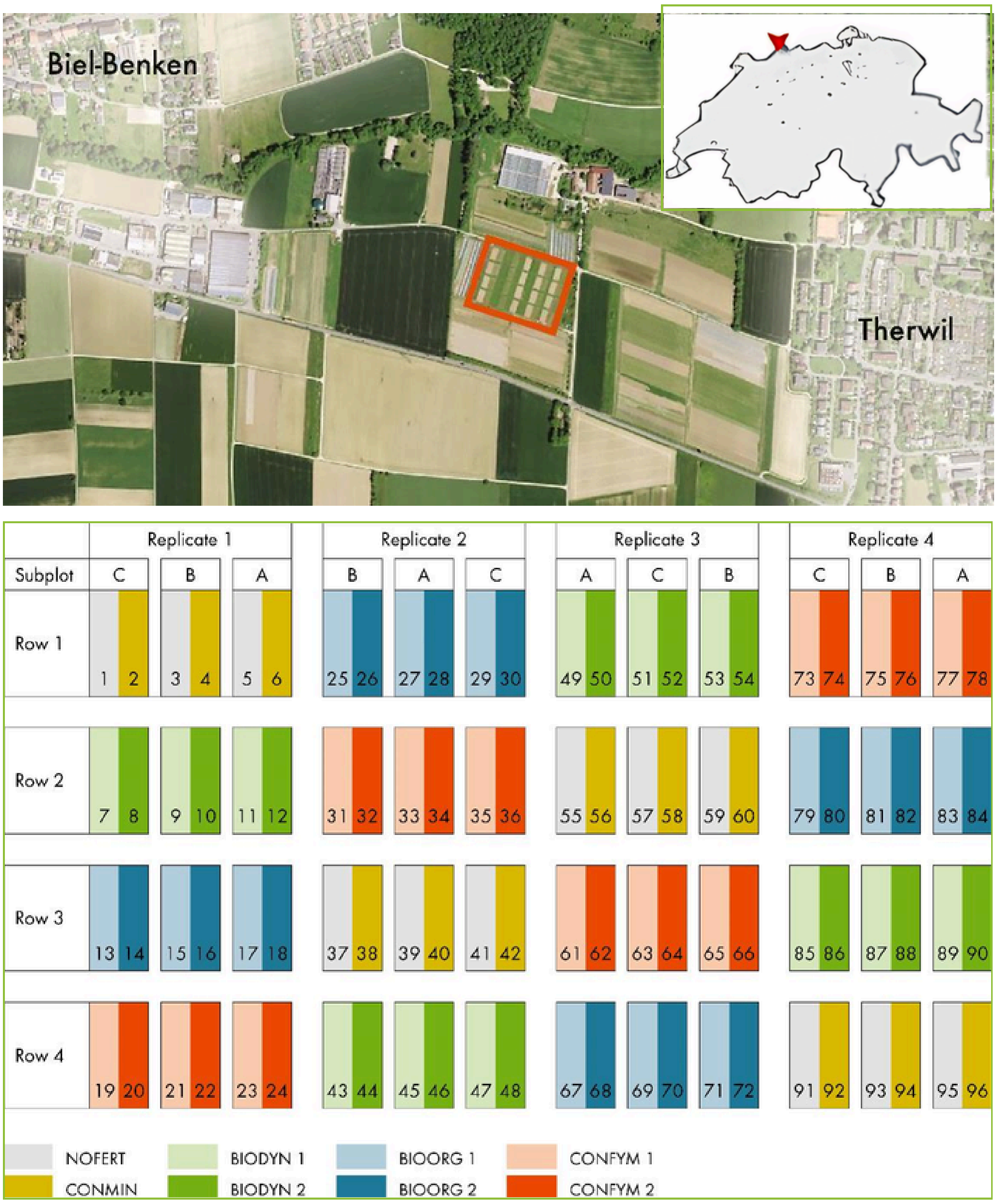

Figure 3: Overview of DOK trial site and experimental design (FiBL)

Germination (Figure 4) was assessed under different temperature and salinity conditions, and field emergence was tested in France and Hungary. In parallel, the microbial communities associated with the seeds were analysed. The analysis of seed microbial communities is still ongoing. Results are expected by the end of the project.

Figure 4 Germinated seeds for wheat (left) and soybean (right)

Several results were obtained by these trials. First, the **experiments confirmed that seed production year had a strong influence on germination and seed performance in both wheat and soybean**. Environmental conditions during seed production appeared to matter more than farming system alone. Second, some management-related differences were observed under specific stress conditions, but they were limited and not consistent across all experiments. Results on seed microbial communities are yet to come. They shall contribute to a better understanding of how these are driven by organic farming practices.

Results from this experiment will be disseminated through the project deliverable "Effect of seed microbiome on seedling vigour and resilience" (D3.5). Seed vigour and seed microbial communities are also addressed in training materials and broader communication on organic seed quality and health. The topic feeds into a wider reflection within LiveSeeding on how to define and manage seed quality in organic systems.

The expected impact is twofold: In the short term, **the results will help seed actors and researchers better frame the role of seed microbiota and better target future work on seed vigour and resilience**. In the longer term, they may **contribute to seed quality approaches that better reflect the biological complexity of organic systems** and that support more resilient crop establishment under variable growing conditions.

Scaling up organic seed production: innovative seed treatments

Seed-borne diseases are a challenge in organic farming. Organic systems rely primarily on prevention through crop rotation, soil health and diversified farming systems, but preventive measures are not always sufficient. Some pathogens remain difficult to control and can compromise germination, seedling establishment and seed marketability. Developing effective alternatives to synthetic seed treatments is therefore particularly important for organic farming, while also contributing to more resilient and less input-dependent agricultural systems more broadly.

To respond to this challenge, **LiveSeeding worked on identifying and validating innovative seed treatments compatible with organic agriculture.** The project aimed to find practical solutions that could reduce pathogen pressure, support seed health and be applied in real seed company conditions.

Researchers, seed companies and development actors worked together to identify the most pressing disease challenges in organic seed production and to test promising treatment options. This work was built on stakeholder exchanges, including a workshop on market opportunities and technical challenges for organic seed producers, which highlighted the limited availability of effective organic seed treatments as a major barrier to sector growth.

From this starting point, partners reviewed existing knowledge, selected candidate products (Table 1), sourced naturally infected seed lots and organised validation trials at seed company facilities in Switzerland, Germany and Greece. The work covered several crops, pathogens and treatment types, including microbial products, chitosan-based formulations and biostimulants.

Product	Composition	Target Pathogen	Crop	Amount of seeds (g)	Control treatment	Tested by
Koncia KMS1943	*Bacillus sp. + Trichoderma sp. + Glomus sp.*	*Alternaria brassicicola*	Kale	200	AST 65° 90s	Sativa Rheinau
		Alternaria dauci	Carrots	400	AST 65° 90s	Sativa Rheinau
		Xanthomonas campestris	Kale	200	AST 65° 90s	Sativa Rheinau
		Xanthomonas euvesicatoria	Pepper	50	AST 65° 90s	Oikos seeds
Koncia XP200EV	*Streptomyces sp. + Pseudomonas sp. + Glomus sp.*	*Alternaria brassicicola*	Kale	200	AST 65° 90s	Sativa Rheinau
		Alternaria dauci	Carrots	400	AST 65° 90s	Sativa Rheinau
		Xanthomonas campestris	Kale	200	AST 65° 90s	Sativa Rheinau
CH193EV	Chitosan-based	*Xanthomonas campestris*	Kale	200	AST 65° 90s	Sativa Rheinau
		Xanthomonas hortorum pv. carrotae	Carrots	50	AST 65° 90s	Bingenheimer Saatgut
		Xanthomonas euvesicatoria	Pepper	50	AST 65° 90s	Oikos seeds
MicroF	*Bacillus amyloliquefaciens*	*Cercospora beticola*	Beetroot	200	AST 68° 120s	Sativa Rheinau
MicroA	*Clonostachys sp.*	*Tilletia caries*	Wheat	500	AST 68° 180s	Sativa Rheinau
MicroB	*Bacillus sp.*	*Tilletia caries*	Wheat	500	AST 68° 180s	Sativa Rheinau

AST = aerated steam treatment

Table 1: Products tested at the facilities of Sativa Rheinau, Oikos Seeds and Bingenheimer Saatgut

These activities produced concrete results. Several candidate products showed high potential against specific seed-borne pathogens, with **some microbial and chitosan-based treatments performed matched or outperformed the reference control treatment in particular crop-pathogen combinations.**

For example, Koncia KMS1943 and Koncia XP200EV, consisting of different microbial mixtures, showed a significant reduction of the fungus Alternaria brassicicola on kale seeds. The former was also effective against the bacteria Xanthomonas campestris on kale seeds.

In all these cases, the pathogen reduction was even stronger than for the control hot steam treatment. None of the tested products had a negative effect on seed germination, and all proved compatible with the existing company infrastructure.

LiveSeeding work showed that the **performance of the treatments tested is highly pathosystem-specific. There is no universal solution, and a product's effectiveness depends strongly on the crop and pathogen involved**. In some cases, treatments also appeared to reduce transmission from seed to seedling even when the pathogen could still be detected on the seed, opening interesting perspectives for future work.

Additional partner activities broadened this picture. Trials in Poland showed positive effects of microbial preparations on seedling number and seedling length in cereals under some conditions, while work in Spain on horticultural crops highlighted the potential of commercial biostimulants to improve root development, leaf growth or germination depending on the product and crop.

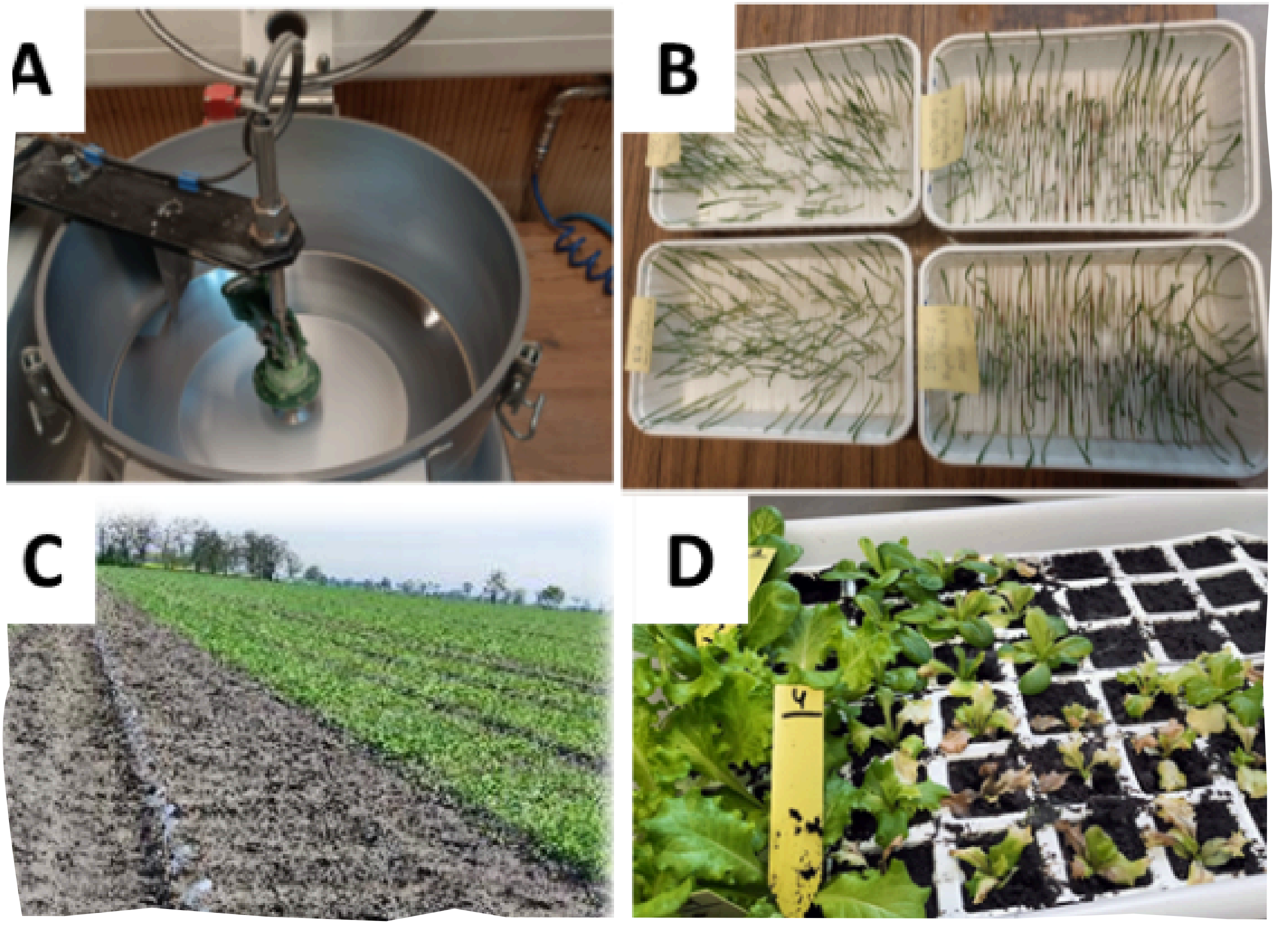

Figure 4: Summary overview of activities: seed coating equipment, germination test, field trial, biostimulant test on lettuce seedlings

These results contribute to a wider project effort to build practical seed health strategies that combine sanitation, vigour and technical feasibility.

This work contributed to the operational validation of certain commercial seed treatment products. Some of them were identified as promising solutions for seed sanitation under real production conditions. It also helped connect research, technical support and company practice more closely.

The expected impacts are significant. In the short term, **the work provides seed companies and other actors with clearer directions for selecting and testing organic seed treatments**. In the longer term, it can **support the scale-up of organic seed production by reducing one of the major technical constraints to reliable seed supply**. More broadly, it contributes to a more robust organic seed sector in Europe.

Further reading

Want to explore this topic further? In this section you will find a selection of related resources. Click on any link to access the full resource.

DELIVERABLES

Training material on the production of healthy, high-quality organic seed (D3.2)
Guidelines for quality and diversity management of OHM seed (D3.3)
Results on case studies following the organic seed health strategy (D3.4)
Effect of seed microbiome on seedling vigour and resilience (D3.5)

TRAINING MODULES & PRACTICE ABSTRACTS

Training materials and webinars on OHM, including resources on regulation, quality management and traceability
General information on the legal basis of OHM: booklet and a short explanatory video by Artemisia AISBL in collaboration with Seeds4All
Practical guidance on seed sanitation is available through several Practice Abstracts. These include materials on the management of common bunt in cereals and on vinegar seed treatments from the previous project named LIVESEED.
PRACTICE ABSTRACT DIY hot water treatment for sanitation of vegetable seeds.
Detailed Practical Guide for Drying and Storing Vegetable Seeds in Organic Small-Scale and On-Farm Seed Production
Material on the simple, non-destructive measurement of equilibrium relative humidity to assess seed moisture levels using a hygrometer.

E-LEARNING MODULES

Self-paced e-learning modules grouped into three learning paths:

- Ensuring seed quality when propagating and storing seed
- Ensuring organic seed health: tools to understand and manage
- Getting to know and tracking Organic Heterogeneous Material

All materials from the LiveSeeding project.

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