SUSTAINABLE STORAGE OF GRAINS
BY IMPLEMENTING A NOVEL PROTECTANT
AND A VERSATILE APPLICATION TECHNOLOGY

D4.6. Co-Creation Workshops – September 2024
novIGRain

Co-Creation Workshops – September 2024	
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Dissemination Level	
X	**PU = Public**
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	CO = Confidential, only for members of the consortium (including the EC)

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1 Introduction

The focus of the novIGRain project is on the development of 3 innovations in the field of grain storage management:

- The development of a novel product that can be applied as a ULV (ultra-low volume);
- The development of a novel application technology that should make it feasible to apply multiple insecticides at the same time;
- The development of tools and manuals for doing proper grain storage management taking into account the possible resistance of insects to substances applied. These will be based on research on insect resistance done within the novIGRain project (in combination with literature studies).

Within the novIGRain project "co-creation workshops" were included to assure that the innovation will be developed according to the stakeholders' needs to assure a good market uptake when the project will be over. Throughout the project, a number of different Co-Creation workshops organised in 3 regions (being: France, Germany and Hungary). The provisioned timing of the workshops is:

- March-May 2021
- September-November 2023
- September 2024
- Summer 2025 (additional workshop – exact timing and format TBD)

1.1 Goal of Co-Creation Workshop in 2024

Following the feedback from the previous sessions of the workshops, the third round of workshops was decided to be focussed on industrial challenges and opportunities, therefore the workshop in 2024 had 2 main goals:

(i) Sharing the perspective and outlook about grain storage from NovIGRain experts to the broader audience from grain protection industry and research

(ii) Open a discussion and exchange of opinions between NovIGRain experts and relevant stakeholders about the future of the industry

Having experienced challenging recruitment for the workshops in the previous periods for 2024 the decision was made to hold a workshop at the location of an industry relevant conference, thereby allowing to have relevant stakeholders already present. For this purpose, an IOBC-organised conference named the Integrated Protection of Stored Products (IPSP2024), held in Novi Sad, Serbia, was chosen as it aligned well with the topic and aims of the NovIGRain workshops. The organisers of the conference kindly provided a 1-hour session within the official programme for the workshop.

2 IPSP 2024

The 14th Conference of the IOBC-WPRS Working Group on Integrated Protection of Stored Products (IPSP 2024) focused on advancing research and practical solutions in integrated pest management (IPM) for stored products. It was held in Novi Sad, Serbia, from 16 to 20 September 2024, and was organised by the International Organisation for Biological Control (IOBC).

IPSP 2024 addressed key challenges in post-harvest pest management by presenting recent research, innovative strategies, and sustainable solutions. The programme emphasised methods for preventing and detecting pest infestations, highlighted environmentally safe alternatives to chemical pesticides, and explored approaches to reduce food chain losses caused by pests such as insects,

mites, fungi, rodents, and birds. Broader agricultural issues were also discussed, including climate change, biodiversity loss, pesticide restrictions, and the increasing demand for high-quality food production, underlining the importance of post-harvest management in the food chain.

The conference promoted integrated pest management strategies that balance environmental sustainability with economic and social practicality. It provided a platform for wide range of relevant stakeholders ranging from researchers and academics to industrial representatives and pest control operators to share research findings, and address key topics in stored product protection.

The conference therefore provided a suiting venue for the NovIGRain co-creation workshop allowing to leverage the expertise of participants to discuss challenges in stored grain protection. As the result, around 50 people attended, with 40 participants actively engaging in the interactive survey. Figure 1 summarises the countries represented by the participants of the workshop.

Figure 1. Countries of workshop participants



3 Workshop Programme

To achieve the primary objectives of the workshop, a programme was prepared that included two presentations. The first, delivered by Frederic Verwilghen (MAXILINE), focused on the challenges and opportunities in grain protection, providing valuable insights into the current state of the industry.

This was followed by a presentation from Anna Kosa-Tass (Babolna Bio), which detailed the development process for new insecticides and the journey from concept to market. This presentation was particularly significant as it highlighted the complexities and lengthy timelines involved in registering new chemical products.

To facilitate further discussion, following the presentations an interactive panel session was organised. Three experts from the NovIGRain network were invited to participate in the panel:

- János Szilágyi (Babolna Bio), a experienced expert, who spent over 26 years leading commerce and responsible for international collaborations at Babolna Bio. Later Janos has been responsible for regulatory affairs and product development.
- Professor Christos Athanassiou (University of Thessaly), an internationally renowned expert in stored product entomology, teaches at the University of Thessaly in Greece. He has

authored numerous scientific publications and coordinates national and international projects in integrated pest management.

- Yann Ciesla (Sitona AgroExpert), joining online an entomologist and expert in fumigation and stored product protection, heads Sitona AgroExpert in France. With over 17 years of experience, Yann specializes in post-harvest insecticide research, industry consulting, and training French fumigators.

The interactive presentation included a series of questions on stored grain protection, designed to identify the most pressing challenges and highlight potential opportunities or areas requiring greater attention. Table 1 summarises the questions used in the workshop.

Table 1. Workshop Questions

#	Question	Question type
1	In one word, what should currently be the top priority in stored product protection?	Word Cloud
2	Rank the following factors by importance for improving stored product protection: • Safety and toxicity • Effectiveness of existing pest control methods • Cost-efficiency • Sustainability • Ease of implementation of existing pest control methods • Other	Ranking
3	What are the biggest barriers for effective pest control of stored products? • Ineffectiveness of current methods against certain pests • Short duration of protection • Concerns about toxicity and safety • High costs • Regulatory challenges • Complexity and difficulty in application • Lack of awareness about new technologies • Lack of training for new technologies • Limited research • Other	Multiple-Choice
4	On a scale of 1 to 5 • How important is ongoing technical support when adopting new pest management solutions? • How important is collaboration between academia and industry for advancing stored product protection? • How do you rate current state of protection of stored products? • How prepared do you think the industry is to address future challenges in stored product protection?	Scale Rating
5	Rank the following trends by potential to shape the future of stored product protection: • Climate change • Technological advancements • Regulatory changes • Consumer demand for sustainability • Global food security challenges	Ranking

	• Other	
6	In one word, what do you think will be the biggest challenge for the future of stored product protection?	Word Cloud

These questions were initially asked to the audience and then presented to the experts, who commented on the audience's perceptions, shared their own opinions, compared the results and explained any differences or similarities in viewpoints. The workshop concluded with a Q&A session.

4 Collected Data and Outcomes of Co-Creation Workshop

4.1 Interactive Survey Results

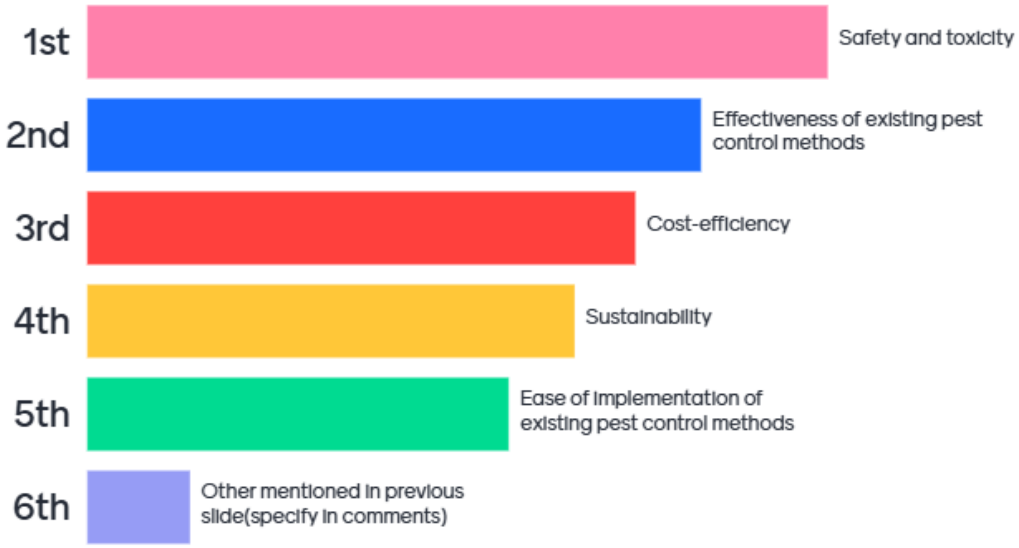
Figure 2. Q1: “What should currently be the top priority in stored product protection?” – Audience response



For the first question, the audience highlighted safety, monitoring, and resistance as the most common areas requiring attention, with sustainability also mentioned as an important aspect.

At the same time, the experts varied in their opinions on what should be the top priority in stored grain protection. In particular, Yann Ciesla highlighted that, although concerns about sustainability and safety are very understandable, current consumers are not ready to accept grain with insects. Therefore, Yann’s priority is efficacy. Supporting Yann, Janos Silagyi strongly emphasised that efficacy should be the top priority. Conversely, Christos Athanassiou focused on safety, not just in terms of the products themselves but also regarding their application and the protection of operators exposed to them. Christos also pointed out that cost is an important factor, although safety remains the top priority.

Figure 3. Q2: Rank the following factors by importance for improving stored product protection – Audience response



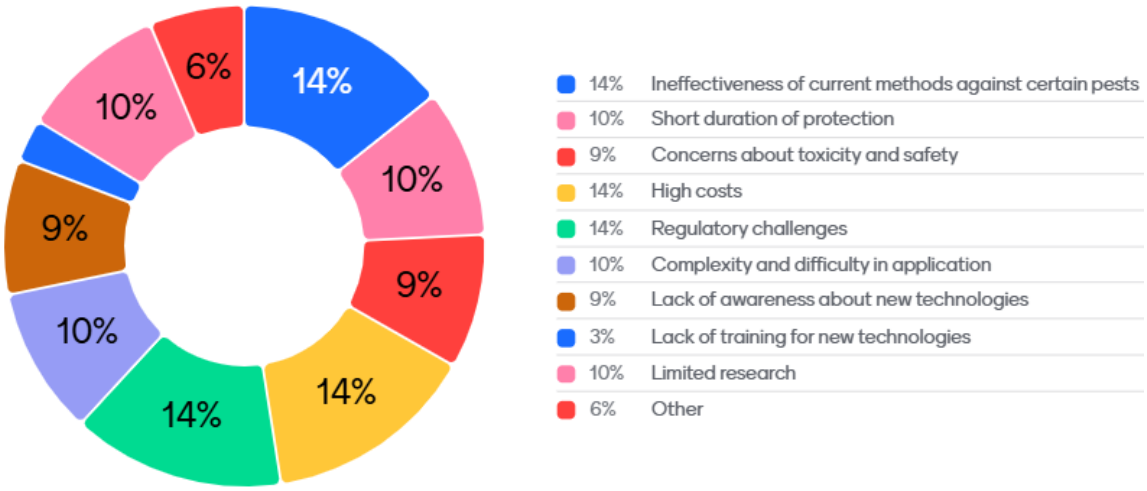
For the second question, the audience ranked safety and toxicity as the most important factors, followed by the effectiveness of pest control methods and cost-efficiency.

Yann highlighted that cost-efficiency is the most important factor for improving stored product protection. He emphasised that, although significant work is being done to develop new methods and approaches, users currently lack the resources to implement expensive techniques, particularly in the case of low value-added products such as cereals.

Janos reinforced his earlier statement about efficacy and effectiveness being the most important factors. He argued that, given the extensive testing required to register a new product, there should be trust that the product is safe, while the safety of operators should be ensured through appropriate training and the professionalism of pest control operators. Therefore, for new products, effectiveness is the most important factor, followed by safety and cost-efficiency.

Christos agreed, while prioritising safety as the most important factor, followed by cost-efficiency and ease of implementation of pest control methods. He argued that highly effective methods have no place in the industry unless they are affordable and easy to implement. Grain protectants are traditionally very easy to apply, and new specialised techniques should compete with the established convenience of existing insecticides.

Figure 4. Q3: Biggest barriers for effective pest control of stored products – Audience response



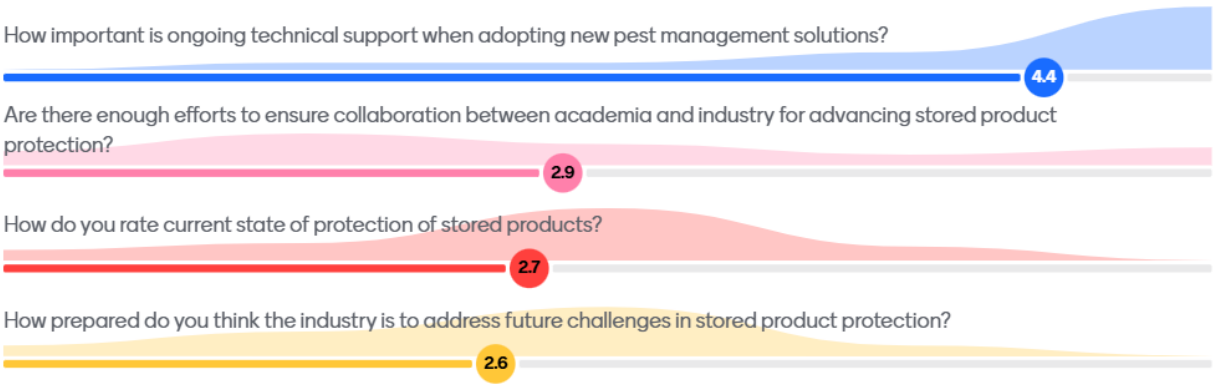
For the third question, the audience identified several equally significant barriers, including the ineffectiveness of current pest control methods, high costs, regulatory challenges, short duration of protection, complexity and difficulty in application, and limited research.

Yann's first priority was the short duration of protection. He noted that fumigation provides only short-term effects, while the liquid insecticides still available on the market offer increasingly shorter durations of protection. His second concern was high costs, which, as mentioned earlier, limit the feasibility of application and consequently reduce the quality of grain protection.

Janos argued that regulatory challenges are by far the biggest barrier. He stated that the current requirements for registering new products are stalling innovation, as the development of new products has become unfeasible under the existing regulations.

Christos agreed with Janos regarding the significance of regulatory challenges, adding that this issue is particularly relevant within the European Union. In other regions, such as Australia, Canada, the USA, and Brazil, regulatory hurdles are far less problematic. He also highlighted instances where countries have banned the application of liquid insecticides on grain, leading to a reliance on fumigation. This dependence means that any changes affecting phosphine will have a substantial impact on all other pest control methods. If phosphine remains effective, no alternatives are likely to be considered. Therefore, given the decreasing availability of active substances for grain protection on the market, it is essential to monitor developments and explore alternatives to traditional methods.

Figure 5. Q4: Scale questions 1-5 – Audience response



The audience strongly emphasised the importance of technical support when adopting new pest management solutions, while perceiving the level of collaboration between industry and academia as average. Additionally, the audience generally held a more pessimistic outlook regarding the current state of stored grain protection and the industry's readiness to address future challenges.

The experts largely agreed with the audience. Yann and Christos further stressed that technical support is a critical aspect, particularly for the adoption of new techniques and methods. They observed that while implementation might appear relatively straightforward in laboratory conditions, it is far more complex in real silos. Consequently, it is essential to approach new methods not merely as isolated techniques but as integrated systems that deliver ready-to-use solutions. These systems should include a specific sprayer, a designated insecticide, detailed instructions, and comprehensive technical training and support.

Janos, commenting on the state of the grain protection industry, noted that there has never been a governmental initiative to monitor insect resistance within the EU. As a result, no resistance maps exist, and the overall situation regarding resistance remains unclear. Regarding the industry's readiness to tackle future challenges, Janos argued that the industry is not ready, referring to high development costs, lengthy return periods and the limited return on investment.

Figure 6. Q5: Rank the following trends by potential to shape the future of stored product protection – Audience response

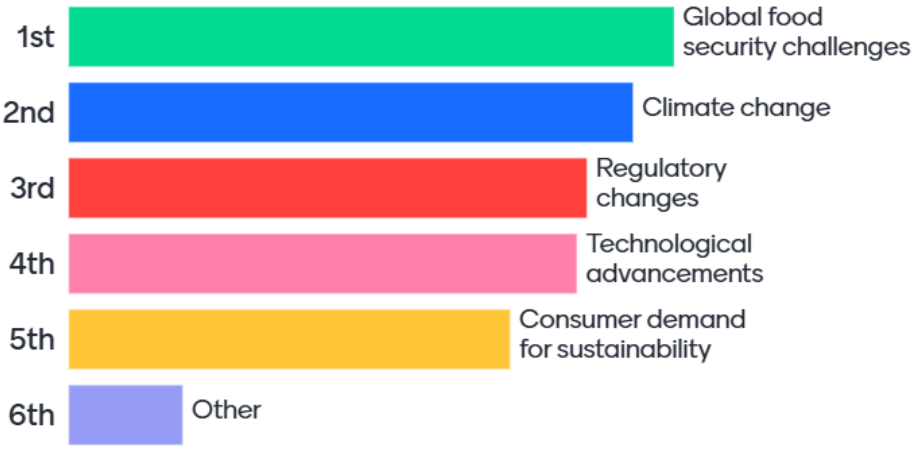


Figure 7. Q6: What do you think will be the biggest challenge for the future of stored product protection? – Audience response



Questions 5 and 6 were presented to the audience consecutively, with experts commenting on both simultaneously. The audience ranked global food security challenges as the trend with the highest potential to impact stored grain protection, followed by climate change and regulatory changes.

Yann argued that regulatory changes would have the greatest impact. Referring to Anna Kosa-Tass's presentation and the extensive challenges involved in registering new active substances, he pointed out that it will be impossible to continue as things stand if new products take 10-15 years to reach the market. As a result, no products will be available in the EU for grain protection. Yann also highlighted the impact of climate change, noting that rising temperatures lead to an increase in insect numbers and exacerbate issues with resistance and reinfections.

Janos agreed that climate change and resistance are the biggest challenges moving forward. Christos concurred with the audience, stating that the "end of phosphine" will have profound implications due to the industry's heavy reliance on fumigation. Therefore, he stressed that the industry must prepare for the possibility of phosphine no longer being allowed and ensure that effective alternatives are available to fully substitute it.

4.2 Follow-up Questions

Following the interactive survey the audience was given as chance to ask the questions to the panel.

Q: *We know that phosphine resistance is a fact. But what about fumigation effectiveness in Europe? Are our treatments effective or not and we just use resistance as an excuse?*

A: *In most of the cases the issue is not resistance, but poor fumigation practices. Improve fumigation practices first and then if resistance is present aim to address this issue. Only after all procedures are done correctly and insects are still alive then we can talk about resistance. In case the exposure time is respected very few issues with resistance are observed. Also, resistance and tolerance should not be confused.*

Due to time constraints, the remaining questions were not addressed during the workshop. As a result, the experts were invited to provide short written responses to these unanswered questions, which were subsequently posted on the NovIGRain LinkedIn page. A summary of their responses is provided below.

Q1: *Which alternative method in grain protection is the most acceptable for you?*

Christos Athanassiou: *"There is no "silver bullet" method – we never had something like that in stored product protection. Basically, there are some alternative methods that seem to be more promising than others. With the term "alternative" we mean the methods that are not "traditional", such as fumigants and grain protectants. Currently, nitrogen generators that flush nitrogen within the silo is a promising method and has been utilized with success. Let's not forget aeration and cooling, which, if done properly, will delay or even eliminate the need for fumigation."*

Janos Szilagyi: *"Probably the physical methods, although these have their limitations too. I have great belief in mild insecticides that opposite to traditional insecticide have no direct killing effect but are considered as larvicide. I would also be happy to make a trial with Methograin + Piriproxifen combo (proposal of Christos)."*

Yann Ciesla: *"It all depends on the insect species targeted, some insects only have external stages (outside the grain), so it is possible to eliminate part of the insects by simple cleaning, but this generally does not achieve 100% efficacy, but just limits the infestation. For insects with hidden stages, it is more a question of scale (treating a small volume of grains in a big bag is different from treating a storage of 10,000 tons). Preventive treatment with diatomaceous earth is sometimes sufficient to achieve good protection, but this is only possible if the batches to be treated are small or for products with high added value because the treatments are very expensive! Unfortunately, there is no universal solution that can be applied in all cases. Finally, controlled atmosphere treatments are very effective if they are well conducted. However, it is necessary to have a perfectly gastight silo, which is easy to achieve on a small scale (few tons of grain) but very expensive in terms of investment on a large scale."*

Q2: *"Probably is hypocrisy of the companies. But most big chemical companies are advertising sustainability. In the survey during the workshop sustainability was our fourth choice. Are we old-fashioned?"*

Christos Athanassiou: *"Sustainability is definitely the focus here, but this is the long-term vision and goal. A goal without a plan on how to achieve it is just a wish. Efficacy and cost are the plan, so these are also part of the overall vision."*

Janos Szilagyi: *"Sustainability is today's magical keyword without a broad definition of what exactly it means. Methograin formulation's largest part is biodiesel, obtained from sunflower. This year's heatwave destroyed sunflowers, so I believe biodiesel will be exceptionally expensive. The real question is: how do we interpret and understand sustainability? Still, I support the use of renewable sources, though they have the same limitations as discussed in the first question."*

Yann Ciesla: *"This is a more philosophical than technical question! What is sustainability today when we talk about grain protection? We sometimes use ventilation machines to cool the grain which consumes energy so we actually reduce the use of pesticides on the one hand, but we consume more energy on the other? What is the best way forward in terms of sustainability? We can ask ourselves the same question: what is more sustainable: using a few grams per ton of insecticide to protect a commodity or accepting to lose a quantity of grain from this storage which in this case leads to food waste and a bad carbon footprint...? I think we need to find the right balance between all of this and take into consideration not only the reduction of pesticides but also the carbon footprint. Each silo is different and the methods to be adopted depend on the specificities of each storage facility. This is why it is necessary, in my opinion, to have as many solutions as possible to be able to try to apply an integrated protection of stored products."*

Q3: *"Given the challenges and current state of the industry – Are we all in a dead end?"*

Christos Athanassiou: *"No. There are plenty of methods out there that need to be addressed. For instance, we haven't fully evaluated a wide range of methods that have been proven effective. The most important factor here is not the method—the method works. What we really need is a "silver gun" to apply the "silver bullet" methods effectively. For example, we know that aeration and cooling work, but we don't know the optimal timing for increased cost-efficiency. We need best management practices."*

Janos Szilagyi: *"If the EU continues with its senseless and unhelpful approach to making approvals and disapprovals, we will indeed reach a dead end. Authorities take no responsibility for the outcomes of their decisions, making it easy to appear strict and environmentally friendly often working against the goal. For instance, wheat production in Hungary is high, but only 10% is suitable for bread, largely due to inappropriate use of insecticides. The result? Bread prices will skyrocket."*

Yann Ciesla: *"Indeed year after year the grain protection solutions are reduced... It was necessary to have banned the most dangerous pesticides but it is also necessary to be able to continue to protect the grain. Alternatives do not always work in all configurations. Fortunately, today European H2020 programs like Novigrain are in progress to put new solutions on the market. Without this it will become more and more complicated in the years to protect grain storages against insects. At the present time there is an economic reality to take into account while looking for sustainable solutions that requires supporting research..."*

4.3 General Conclusions

The discussions surrounding stored grain protection reveal several key conclusions about the priorities, challenges, and future direction of the industry.

Firstly, there is a clear tension between the immediate needs of the industry and the long-term goals of sustainability. While safety, efficacy, and cost-efficiency are identified as top priorities for the industry, sustainability often takes a back seat in terms of immediate action. It is emphasised that without efficacy as a primary focus, consumers will not accept the product, especially when faced with the growing issue of insect infestations. However, the reliance on traditional, effective methods like fumigation, particularly phosphine, creates a significant vulnerability as regulatory changes threaten to limit their use. This exposes the broader challenge: the industry needs to prepare for a future where current practices may no longer be viable, requiring alternative solutions that are both effective and scalable.

The regulatory landscape is a critical obstacle to innovation in grain protection. It is agreed that the complex and often slow regulatory processes, especially in the EU, are stalling progress by making it difficult for new products to come to market. The concerns over long timelines required to bring new products to the market reflect the frustration of many in the industry, as innovation is hindered by stringent rules. This regulatory bottleneck, combined with the industry's heavy reliance on existing technologies, creates an uncertain future. There is also a lack of effective monitoring of resistance patterns, further complicating efforts to manage pests.

Cost remains a significant barrier, particularly in the context of low-value crops like cereals. Although new methods and products are being developed, the high cost of implementation often makes them impractical for many operators. It is stressed that cost-efficiency, alongside safety and efficacy, must remain a priority for the industry, especially for solutions targeting large-scale operations. This reinforces the need for a balanced approach, where effective pest control methods must be both financially viable and technically feasible.

Another overarching theme is the complexity of implementing new methods in real-world conditions. While innovations may seem promising in controlled environments or laboratories, the practical realities of grain storage and pest management often make it challenging to scale these solutions. The importance of technical support and integration of new methods as comprehensive systems, rather than isolated treatments, is critical for adoption. This reflects the need for the industry to develop not only new products but also the infrastructure and training to ensure their proper application.

Finally, despite these challenges, there is cautious optimism. The ongoing research efforts, such as the NovIGRain programme, suggest that there are potential solutions on the horizon, provided the industry can adapt to new technologies and address the regulatory and practical barriers that currently limit their deployment. However, it is warned that the future of grain protection will depend on the ability to find a balance between sustainability, efficacy, cost, and safety ensuring that solutions are not only effective but also adaptable to changing conditions and market demands.

5 Way forward

This workshop was originally the final planned stakeholder interaction event for NovIGRain, with satisfactory attendance and a wide representation of participants from various European regions. Looking ahead, considering the additional workshop planned in the project, there is an opportunity to organise one more workshop, potentially combining it with a dissemination event for NovIGRain.

Currently, several consortium partners have been selected to deliver oral or poster presentations at ICUP 2025 (International Conference on Urban Pests) in Lund, Sweden. As a majority of NovIGRain participants have expressed interest in attending the event and highlighted the relevance of the ICUP community gathering for the project, this conference presents a valuable opportunity.

In the upcoming consortium meeting, the details of this plan will be discussed and the conference organisers will be approached to explore the possibility of dedicating a session within the conference programme for the workshop.

6 Confidentiality / GDPR

During the workshop in 2024 no sensitive or company specific data was shared, only general comments.

7 Attachments

- Video recordings of the workshops can be requested at contact@novigrain.eu