Critical Success Factors for Producing Sustainable, High-Performance Seed Coating Solutions

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Critical Success Factors for Producing Sustainable, High-Performance Seed Coating Solutions

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Seed coating techniques such as filming, encrusting, and pelleting offer seed protection that contributes to higher yields, while also delivering application improvements like easier and safer handling, reduced dusting, and improved flowability.

As such, it's no surprise that the global market for seed coating materials alone is forecast to reach $3.8B by 2035.[1]

As sustainable farming gains momentum, the market for seed coatings is moving forward to more plant-based ingredients that minimize environmental impact.

This paper outlines the key drivers currently shaping the global seed coating material market and identifies four of the most critical factors for successful seed coating formulations.

I. Seeds of Change: An Evolving and Dynamic Market[1,2,3,4,8]

Grounded in History

The very first seed treatments can be traced back to ancient Egypt and Rome, in the use of onion sap and cypress extracts. By the 1800s, treatment techniques became more sophisticated, such as immersion in copper sulfate solution as a treatment for bunt, a fungal grain disease.

Fast forward 200 years, and seed treatment became the industry standard for most agricultural crops, highly prized for growth benefits like:

- Protection against pests, diseases and abiotic stress
- Optimal nutrition for germination and early plant growth
- Reduced exposure to dust
- Precise, even, uninterrupted seed distribution

Protecting seeds from various factors like pests, diseases and stress, seed treatment significantly reduces the risk of seed loss. Indeed, the percentage of seed loss can vary depending on the crop, region and specific conditions. For instance, in temperate regions, seed losses without adequate protection can reach around 10%. However, in more challenging environments like humid tropical regions, the losses can escalate significantly, reaching nearly 50%. These figures highlight the critical importance of seed treatment in safeguarding seed viability and optimizing crop production.

Early Intervention

With seed treatment, inputs work harder because of precision targeting at the earliest stages of plant growth, when small quantities have a major impact. Effective seed treatment means less reliance on broadcast agrochemical applications, lowering active ingredient loadings in the environment.

In particular, seed treatment has an important role to play in integrated pest management strategies keeping pesticide levels to a minimum and predominantly within the soil rather than airborne.

Market Impact

In a market historically characterized by rapid advancements in agricultural practices and an increasing emphasis on sustainable farming, the growing demand for high-yield crops, to support the growing population, has put a spotlight on seed treatment solutions. The seed coating material market has emerged as a key area of innovation and efficiencies.

Sustainability Goals

There is a noticeable shift towards sustainable farming practices, with a growing preference for environmentally friendly and biodegradable seed coating materials. Additionally, key players are expanding their seed treatment facilities and investing in research and development to meet evolving market demands.

Notably, North America and Europe lead in market share, attributed to the widespread adoption of advanced agricultural practices and governmental initiatives promoting sustainable farming. The increasing adoption of genetically modified (GM) crops, rising demand for high-quality seeds and the need for sustainable agriculture practices are driving the growth of the seed treatment market in Brazil and the Asia Pacific region. The projected compound annual growth rate (CAGR) for these regions is over 9%, 4% and 6%, respectively.

In addition to the growing market for seed coating, forecasts indicate significant growth due to the increasing adoption of coated seeds across various crops. Polymer-based seed coating for instance, accounted for over 60% of the market share in 2020, driven by their superior properties such as increased seed germination rates and enhanced nutrient absorption.

II. The Farmers' Perspective

Lack of Awareness
Farmers frequently lack knowledge regarding the advantages of seed coatings in enhancing seed performance and providing pest protection.

Regulatory Hurdles
The approval processes for new seed coating materials can be intricate and slow, thereby impeding innovation.

Cost Concerns
The costs associated with advanced seed coating methods may be prohibitive for certain farmers.

Environmental Sustainability
There is a demand for seed coatings that are environmentally friendly and safe for farmers' health.

Integration Challenges
Farmers and seed handlers require coatings that can be seamlessly integrated into existing processes without necessitating significant equipment modifications.

Roquette and Farmers

Roquette has consistently strived to meet the needs of its customers and consumers while upholding its values and commitment to sustainable development. For over 90 years, plant-based raw materials such as wheat, corn, peas, and potatoes have been the foundation of its solutions, and ensuring their availability in the coming years is a significant challenge. Roquette is convinced of the value in changing agricultural practices to secure these resources and has committed to supporting 20 regenerative agriculture programs by 2030 across all regions where it operates.

Recognizing the importance of healthy soil, which not only provides nutrients for plant growth but also sequesters carbon and improves water quality, Roquette joined Pour Une Agriculture du Vivant (PADV) in 2024. This partnership allows Roquette to collaborate with stakeholders in the agricultural sector to advance regenerative agriculture programs, enhancing climate resilience and promoting innovative models. Additionally, through its support and integration of Vivescia's Transitions Program, Roquette aims to contribute to soil resilience and progress in soil, carbon, and biodiversity by supporting nearly 1,000 French farmers by 2026 toward resilient and productive agriculture. Thus, Roquette works closely with its stakeholders to develop sustainable and innovative seed coating solutions that benefit everyone in the value chain, from farmers to seed-bearers and formulators.

III. Critical Success Factors in Seed Coating Formulation

Success Factor 1 – Transitioning to Sustainable Practices[5,6,7,11,12]

Seed treatment formulations include several excipients, in addition to active ingredients, to ensure on the one hand that the product is stable and on the other that it disintegrates in a timely way, within the ground, releasing active ingredients as required.

Examples of excipient ingredients include:

- Wetting agents
- Colorants
- Coatings
- Binders
- Fillers
- Processing aids
- Disintegrants

These functionalities include improving the adherence of treatment components to seeds, ensuring uniform distribution, minimizing dust-off during handling, and enhancing seed flowability, all without compromising the physiological quality of the seeds. Traditionally, synthetic polymers have facilitated these functions due to their adaptable properties, making them difficult to replace. Seed coatings are an identified source of microplastic pollution, and binders are often fossil fuel-derived, synthetic polymers. Now in light of the scientific data attesting to the hazards of microplastics, formulators are driven to lighten the environmental footprint associated with seed treatment, particularly with respect to synthetic polymer usage.

Plans for wide restrictions in the European Union (EU) on the use of microplastics are likely to directly impact the materials used for seed coating. Going forward, increasing scrutiny of the source, fate and impact of microplastics will increase demand for less harmful, biodegradable alternatives. The EU has taken a significant step toward environmental protection by introducing Regulation (EU) 2023/2055. This regulation specifically targets microplastics, which are tiny synthetic polymer particles that pervade our daily lives. Understanding the context and implications of this regulation is crucial for stakeholders across various industries, including seed treatment.

What are microplastics?

The EU defines microplastics as particles smaller than 5 millimeters in size. These particles are organic, insoluble and remarkably resistant to degradation. They can be found in a wide range of products, from cosmetics to textiles, and even in agricultural practices. Products made of material that is inorganic, natural, biodegradable or soluble in water are not regarded as microplastics. The EU Regulation on Microplastics recognizes the potential hazards associated with dust emissions from treated seeds. By addressing microplastics, it aims to mitigate these risks. Seed companies must now consider not only the efficacy of their treatments but also their environmental impact.

III. Critical Success Factors in Seed Coating Formulations

Success Factor 1 – Transitioning to Sustainable Practices[5,6,7,11,12]

Coming Changes in 2028-2031

Regulation (EU) no. 2023/2055 is poised to introduce significant restrictions on the use of microplastics in various products and applications over the coming years. Beginning in October 2028, the regulation will target plant protection products, seeds treated with these products, and biocides, imposing limitations to mitigate the environmental impact of microplastics.

The regulation sets transitional periods for the ban on the sale of products containing microplastics in the EU. During these periods, companies must adapt their seed treatment practices complying with the new standards:

- **Environmental:** By adhering to the regulation, seed companies contribute to environmental stewardship. Reduced microplastic emissions mean less contamination of soil, water and air.
- **Public Health:** Dust generated during seed handling can affect workers, nearby residents and consumers. Compliance ensures that treated seeds are safe to handle and sow.
- **Market Access:** Noncompliance could lead to restricted market access within the EU. Seed companies that prioritize compliance gain a competitive edge.

As we navigate this transition, seed companies must prioritize compliance, environmental responsibility and public health. In this matter, Roquette is committed to sustainability and responsible use of our products, and our range of seed treatment solutions aligns with the anti-dust and microplastic policy.

The shift toward sustainable seed treatments presents a complex challenge for producers, primarily driven by evolving regulations and an increasing commitment to environmental stewardship. Producers are tasked with reformulating seed treatments to incorporate eco-friendly materials that comply with regulatory standards while maintaining or enhancing the functional properties necessary for effective seed treatment.

However, the transition to sustainable alternatives, such as biopolymers, offers promising opportunities for producers to innovate while reducing environmental impact. Biopolymers, derived from natural sources, are less persistent in the environment and can potentially offer beneficial properties. Intelligent combinations of biopolymers, such as polysaccharides and proteins, may be required to achieve the desired mechanical strength, adhesion, and water resistance.

Biopolymers: Paving the Sustainability Path

Biopolymers have garnered significant attention in recent years due to their potential to support sustainable practices across various industries. In the United States, research clusters focused on biopolymers span domains such as medicine, biochemistry, and food science, exploring their physical and chemical properties, performance mechanisms, and impact on human well-being. Since 2018, there has been a surge in interest in nanoparticle polymers and biodegradable materials, with industries recognizing their potential for environmental sustainability. In the context of seed treatments, bio-based seed coatings have emerged as sustainable solutions, not only enhancing environmental sustainability but also fostering healthier crops.

Biopolymers can be derived from various sources, including plants, animals, microorganisms, and agricultural waste, such as wheat, potatoes, or corn. Their biocompatibility, cost-effectiveness, and distinctive properties make them promising alternatives to synthetic polymers. For example, Roquette's Agriscience team has developed an anti-dust solution using biopolymers, demonstrating their effectiveness in reducing dust and fine particulate matter in industrial and agricultural environments.

Case Study:
Assessing the Performance of Roquette Products for Alfalfa Seed Encrustation

Processes used routinely for seed treatment are shown in Figure 1, along with the different types of coating applied. Film coatings typically account for just 1-3% of total seed mass. They protect from moisture and can be used for coloration, making seeds easier to see on the ground.

Encrusting applies a thicker layer, typically up to 30% of the seed mass, offering additional scope to add nutrients and microorganisms while still preserving the shape of the seed. Pelleting adds most mass to the seed, increasing it by between 15 and 100 times, and transforming seed shape.

It offers even more scope to include a range of ingredients for seed protection and growth, and the resulting regularly shaped pellets flow easily from the drill enabling uninterrupted, closely controlled sowing at the required density. Processing technology for any seed treatment is selected based on coating requirements, practical concerns such as throughput, and the ability to efficiently achieve a uniform product, with minimal seed damage.

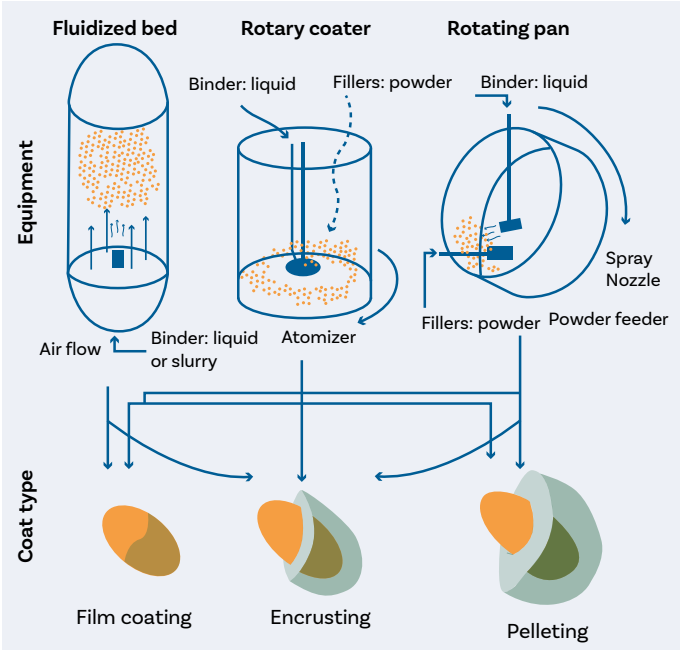


Figure 1: Examples of processes used for seed treatment and the resulting products.

Objective: Assess the performance of Roquette products for encrusting alfalfa seeds.

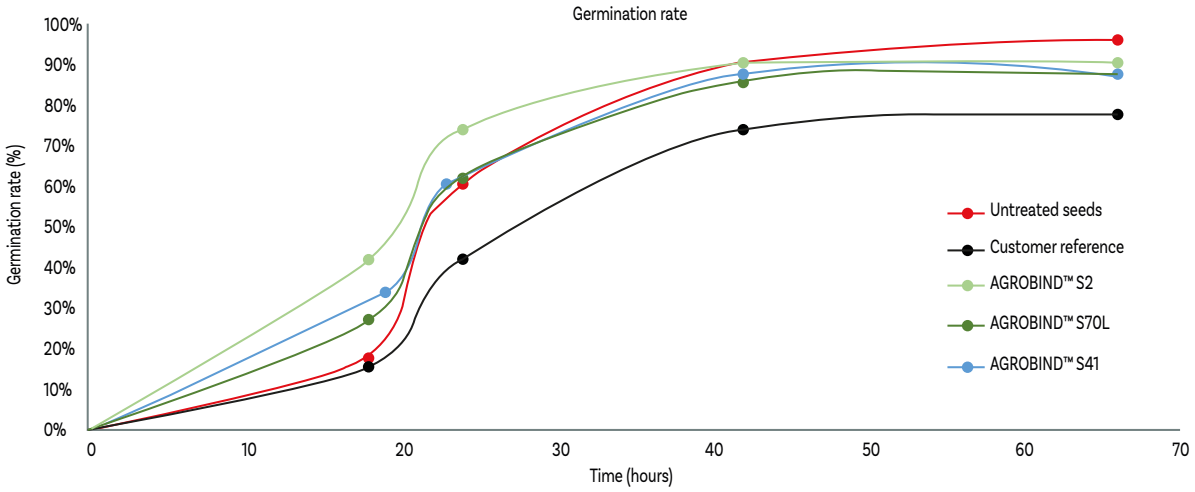
Evaluation:
Firstly, tests were carried out using AGROBIND™ S100L liquid dextrin which was added at different concentrations in the range 30-60% (w/w dry) with the aim of determining the level required to maximize coverage. The balance of the encrusting mix was filler, and the encrusting process was carried out in a rotary coater, sequentially adding dry ingredients and water to produce a stable coating.

Unsurprisingly, increasing AGROBIND™ S100L concentration increases coverage (see figure 2 on the next page), but even at high loadings, coverage is incomplete. A surfactant/dispersant was therefore added with the aim of decreasing the surface tension of the encrusting mixture and improving coverage.

Figure 2 shows the impact of the dispersant in terms of number of covered particles (green line), partially covered particles (amber line) and agglomerated particles (red line). Just 1% dispersant gives optimal performance in combination with an AGROBIND™ S100L concentration of 40%; higher binder concentrations result in agglomeration.

Figure 2: The addition of a dispersant improves coverage. Maximum coverage is achieved with a 1% dispersant level in combination with a 40% AGROBIND™ S100L concentration.

Three other Roquette products, AGROBIND™ S2 thermally modified starch, AGROBIND™ S70L liquid dextrin and AGROBIND™ S41 thermally modified starch, were also assessed for this encrusting application. AGROBIND™ S2 gives good coverage at both 20 and 30%, but the viscosity of the encrusting solution becomes too high for successful processing at 40%; AGROBIND™ S41 exhibits good coverage at 30%.



Binder	Untreated Alfalfa	Customer reference	AGROBIND™ S2 (15%)	AGROBIND™ S70L (70%)	AGROBIND™ S41 (30%)
Thousand Grain Weight	1.98	3.00	2.85	2.92	3.13
H_2O (%)	-	6.1	5.8	6.2	5.6
Abrasion (%)	-	0.46	0.27	0.00	0.09
Observations			Presence of dust Regular shape Full seed coverage	No dust Lower seed coverage	Low dust Good seed coverage

Figure 3 and **Table 1** show summary data for seeds encrusted using the Roquette product formulations (AGROBIND™ S2 , AGROBIND™ S70L and AGROBIND™ S41), the customer reference formulation and for untreated seeds.

Conclusions: Germination data show that the Roquette solutions accelerate germination relative to the reference as well as ultimately delivering germination rates closer to those of the untreated seeds, far higher than those of the reference.

The tabulated data show that it is feasible to make encrusted seeds of comparable weight and water content to the reference, but with lower abrasion, minimal dusting and with significantly higher germination rates. These are beneficial gains to set alongside the better environmental credentials of Roquette products.

Experts' Insights

Nicolas Van Hanja, Seed Specialist at Innoveins

What emerging trends and innovations do you foresee shaping the future of seed treatment technology, and how might they impact producers in the near future?

Emerging trends and innovations in seed treatment technology are poised to significantly shape the future for producers. One key trend is the shift towards sustainable ingredients, utilizing microplastic-free formulations in combination with biologicals. This involves the use of living organisms, protein-based treatments, and other advanced seed treatment products. Currently, the industry is witnessing a rise in the use of microbes, plant extracts, and seaweed extracts. Looking ahead, these developments are likely to lead to more complex formulations incorporating protein components or RNA-based technologies.

The planned ban on microplastics in Europe could indeed signal a broader global trend, particularly if the alternatives prove to be effective. For any replacement to be successful, it must perform similarly to microplastic products. If the alternatives can match or exceed this performance while being affordable and sustainable, they stand a strong chance of being widely adopted.

What are the primary challenges faced by seed treatment producers, and how can they effectively address these challenges to ensure product efficacy and safety?

Seed treatment producers encounter several significant challenges that impact product efficacy and safety.

Firstly, compatibility is a critical issue. It is essential to assess how well a seed treatment product integrates with existing and emerging products in the market. Some seeds are more difficult to treat, and potential compatibility issues can arise, particularly when scaling up from treating 1 kg to 5000 kg due to varying application methods, such as spraying techniques.

Safety is another major concern. In industrial seed treatment factories, the process begins with a controlled application of treatments to seeds, which often involves using solvents. The primary concern at these sites is the potential air pollution caused by the solvents, particularly at high concentrations. However, with water soluble products such as Roquette's products, this might be less of an issue. Once these treated seeds reach farmers, another safety issue arises. Handling or disposing of treated seeds can generate dust. This dust may contain chemicals or spores from microbial products, potentially causing allergic reactions. Minimizing dust generation is crucial for ensuring safety.

The third challenge involves regulatory aspects. Banned products or elements can significantly influence the uptake of active components, which can reduce the efficacy of chemical products and impact their perception in the market. Additionally, the gradual disappearance of many chemical ingredients means fewer molecules are available, necessitating extensive testing of alternatives, particularly biosourced options.

What are the key factors that producers consider when selecting ingredients for seed treatments, and how do these factors influence the formulation and performance of the products?

When producers select ingredients for seed treatments, they consider several key factors that significantly influence the formulation and performance of the products. One major aspect is the technical side, which includes formulation stability across various temperatures and the chemical compatibility of the product. This ensures the treatment remains effective under different storage conditions. Chemical producers focus on the combination of active ingredients and the physical stability of the formulation, assessing how long it can be stored and under what conditions—this is fundamental.

From the perspective of seed companies, germination is crucial because it is a key selling point for their customers. They need to ensure that the treatment does not negatively affect seed viability. Conservation is also important; the chemical load must be balanced to prevent damage to the seeds. If the chemical margins and values are not high, then cost-effectiveness becomes a priority. Producers need to evaluate what added value their treatment provides while keeping the price competitive, as this greatly influences purchasing decisions.

III. Critical Success Factors in Seed Coating Formulations

Success Factor 2 – Balancing Cost and Innovation[12]

The transition to microplastic-free seed treatments represents a promising advancement for environmental sustainability but introduces significant financial challenges due to the requisite research and development (R&D) investments. Producers encounter substantial costs as they endeavor to develop new formulations that comply with regulatory standards while maintaining the performance characteristics of traditional treatments. This process necessitates extensive experimentation and testing to identify suitable biopolymers, optimize their combinations, and refine production processes, ensuring that the resulting seed treatment product is both stable and effective.

The complexity of this development landscape implies that costs can be considerable. Producers must account for material sourcing and testing, as well as potential modifications to manufacturing equipment and processes. These increased costs often cascade down the supply chain, potentially affecting the price of treated seeds available to farmers. As producers strive to innovate while adapting to regulatory changes, the financial burden may impact agricultural economics, influencing farmers' purchasing decisions and operational budgets.

Balancing the cost of innovation with affordability for farmers is a critical challenge. Producers require strategic approaches to minimize price increases while fostering sustainable agricultural practices. This necessitates collaboration among producers, regulatory bodies, and agricultural stakeholders to develop economically viable solutions that align with environmental goals without compromising farmers' financial viability. By working together, these entities can ensure that advancements in seed treatments contribute positively to the agricultural sector, supporting both environmental sustainability and economic stability for farmers.

III. Critical Success Factors in Seed Coating Formulations

Success Factor 3 – Enhancing Health and Safety[8,9,10]

Dust generated from treated seeds can cause respiratory issues and skin irritations among agricultural workers, necessitating stringent industry standards and guidelines. Excessive dust can lead to environmental concerns and health risks for workers handling the seeds. Anti-dust requirements in seed treatment are essential for minimizing dust-off during handling, transportation, and planting, thereby reducing potential health risks to farmers.

The regulatory landscape surrounding antidust requirements is driven by increasing health and safety concerns, environmental impacts, and advocacy from farmer unions and health organizations. Regulations vary across regions, posing challenges in consistent implementation due to technological limitations and compliance costs. Programs like the European Seed Treatment Assurance (ESTA) and the Seed Treatment Stewardship (STS) administered by the American Seed Trade Association (ASTA) play pivotal roles in maintaining seed treatment quality. These initiatives promote safe handling and use of treated seeds, ensuring that seed treatment products are used responsibly.

They achieve this by providing training and certification opportunities for seed treatment applicators, as well as offering guidelines and best practices for seed treatment operations.

By understanding the significance of dust reference values, embracing ESTA guidelines, and employing standardized assessment methods, stakeholders contribute collectively to a safer and more sustainable seed treatment industry. Adhering to these guidelines demonstrates a commitment to environmental stewardship and public health, showcasing dedication to sustainable and responsible seed treatment practices.

Compliance ensures that treated seeds meet safety standards and do not pose undue risks to handlers, consumers, or the environment. Legal dust limits may vary by region, emphasizing the need for harmonization and consistent adherence across borders. Industry laboratories are crucial in ensuring compliance with dust reference values by participating in ring tests or obtaining certification confirming the use of the Heubach methodology. The Heubach Dust Test is a well-established method used to assess the quality of treated seeds, measuring the amount of free dust released from seeds under specified conditions.

Compliance with anti-dust requirements involves using advanced coating materials and application techniques that effectively reduce dust emissions, safeguarding farmers' health while maintaining seed efficacy. Enhancing anti-dust solutions in seed treatment involves assessing dust levels and establishing industry dust reference values to guide practices that minimize dust generation. Ongoing innovation in seed treatment technology offers promising solutions to these challenges, highlighting the need for collaborative efforts among stakeholders to enhance farmer safety and meet anti-dust standards effectively.

Case Study:
Reformulating for Dust Reduction with a Plant-Based Binder[2]

Objective: Assess the feasibility of replacing a synthetic polymeric binder in an existing corn seed coating formulation with a plant-based modified starch.

Table 2: Conventional seed coatings can be reformulated with plant-based binders such as AGROBIND™ S780 modified waxy maize starch.

Formulas	
Product	Dose
Binder	9.15%
Phytosanitary	1.15 g/kg
Fillers	1 g/kg
Water	qsp
Total	12-16-20 g/kg

Reference formula	
Customer Formulation	Dose
Binder	10.85 g/kg
Phytosanitary	1.15 g/kg
Total	12 g/kg

Evaluation: Table 2 provides details of the reference formulation, and the alternatives assessed. The reference formulation is applied at a level of 12 g/kg of seed, 10.85 g/kg of proprietary formulation and 1.15 g/kg of a phytosanitary product, for disease control.

Encrusting applies a thicker layer, typically up to 30% of the seed mass, offering additional scope to add nutrients and microorganisms while still preserving the shape of the seed. Pelleting adds most mass to the seed, increasing it by between 15 and 100 times, and transforming seed shape.

Reformulated coatings were made up as aqueous solutions containing either 9 or 15% of AGROBIND™ S780 modified waxy maize starch and identical levels of phytosanitary product and filler (relative to the reference formulation). These were applied at a dosage rate of 12, 16 or 20 g/kg using a lab-scale rotary coater. Dust-off values were measured using the Heubach dust meter, as previously described.

Conclusion: Roquette plant-based formulations can deliver identical dust-off performance to commercial synthetic formulations for corn coating.

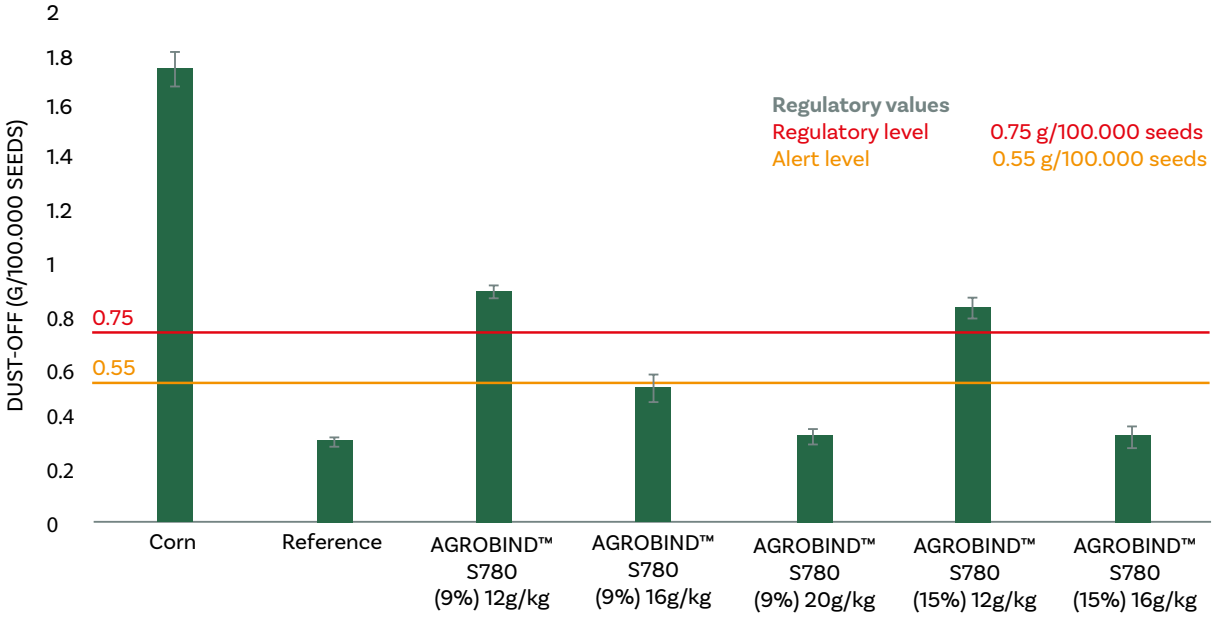


Figure 4: Plant-based formulations can deliver identical dust-off performance to commercial synthetic formulations for corn coating.

Figure 4 shows how the dust-off performance of the formulations compares with untreated seed, with one another, and with the regulatory levels for corn; the customer also applies an alert level to provide an indication of suboptimal seed coating performance. Increasing AGROBIND™ S780 concentration reduces dust-off, as does increasing dosing levels. Performance equivalent to the reference formulation can therefore be achieved with either a binder concentration of 9% and a dosing level of 20 g/kg or a binder concentration of 15% and a dosing level of 16 g/kg. The reformulated coatings easily reduce dusting to below the ESTA reference values.

While these dosing levels are somewhat higher than those required for the reference formulation, they clearly illustrate the potential to use AGROBIND™ S780 to move away from a synthetic formulation with no loss of performance. Furthermore, there may be scope to further reduce dosage levels through process optimization and/or by using alternative coating equipment.

III. Critical Success Factors in Seed Coating Formulations

Success Factor 4 – Transitioning from Legacy Chemicals[13,14]

The agricultural sector is undergoing a transformative shift, driven by the increasing adoption of biologicals and biostimulants. Traditionally, chemical pesticides have played a crucial role in enhancing crop yields and preventing losses due to pests. However, their extensive use has raised environmental and health concerns, such as soil and water contamination, ecosystem disruption, and the emergence of pesticide-resistant pests. These issues have prompted regulatory bodies to enforce stricter guidelines, making it challenging for producers to maintain chemical pesticides in the market. The uncertainty surrounding health hazards associated with pesticide use has further propelled the search for safer alternatives. In response, there is a growing trend towards natural solutions like biologicals and biostimulants in the seed treatment industry.

Currently, seed treatment is predominantly based on chemical treatments, mainly as insecticides, nematicides, fungicides, and fertilizers. However, market insights indicate an increasing demand for biopesticide seed treatments, which are augmented by the use of biostimulants and biofertilizers. The relative importance and status of each type of treatment differ between countries and regions across the globe. Overall, environmental concerns, consumer demands, and regulatory pressures on conventional crop protection products are driving the demand for biological seed treatments, as is the rise in organic farming practices.

Biological seed treatments utilize living microbes, either as a single species, a mixture of selected species, or as a more complex consortium of species, to protect seeds from pathogens, as opposed to conventional seed treatments using synthetic chemicals. These biologicals, which include living organisms such as beneficial fungi (e.g., *Trichoderma*) and bacteria (e.g., *Bacillus thuringiensis*), offer an eco-friendly approach to crop management. These organisms effectively target pests and diseases while minimizing environmental impact.

Biostimulants, derived from natural substances such as humic acid and seaweed extracts, enhance plant growth by improving nutrient uptake and promoting beneficial soil microbial communities. Farmers and seed dealers worldwide are increasingly integrating these natural solutions into their practices. Biologicals and biostimulants not only improve soil health and seed quality but also increase yields and profitability.

Formulating effective seed treatments requires consideration of several key factors due to the diverse nature of seeds and target pests. A thorough understanding of formulating both liquid and solid crop protection products, as well as an understanding of application processes, is essential for developing effective conventional or biological seed treatment formulations.

The physicochemical characteristics of the formulation impact the ease of application to seeds, ensuring active components adhere to the seed surface and maintain active.

Achieving uniform distribution of active components or maintaining CFU (colony-forming unit) counts for bioefficacy is crucial. Additionally, evaluating the risks to operators and the environment is vital when developing new seed treatments to ensure safety and compliance with regulatory standards.

Experts' Insights

Etienne Regost, Chairman of the Executive Board of Exelience

Can you introduce yourself?

I am Étienne Regost, Chairman of the Executive Board of the Union of Cooperatives Exelience, an organization specializing in seed production. Exelience unites several entities, including Advitam, Natup, Noriap, InVivo, Semences de France, and Ucac.

How does a seed station operate, and where does seed treatment take place? What are your needs and expectations regarding seed treatment?

At Exelience, we do not maintain an internal research and development department. Our primary role is to identify future varieties through collaboration with breeders and selectors. Our core activities encompass seed multiplication, preservation, and commercialization.

Multiplication is conducted by a network of selected farmers. Subsequently, preservation ensures seed certification concerning germination capacity, varietal purity, and specific purity.

The final phase is protection which take place in our industrial and secured facilities. Mechanical protection, through the succession of different sorting devices, allows for the elimination of waste, impurities, and diseased or weed seeds. Sanitary protection, thanks to industrial treatment devices, enables precise and homogeneous application of active substances, such as fungicides, insecticides, as well as trace elements and biostimulants, around the seeds.

The scarcity of authorized phytosanitary molecules presents a significant challenge. We are, therefore, testing new solutions such as biostimulants and biocontrol.

What are the most important criteria when selecting seed treatments, and what are the main challenges?

Each new introduction requires comprehensive testing. We depend on trials and experiments conducted by our cooperatives and technical institutes, such as Arvalis. The selection criteria include the compatibility of new products with our industrial processes, their fluidity, density, acidity, and their interaction with synthetic molecules. The interactions between chemical molecules and biocontrol or biostimulation agents are a real challenge. It is also necessary that the new product does not cause the seeds to clump together during sowing.

What are the current trends? What are your thoughts on the incorporation of biostimulants in seed treatment formulations?

The incorporation of biostimulants is an emerging trend. We have tested several products for two years before introducing them into our portfolio. Although biostimulants can provide benefits under stressful conditions for seeds, they do not necessarily offer advantages under normal conditions. Farmers have reported visual improvements in their fields. The desired innovation would be a product that could replace chemical molecules, providing vigor to the seedlings, resistance to storage, and compatibility with our industrial processes.

Which regulations impact you the most, and how do you ensure compliance with your practices?

The most impactful regulations for us are Plant Protection Products (PPP) and the EU Fertilizing Product Regulation (FPR) because they govern market authorization and generate costs for market operators.

At Exelience, we carefully select innovations based on their promise while limiting costs for farmers; we ensure to offer profitable solutions for them.

III. Critical Success Factors in Seed Coating Formulations

Success Factor 5 – Finding the Right Partner

In the dynamic landscape of seed treatment development, collaboration stands as a pivotal success factor, especially when navigating the complexities of updating intricate formulations. As formulators strive to ensure compatibility between bio-based ingredients and active components, the process becomes increasingly sophisticated. A common misstep is the direct substitution of synthetic ingredients—a strategy that rarely yields the desired results. On the contrary, there is a widespread belief that replacing synthetics requires extensive reformulation of other components. However, evidence shows that achieving optimal performance is often possible by streamlining or eliminating previously deemed essential ingredients.

This underscores the critical need for collaboration in replacing synthetic elements within seed treatment formulations. Engaging with an experienced ingredient supplier who has deep expertise in these materials and is committed to guiding you through the reformulation process is essential for success. A strategic partnership can offer invaluable insights and support, enhancing the likelihood of achieving desired outcomes.

Seed treatment formulation demands a diverse array of expertise and capabilities, spanning chemistry, microbiology, and agronomy. These skills are vital to effectively navigating the development pipeline, from characterization to formulation and testing. Ensuring that these capabilities are aligned with the latest global trends and regulatory requirements is crucial, along with the ability to apply new technologies and methods. Partnering with individuals who possess both industry knowledge and scientific acumen enables a nuanced understanding of customer needs across different geographical areas.

Effective communication and project management skills are paramount in maintaining timelines and tracking advancements. By collaborating with teams that complement your internal capabilities, you significantly enhance your prospects for success. A well-chosen partner not only bridges gaps in expertise but also fosters innovation and efficiency, driving the seed treatment development process toward a successful outcome.

IV. Best Practices for Seed Treatment Producers

When choosing plant-based ingredients for seed treatments, producers should prioritize several key factors to ensure successful outcomes. Quality is paramount, encompassing both functional performance and consistency. Some plant-based materials may exhibit variability in performance from one batch to another or across different seasons. Therefore, partnering with a supplier who possesses substantial industry experience is crucial for navigating and mitigating these inconsistencies effectively.

Producers should engage potential suppliers by inquiring about the processes they implement to guarantee consistency and reliable supply. Requesting product samples is advisable to evaluate performance firsthand. Additionally, it's important to confirm whether suppliers provide technical support throughout the development process, ensuring comprehensive assistance and guidance. By adhering to these best practices, producers can make informed decisions that enhance the effectiveness of their seed treatment formulations.

Roquette's Sustainable and Innovative Products

At Roquette, our commitment to sustainable development is at the core of our operations. We prioritize environmentally friendly practices and resource conservation, striving to create a better and healthier future for all generations. By partnering with us, you join a mission to leverage nature's potential to improve, cure, and save lives.

Inspired by life and nature, we unlock nature's potential to develop innovative plant-based ingredients. Using corn, wheat, potato, and pea as raw materials, we employ progressive refining processes to extract consistent, stable, and biodegradable starches, proteins, and other valuable ingredients.

Our tailored approach ensures that we meet the specific needs of our partners, providing high-quality solutions for their formulations. Whether it's for agriscience, human and animal nutrition, nutraceuticals, or drug delivery, Roquette distinguishes itself as a key partner dedicated to sustainable and innovative advancements.

Sustainable ingredients for your formulations

	Soluble fraction	Fatty fraction	Cellulose fraction	Protein fraction	Starch fraction
	Corn steep	Germ	Fiber	Protein	Corn starch
	Potato soluble		Pulp	Protein	Potato starch
	Pea soluble		Fiber	Protein	Pea starch
	Wheat soluble		Bran	Gluten	Wheat starch
			Cellulose		
			Fermentation products		

Figure 5: Roquette creates a range of plant-based ingredients using a progressive refining process that extracts starch, proteins and other valuable ingredients or using them as raw materials for fermentation.

IV. Best practices for Seed Treatment Producers

Solutions Addressing Seed Coating

Roquette offers comprehensive solutions providing **effective and reliable raw materials** for plant nutrition, biostimulation, biocontrol, and seed treatment.

Roquette's **microplastic-free seed coating solutions**, predominantly derived from **starches, proteins and cellulose**, are **designed to minimize dust emissions** during the application process, reducing the risk of inhalation and environmental contamination. Roquette offers many plant-derived products for seed treatments:

- **AGROBIND™ plant-based coating technology is a biodegradable binder with good microbial compatibility, film-forming and binding properties.**
- **NEOSORB® sorbitol range acts as coating systems, bulking agents, binders and plasticizers.** They are quality additives to coating blends.

Table 3: Roquette solutions for seed coating.

Products	Form	Microplastic-free	Biodegradable	Cold water soluble	Type	Seed recommendation
AGROBIND™ S100L	Liquid	✓	✓	✓	Film/Encrust	Corn, Turf
AGROBIND™ S70L	Liquid	✓	✓	✓	Film/Encrust	Turf, Vegetable
AGROBIND™ S780	Powder	✓	✓	✓	Film	All
AGROBIND™ S41	Powder	✓	✓	✓	Film/Encrust	All
AGROBIND™ S4	Powder	✓	✓	✓	Film/Encrust	All
AGROBIND™ S2	Powder	✓	✓	✓	Film	All
NEOSORB® P60	Powder	✓	✓	✓	All	All
NEOSORB® 70/90	Liquid	✓	✓	✓	All	All
NEOSORB® 70/20	Liquid	✓	✓	✓	All	All

Performance can vary based on seed type and may be influenced by co-formulants, indicating that concentration and dosage may require trials. For available test data, please contact the Roquette technical services team. By partnering closely with customers to understand their specific requirements and goals, our team offers expert guidance and support throughout the seed treatment process. Our Customer Technical Services (CTS) team, composed of specialists in agronomy, granulation, and seed coating, collaborates to formulate active ingredients into safe, effective, and easy-to-use products that boast excellent biodegradability and a minimal environmental footprint.

Experts' Insights

Audrey Sahut, Team Leader, Agriscience Customer Technical Services at Roquette

What are the main advantages of working with Roquette?

Roquette, as a global leader in plant-based ingredients, is a strategic partner for seed producers. Our expertise in this field provides us with a significant advantage to be at the forefront of change and to offer our customers innovative, environmentally friendly, safe, and high-quality solutions that meet market expectations and developments.

What technical support do we offer to aid the development of new seed treatments and optimize the use of our ingredients?

Roquette provides technical support through a team of multidisciplinary experts, including chemists, microbiologists, and agronomists, to assist customers in integrating our ingredientsinto their seed treatment formulations. We are committed to sharing our knowledge and expertise to ensure the success of our customers' projects by conducting specific studies and establishing partnerships with universities, institutes, and contract research organizations. These collaborations enhance our offerings and guarantee cutting-edge support for our customers. Our laboratories, equipped with advanced technologies such as rotary coaters, coating pans, and fluidized air beds, enable us to conduct evaluative tests, including dust control using the Heubach test, as well as assessments of fluidity, abrasion resistance, friability, and germination.

How is our range of ingredients evolving to meet new market trends?

Our range of ingredients is adapting to the growing market demand for more sustainable and eco-friendly solutions. Our products comply with the new EU regulations on microplastics, which are expected to be implemented by 2028.

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