Top Interview

Insight Into Requirements, Challenges and Innovations in Formulation and Application Technology

Formulation of Agrochemicals in High Electrolyte Systems
Even greater focus on innovation

Our portfolio is rich with cutting-edge products, and now that we’re Nouryon, we’re putting even greater focus on innovating with our partners to create shared success and lead the way to a more sustainable chemical industry. Agrilan® 1028 is the latest proven solution from Nouryon — an adjuvant for solving challenges in formulating complex products containing fertilizers or organic salts.

Our agrochemical product line includes well-known brands such as Morwet® dispersants, Adsee™ adjuvants, Agrilan® polymers, Armid® solvents.

Contact us at agro@nouryon.com or visit our website nouryon.com/agriculture.
Nouryon: Formulation of Agrochemicals in High Electrolyte Systems

The need to incorporate agricultural actives (ais) in high-electrolyte systems such as fertilizers for in-furrow applications, or in tank mixes for spray applications, provides a significant challenge to the formulator. Many ais have poor water solubility and are often formulated in suspension concentrates (SCs). However, the addition of SCs to a starter fertilizer such as 10-34-0 often result in a rapid flocculation of the system. This is clearly undesirable; farmers require a system that is sufficiently stable to allow them time to complete their application without the risk of blocked nozzles or uneven application.

SCs use a variety of surfactants and polymers to provide a stable concentrate that can be further diluted to the desired application concentration. However, many of the common surfactants used in SCs don’t perform well in high electrolyte systems due to poor solubility or a loss of stabilization due to depressor electrostatic repulsion effects. Phosphate esters are a category of surfactant that shows good compatibility with electrolyte systems and also offers significant flexibility in design allowing their performance to be fine-tuned.

Phosphate esters are versatile anionic surfactants providing a range of performance characteristics. The variety of raw materials and methods of production provide ample scope for fine tuning of structure and performance. Phosphate esters are commonly prepared by reaction of an alcohol with either polyphosphoric acid or phosphorus pentoxide. This always results in a mixture of esters, however, depending on the method used you can get a product with a high level of monoester, or a product with a more even mixture of monoester and diester, Figure 1.

Figure 1. Structure of Monoester and Diester

Polyphosphoric acid yields a product with a high level of monoester which is more tolerant of electrolytes than a monoester/diester blend. As noted in Table 1, the ester distribution impacts the surfactant’s performance; e.g. higher monoester leads to better hydrotroping and greater electrolyte tolerance, whereas increased diester aids in dispersion. Further tuning of the performance can be achieved by altering the carbon chain length of the hydrophobe or by using an ethoxylated alcohol. Ethoxylated phosphate esters have better electrolyte tolerance.

Our initial goal was to identify a surfactant that would provide a stable suspension concentrate that could be further diluted in a 10-34-0 starter fertilizer to afford a stable mixture. To achieve this a fine balance of surfactant properties was going to be required. While much of the effort was directed towards Bifenthrin and Imidacloprid as the ais other actives were also screened, as were other fertilizers.

A significant number of phosphate esters were tested before finding one that afforded a stable SC that diluted well in 10-34-0 fertilizer. Fine tuning of both the process and the structure resulted in Agrilan® 1028. Agrilan 1028 is a phosphate ester based on an alcohol eithanolamine. It has a high monoester content and is both TSCA and FIFRA listed; it also falls under the Reach polymer definition.

In our evaluations we found that the degree of ethoxylolation on the alcohol was critical and that a sharp fall-off in in-fertilizer performance was seen, particularly if the product was over ethoxylolated by as little as one mole of ethylene oxide. A similar sensitivity was seen in the selection of the hydrophobe and alcohols with the same number of carbons exhibited differences in performance depending on their source. Thus, the source of alcohol and the degree of ethoxylolation need to be well defined for optimum performance. For the SC formulations, we found that Agrilan 1028 works best in acid form and its good performance as a wetting agent can eliminate the need for a separate wetting agent.

Table 1. The ester distribution impacts the surfactant’s performance

A comparison of performance of Agrilan 1028 was made against commercial materials recommended for use in electrolyte systems. The comparative examples had the same number of carbons in the hydrophobe and similar levels of ethoxylolation as Agrilan 1028. Despite the similarities, the SC made with the Agrilan showed no separation after 24 hours at room temperature whereas the comparative examples both showed clear separation. When these SCs were diluted in 10-34-0 fertilizer the comparative examples started to phase separate after a few hours while the Agrilan 1028 formulation remained stable for 24 hours, Figure 2. This result confirmed our original findings that the specific alcohol used, degree of ethoxylolation, and method of manufacture are key to achieving stability in both the SC and the fertilizer dilution.

Figure 2. A comparison of performance of Agrilan 1028 was made against commercial materials recommended for use in electrolyte systems

Conventional SC formulations using water as the carrier medium rely on dispersants and thickeners to provide a stable suspension. An alternative to this type of formulation, for in-furrow applications, is to formulate the SC in the preferred starter fertilizer, which then avoids any incompatibility on dilution. We found that by using this approach with Agrilan 1028 we were able to produce a 33% Bifenthrin SC in 10-34-0 fertilizer which when diluted to 3% in the same fertilizers showed no separation after 5 hours of standing. This unconventional approach offers formulators a higher loading of ai than with standard SCs.

While 10-34-0 was our reference fertilizer we also looked at some other fertilizers. Figure 3 shows the results with different fertilizers and actives after 6 hours of standing. For this screening a very basic SC comprising 17.5% of the ai., 8% Agrilan 1028 and 0.3% defoamer was diluted at 2% in the fertilizer. The screening results indicate compatibility with both nitrogen and sulfur-based fertilizers.

Figure 3. The results with different fertilizers and actives after 6 hours of standing

Our initial focus was on in-furrow applications, but we also were interested in tank mix formulations. To evaluate the potential of Agrilan 1028 as a tank mix compatibility agent we looked at a 3-component mixture. For this evaluation, 4 commercial 540K Glyphosate formulations were used alongside 4 formulations utilizing our own actives. Added to these solutions were an Atrazine WDG and a Triflurilin EC. All these 3-way component mixtures flocculated upon mixing. However, this could be avoided by adding Agrilan 1028 – the addition of 0.5% Agrilan 1028 gave full compatibility with no phase separation or flocculation in all 8 cases.

Conclusion

Formulation in high electrolyte systems severely limits the tools available to the chemist. Due to the complexity of many agrochemical formulations the ability to fine tune surfactant properties to meet the formulation challenge is highly desirable. We have seen that some systems can be sensitive to relatively small differences in surfactant structure. Phosphate esters have been shown to be a useful surfactant class for this application due to the variety of structural options they provide and their tunable surfactant properties. Phosphate esters, in particular Agrilan 1028, have proven to be a versatile addition to our toolbox when working with high electrolyte systems.

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Future Requirements, Challenges and Core Competences in Formulation Innovation and Development

“Regarding the formulation technology innovation, an agrochem company core competence should have the following strategies and objectives: 1) developing new pesticide molecules, 2) discovering new biopesticides, 3) design formulations of either single or combo AIs (both new and generic) with the aid of effective, safe co-formulants, and 4) manufacturing the resultant formulation products in a safe and cost-effective manner, which should be deliverable and efficacious for the farmers,” said Roy C. Chen, PhD, former ADAMA US Formulation Team Leader, in a recent interview with AgroPages. He also shared his views on the future development trends of novel formulation and application technologies, regulatory and R&D challenges that affect formulation innovation and development, as well as core competence to drive formulation technology innovation.

**Q1**

**What novel formulation and application technologies are needed to meet the needs for growers over the next 5-10 years in different global regions?**

In the next 5 to 10 years, the worldwide population will demand more secure and reliable food crop production, in terms of quantity and quality, while adjusting to climate change and reduced arable land. The future of novel formulation technological development for agrochemical companies will center around developing not only new AI molecules by R/D companies, but also combo AIs, or so-called hybrid mixture formulations by most generic companies. The latter direction is due to the need to differentiate oneself in local and global market places. Furthermore, there is also a desire to be environment-friendly, while keeping safe and efficient applications, and breaking weed resistance, such as those of glyphosate and triazines, among others. Formulation technology could be part of an integrated approach involving a weeder machine, and crop rotations in conjunction with novel agri-formulations. How about using chemical/biological combo formulations to fight against resistance? For example, one could use certain fungal spores in the formulation. The major formulation challenges lie in dealing with formulation mixtures which are becoming more complex, so do the coformulants needed to make that happen. Usually, these include new functional co-formulants, green solvents, biostimulants and other related adjuvants.

**Q2**

**What are the regulatory challenges to affect future formulations? Could you share some specific cases of how an agrochem company develops agrochemical formulations suited to different global regions?**

As national authorities manage formulation registrations individually, through various local laws and policies, agrochemical producers may face challenges in cases of the same co-formulants which may not be globally accepted. Therefore, separate versions of the same product formulations may be necessary, so do the corresponding tox data requirement. As a result, more resources are needed for registering the same product. By the same token, managing the downstream supply chain issues would be just as challenging and costly. Furthermore, due to different pesticide regulations among countries, there could be issues involving pesticides in international trade. A recent example concerns glyphosate re-registration in the EU. Because glyphosate formulations, particularly those coupled with polyethoxylated tall oil emulsifiers (POEA), have been shown to cause elevated cytotoxic or endocrine disrupting effects, compared to the active ingredient glyphosate. However, this is not an open and shut case for some. Opinions among scientific communities, health officials and environmental authorities/organizations are divided. Essentially, the case touches upon fundamental aspects of risk assessment and product regulation. A very recent news item is that a French court has issued a ban on glyphosate sales in France. Several other countries outside the EU, including Argentina, Australia, Bermuda, Brazil and Canada, are banning or restricting glyphosate use, while the US has not. Because of the glyphosate issues, the fate of POEA Tallowamine coformulant has also been affected. In response, Bayer/Monsanto, the glyphosate formulation manufacturer, is now removing the Tallowamine emulsifier away from all glyphosate formulations. There is also movement in the EU to use alternative weeding methods, in addition to IPM techniques, plus using other safe organic herbicides, such as essential oils, acetic and citric acids, as well as fatty acids, as in soap formulations which may be necessary to help manage post-glyphosate market needs.

**Q3**

**What are the challenges in R&D for new formulations and possible solutions?**

In the broad background of satisfying the overall agricultural production needs in food, fiber and fuel crop productions, farmers usually rely heavily on agrochemicals in modern farming to enhance crop yield, increase plant growth, neutralize the soil, and protect against pests, including weeds, insects, and fungi. The issue is how to increase and optimize the agricultural output in each region through smart utilization of agrochemicals. The corresponding formulation R&D challenges resides in developing new combo formulations, which are becoming more complex to formulate. Take a close look at potential formulation components that a formulator must face; including the chemical active ingredients, wetting agents, emulsifiers, surfactants, dispersants, polymers, solvents, oils, adjuvants, suspension aids, powders, buffers, rheology modifiers, water, adjuvants and more. Their physical and colloidal interactions with one another must be noticed and acted upon accordingly. Obviously, the goal is to have an end formulation product which must be physically and chemically stable in storage, and easily applicable for tank mixing, while delivering the pesticidal efficacies. More challenging are those of agrochemicals and biopesticides. For example, there are biopesticides consisting of bacterial or fungal spores for seed treatments, combined with the chemical insecticide on crop seeds, such as corn, soybean, and cotton. The seed treatment combo formulations may be one of the reasons why the biopesticides market is growing. Prominent examples are BASF’s Poncho Votivo and PV 2.0 (nematicide) and Syngenta’s Clariva Complete (Soybean Cyst Nematicide).

**Q4**

**Could you share some cases of digitalization technologies that enhance efficacy for formulation development / application / delivery?**

As we are living in a digitized world, it is only natural that digital technology can be utilized or considered in agrochemical formulation development, such as data collection and organization for formulation definition and registration purposes. Databases of co-formulants, including their chemical and physical properties, can be searched for data mining. For now, there is still no computer modeling or simulation of agrochemical formulations. Actual formulations still need to be put together physically, according to compositions on the bench for realistic testing and monitoring. This is an area yet to be explored.

A very useful statistical methodology applied to formulation development is the “Design of Experiment” (DOE). It is a well-established systematic approach to create good formulations. There are commercial computer software packages marketed to perform formulation DOE. This statistical method is a powerful tool for formulation optimization, particularly when multiple ingredients are involved to achieve the final performing formulations. Generally, DOE technique is highly recommended, as most formulators have been trained or are used for employing traditional techniques of changing one-variable at a time (OFAT), versus something like factorial designed experiments through DOE techniques.

Other areas of agrochemical digitization start from digitizing lab formulation test equipment, which can be computer controlled and monitored, and examples include lab viscometer and incubators for freeze-thaw tests. Regarding the downstream agrochemical pilot plant operation and the further down-stream production, the associated digitization is expected to follow those of a digitized chemical plant, both in unit operation and unit process. From plant control panel to process unit feedback, modern digital technology can be a great tool, in terms of safety and good quality control. One critically new area for all agrochemical companies to consider is the formulation production simulation for formulation plants. Not only can a normal formulation operation be simulated, but also an inconceivable formulation mishap. A simulation software module can be a cost-effective training tool for pilot scale up and production crews. The final area to consider is formulation plant automation. This can be an effective way to increase productivity, minimize costs and make your facility
operate more ergonomically. Plant automation should be well suited to a stepwise type of processing for a production facility which manufactures agrochemical formulations.

In the near future, delivering formulations to the field will be done by robots in modern farms, usually by Agbots plus flying drones. Accordingly, agrichemical formulations can have higher concentrations, while formulation types and design also can be more versatile, without human safety concerns. For the same reason, formulation sprays can be more flexible, as well.

Furthermore, formulation application can be performed in a high precision manner and be far less polluting to the environment.

What's the core competence to drive formulation technology innovation in an agchem company? What innovation formulation technologies have been launched in the agchem industry?

As far as a modern agrochemical company is concerned, regarding the formulation technology innovation, the company core competence should have the following strategies and objectives: 1) developing new pesticide molecules, 2) discovering new biopesticides, 3) design formulations of either single or combo AIs (both new and generic) with the aid of effective, safe co-formulants, and 4) manufacturing the resultant formulation products in a safe and cost-effective manner which should be deliverable and efficacious for the farmers.

Furthermore, regarding the formulation technology innovations necessary to follow up the above strategies, the agrochemical company needs to excel in the traditional formulation technologies such as the emulsifiable concentrate (EC), soluble concentrate (SC), suspension concentrate (SC), water dispersible granule (WG), and wettable powder (WP) by Improving and optimizing the compositions. Have a pipeline of formulation products each year for the market. Beyond the traditional formulations, other specific formulation types may be considered, such as suspo-emulsion (SE), oil dispersion (OD), and capsule suspension (CS) formulations utilized to deal with the specific cases including physical or chemical incompatibility, bioefficacy improvement, reduced environmental toxicity, etc. Typically, these formulation types require longer time to screen and test. Lastly in the case of microbial spore biopesticides, the up-stream fermentation excipients usually are mingled with the spores in the very formulation mixture, that can be a challenge to the formulators!
Bayer, Corteva Agriscience and ADAMA: Insight Into the Innovation and Development of Formulation and Application Technology

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The agrochemical formulation development is facing significant challenges not only from a technical perspective, but also regulatory and market demands. These challenges facilitate the iterative upgrading of formulation and application technologies. It is worth mentioning that the digitalization technologies are enhancing both formulation development and the application of products. AgroPages recently invited three key players Bayer, Corteva Agriscience and ADAMA in this field to share their views on future development trends of novel formulation and application technologies, challenges that affect formulation innovation and development, strategies of formulation development, digitalization technologies to enhance efficacy for formulation development/application/delivery, as well as innovation formulation and application technologies launched by them.

Q1 What novel formulation and application technologies are needed to meet the needs of growers over the next 5 to 10 years in different regions of the world?

Bayer: New advancements in application technologies, such as drones, direct-injection systems and autonomous field robots, change the way our crop protection products are applied. Improvements in sensor-technology and image recognition, combined with ultra-fast computing power, are allowing high-resolution weed detection and increasingly precise disease and pest prediction, which form the basis of new service offerings for our customers.

The fundamental formulation solutions and approaches will not change. Nevertheless, I believe that the overall relevance of formulation technologies will increase in the future, specifically as the rate of introduction of new active ingredients has declined in recent years. Formulation technologies have to meet increasing regulatory requirements for reducing the environmental impact, such as the reduction of off-target losses, biodegradability and also technical challenges resulting from new active principles such as biocontrol solutions, peptides, and RNA-based or antibody-based solutions. However, this will also help to generate IP and introducing new competitive solutions.

Further advancements in formulation science are key to improve bio-delivery, reduce environmental impact, ease handling and increase stability, particularly in low-volume applications by drones, boom-sprayers and robot applications. These features are quickly becoming key selling points for our customers, and increase the perceived value for important Bayer product brands. Another example of the relevance of formulation technologies are innovative solutions allowing a slow/delayed release of active ingredients, thereby improving crop safety and duration of control in soil or paddy fields. Encapsulation technologies can also reduce the volatility of active ingredients, chemical compatibility and the shelf-life of biological crop protection products. Other formulation technologies aim at reducing off-target losses, such as dust from seeds, drift, wash-off or improving rain-fastness.

Finally, despite their relatively low market share today, biologicals (or biopesticides) will offer clear growth opportunities for our industry in the future. Due to the active nature of biological crop protection products, formulation technology will help to address challenges around shelf-life, formulation stability and the efficacy of these solutions.

Corteva Agriscience: It is an exciting time for agriculture with new advances in active ingredients, biotechnology, application technology and data science all impacting new product development. Despite rapid change in many areas, the macro-level trends continue to be consistent. Growers require convenient products and solutions that maximize yield potential in a cost-effective manner, while enabling them to be good stewards of the land, environment, and human health. Growers will continue to need easy-to-use solutions to address resistance challenges through multiple modes of action. I expect there to be significant growth in naturally-derived and biological control products coming to the market to meet the increasing public and regulatory pull for these types of products, especially in some highly developed regions. Additionally, product sustainability in terms of low use rates, as well as use of low environmental-impact and inherently safe co-formulants, will be prevalent. Application technologies that enable crop protection products to be applied only where needed will also be required to continue to improve the profitability and environmental footprint of agriculture.

ADAMA: Growers today are facing multiple challenges that are driving two primary industry needs.

The first challenge is presented by the growing resistance to the different crop protection products that are being applied around the world. This phenomenon is quite similar to what we’ve seen in the pharma industry – where different bacteria are becoming immune to the antibiotics that have protected the world’s population against illness for decades – although possibly escalating at an even faster rate.

In the AgChem industry, such resistance is posing great challenges to growers. Namely, as pests become more resistant, more products need to be applied at a higher frequency. Clearly, this bears great financial and ecological consequences.

In some cases even increasing application rates and frequency does not effectively control the disease. As a result, output decreases, crops are lost, and prices increase. In fact, there is no part of the supply and value chain that is not impacted.

One example of resistance comes from black grass, a weed that is particularly prevalent in Europe, but also beyond. Black grass grows next to cereal crops, such as wheat and barley, adversely impacting yields. Despite the variety of herbicides applied to combat it, black grass has developed resistance to most products and requires increased application rates of others.

Another example comes from a fungal infection called Asian Soybean Rust, common in Brazil and surrounding countries, including Bolivia and Paraguay. Over the last number of years, this fungal disease has developed significant resistance to existing fungicides and has caused profound economic losses to both farmers and the food chain.

For effective resistance management, plant protection products based on several chemical classes and different modes of action need to be available to farmers. The development of new formulation and application technologies needs to evolve accordingly. We need to be innovative and user-focused in our approach, while balancing the various and competing factors we need to take into consideration, including environmental, regulatory and financial aspects.

While players in the industry are working hard to bring new innovative active ingredients (Alts) to market, the rate of innovation appears to be slower than the rate of the evolution of resistances. As soon as a new product is launched, work on the next one needs to start, if not before.

The second challenge that farmers face is the often adverse public perception of the environmental and health impact of plant protection. As ADAMA we understand that societal
concerns need to be addressed and we also need to be clear that all our products have undergone a rigorous and robust regulatory assessment before being allowed on the market. If applied correctly, plant protection products are an important and safe tool for farmers to help safeguard yields and increase the quality of their produce.

I believe that there has to be a wider discussion on the issues of food and feed production, which should include farmers, scientists, manufacturers, regulators and NGOs. There should be an informed and fact based debate on how to sustainably secure food supply and food safety for a growing population.

So yes, our formulation research and development should address a complex environment, balancing technological, biological and regulatory challenges. This is what makes our job so interesting and rewarding.

Could you share some specific cases of how your company develops agrochemical formulations suited to different global regions?

Bayer: One example is in Europe, as well as the cereal market where EC Fungicide formulations with good leaf activity and penetration of cereal fungicides are needed. In North America, we typically develop liquid formulations, such as SL-type herbicides or non-adjuvanted SC-type formulations, in light of the established strong tank-mix adjuvant market. In the Asia-Pacific region, and especially in Japan, we focus on specialty solutions for rice growers. For example, we develop shaker bottle solutions, granules and jumbo granules, and there is a growing market for drone applications with a need for ultra-low water volumes. In Latin America, where the market is dominated by large farm operations, there is a particular need for the easy handling of products and preparation of spray solutions.

Corteva Agriscience: The development of any new agricultural product at Corteva Agriscience starts with the customer in mind and a clear understanding of local application practices in the targeted markets and regions. Corteva Agriscience has a global R&D presence for both formulation and application technology – in North America, Latin America, Asia-Pacific, and Europe – to ensure that we can easily collect first-hand knowledge of local application practices and test our products under relevant conditions, often in partnership with growers and applicators.

For example, a product that will be applied by backpack sprayer needs to have excellent “bloom” upon addition to water because mixing in the application is uncertain. Products designed for the northern United States and Canada need to disperse quickly in cold water, and products designed for drone application in Asia should have exceptional compatibility at high concentration to maximizepayload. Our scientists take these and many other region-specific considerations, such as typical equipment, water quality, application rates, and storage conditions into account when developing design and testing protocols for both the lab and field to ensure a positive applicator and grower experience.

ADAMA: Our product development process starts with ideation. That is, first we investigate and identify the needs of growers in different regions of the world. We translate these needs into product concepts, and then make decisions about which products we want to develop and prioritize.

A variety of functions are involved in this decision-making process, including local as well as global assets. This ensures that we stay close to the local needs, even as we build on our wider global resources.

Indeed, our product concepts come from the field – literally. It’s not just about headquarters bringing in the ideas and making decisions. The countries themselves are deeply involved.

As a company, we are locally driven and globally backed. We have a presence in 50 countries, endowing us with great access to nurturing mutually-beneficial relationships with farmers. And the result is a product development process that is tailored to meet the specific needs of farmers in every region and key market.

At ADAMA, we invest in both internal and external capabilities. We are expanding our internal resources, and recently opened two new state-of-the-art R&D centers, in Nanjing, China, Hyderabad, India and the recently launched R&D center in Beer-Sheva, Israel.

In addition, we’ve also established more third-party partnerships, in order to accelerate our access to innovative technologies and methodologies.

I would highlight our network of agronomists located in dozens of countries, a number of local formulation labs, including in Israel, India, Brazil, China, and the US.

Beyond resources, I believe that our culture and mindset enables us to react rapidly to change, to be agile, and to innovate in the way we connect the needs of the market to our expertise and ability to deliver on them.

I am proud of how we mold local with global, and apply agility and an innovative spirit to many things we do daily at ADAMA.

Could you share some cases in the digitalization technologies that enhance efficacy for formulation development/application/delivery?

Bayer: Digital tools are enhancing both formulation development and the application of delivery of products. In Development, we use modeling and prediction tools to speed up screening or to simulate operating environments. We are also able to use robot technologies in formulation screening to improve accurate handling and dosing of a large range of active ingredients and formulation inert.

Digital tools are rapidly changing how our products are used. For example, digital weed control is being used on railways. With partners, we have developed a train equipped with camera systems to detect weeds, which opens spray
control of resistant and hard-to-control broadleaf weeds in Enlist E3 soy, Enlist corn and Enlist cotton fields — including Palmer amaranth, waterhemp and giant ragweed. Both products use new 2,4-D choline and Colex-D® technology to help address challenges beyond controlling tough weeds, including minimizing potential for physical drift and delivering near-zero volatility to ensure that the product lands and stays on-target. Colex-D technology also provides applicators the benefit of better handling.

As farmers continue to fight herbicide-resistant weeds, Resicore® corn herbicide brings together three modes of action and a wide rate range to fit a variety of agronomic programs, including pre-emergence and post-emergence. Resicore® corn herbicide gives farmers power over weeds deep into the growing season. With strong residue control and versatile application timing, Resicore controls more than 75 high-anxiety broadleaf weeds and grasses, including waterhemp, marestail and Palmer amaranth. Resicore® was awarded the Agrow Award for Best Formulation Innovation 2016.

Loyant™ herbicide, with Ringskor® active, provides excellent control of ALS-resistant grasses and sedges in rice with an alternative mode of action. The product received a U.S. EPA Reduced Risk designation for its favorable environmental profile and was recognized by the US Green Chemistry Challenge Award. Also, Ringskor™ has been recognized by R&D 100 and by Agrow as the Best New Crop Protection Product. Loyant™ herbicide utilizes novel NeoEC formulation technology, to deliver a similar sustainability profile to water-based formulations, while also achieving many of the benefits traditionally associated with solvent-based formulations, including high efficiency, good stability and excellent handling properties.

Pexalot™ insecticide, powered by Pynassit™ active is a crucial insect management tool specifically for rice farmers in Asia. Pexalot™ can control damaging plant and leaf-hoppers with one application, followed by a different mode of action chemistry, reducing the number of spray applications compared with traditional treatments due to the long-lasting nature of control and excellent rain-fastness.

ADAMA: ADAMA strives to create simplicity in agriculture — with one of the most comprehensive and diversified portfolios of differentiated, high-quality products, we provide farmers around the world with crop protection solutions that help to produce safe and nutritious food for a rapidly growing population.

Soybean rust is a highly impactful disease which causes significant damage. It is particularly destructive since it can develop very quickly, be carried by wind over large distances, and cause rapid, irremovable loss of leaves, with the possibility of causing crop losses of up to 80%. In 2018, ADAMA launched a unique three-way mixture fungicide to combat soybean rust, CRONNOS® (picroxydim + Tebuconazole + mancozeb). Its liquid formulation, CRONNOS TO® provides effective protection for soybean diseases, saves time for growers by strongly adheing to the plants’ leaves and preventing spray nozzles from clogging. Its flexibility provides farmers with further benefit by being able to apply the fungicide at any time during the plant’s development.

BREVIS® (metamitron) was developed with the aim to replicate the known effects of shade thinning on apple and pear trees and is the most effective Carbaryl substitute among all other thinning candidates. It combines a photosynthesis inhibitor and a commonly used fertilizer (Calcium formate). For the last 6 years ADAMA has been testing and improving the formulation of BREVIS® in a wide range of varieties, growing conditions and geographical zones (Europe, Americas, Asia, Africa, and Australasia). BREVIS® is now registered in 23 countries worldwide, with other key apple and pear markets to follow in the coming years. BREVIS® is an innovative product now patented in Europe and other countries globally.
Crop protection chemical products play a pivotal role in controlling the pests and diseases that infect and damage overall farm produce, and can further reduce the quantity and quality of food production. Excessive and unsuitable applications of crop protection chemicals, such as pesticides, herbicides, insecticides, and fungicides, among others, through traditional manual spraying, has resulted in an intensification of hazardous elements in the environment. Moreover, these crop protection chemicals demand high prices, leading to an increase in operational costs. Thus, incorporation of precision technologies for spraying of these chemicals has emerged as an ideal alternative to address the limitations faced by farmers, and to ensure ecological sustainability. This article covers the following points in detail about:

- Major applications, use cases, and downsides of UAV/drones in the agriculture industry
- Stakeholder Analysis: Effect of UAV Based Delivery System on the Adjuvant’s Supply Chain

**Market Consolidation**
Companies are expected to merge, acquire, or partner to offer consolidated drone business solutions. Increased precision will lead to increased market sizes. Credit and insurance companies play an important role in the success of the development and adoption of such technologies.

**Counter Drone Solutions**
Rising need to protect critical infrastructure and ordinary people from malicious drones is expected to fuel advancements in anti-drone technology and increased awareness about drone threats.

**Drone-as-a-Service**
Aiming for affordable drone solutions, an increase in number of service providers for drones is expected thus lowering the entry costs associated with the drone technology.

**Regulations**
As the drone industry matures, formidable advancements in strengthening the regulations across the globe is expected. Major developments from FAA and EASA in Europe are being speculated.

**Artificial Intelligence**
Rise in AI driven drone solutions, especially for data analytics, aerial mapping & imaging is expected to drive the drone industry for autonomous solutions.

**Business Expansions**
Companies are expected to expand their business solutions across end-user industries. Internal teams shall also expand to manage large data & workflows.

**Adjuvant & Crop Protection Chemical Manufacturers**
Make use of the real-time information received from UAV in this farm for better decision-making.

**Credit and Insurance Companies**
Expand market presence in by partnering with various farm cooperatives and agriculture consultants.

**Agronomists/Distributors**
Provide financial services for drone/UAV procurement and judge the credit worthiness of the farmer.

**UAV/Drone Manufacturers**
Enter strategic partnerships with drone manufacturers and expand existing product lines.

**Use Cases of UAV Delivery System and Application in the U.S., India, and Africa**

The U.S. is currently at the forefront of the global agricultural adjuvants market, with the Federal Aviation Administration (FAA) dictating the use of UAVs for farming operations in the country. The Yamaha RMAX, an unmanned helicopter developed by the Yamaha Motor Company, is being used in the USA. It consists of a two-bladed rotor and is remote-controlled by a line-of-sight user. Initially used only in Japan for agricultural spray applications, the UAV is now approved for operations in Japan, Korea, Thailand, Australia, New Zealand, and the U.S. Another renowned Chinese drone manufacturer, Dji, has introduced the Agras MG-1, designed for precision variable rate application of pesticides. The company is now working on automating these UAVs to apply chemicals to broadacre crops.

Likewise, in India, a farmer from the state of Haryana deployed customized drones that can aerially spray pesticides on crops. These drones (still unnamed) are of two versions - manually operated and automatically operated, and can carry a 35 kg load.

Even in Africa, some 26% of the countries have stringent regulations governing the use of UAVs. Countries such as South Africa, Mauritius, Rwanda, Morocco, and Tanzania, among others, have successfully deployed UAVs for inspecting crops. In Morocco, OAS is used primarily for efficient application of crop protection chemicals. Les Domaines Agricoles, the largest Moroccan agribusiness, is one such company, which is utilizing UAV technology and image data analytics to ensure effective fertilization.

**Stakeholder Analysis- Effect of UAV Based Delivery System on the Adjuvant’s Supply Chain**

UAV/Drone providers effectively contribute a large value to the entire crop supply chain. Spraying of crop protection chemicals for disease, weed, and pest control is currently one of the emerging applications of drones in the agriculture sector. Drone manufacturers are expanding their market capabilities in this industry by partnering with various farm cooperatives and agriculture consultants.

Farmers use real-time information extracted with the usage of UAVs to plan their cropping cycle, and also for better decision making. Though the initial cost of implementation is high when compared to the benefits/results received from this technology, UAVs as a viable technology is a justified investment.

Adjuvant manufacturers and companies providing crop protection chemical products can reduce wastage of their stocks and pre-plan accordingly through this data-driven approach.

Credit and insurance companies play an important role in the crop cycle, considering that majority of farmers’ livelihoods are largely dependent upon farm produce. Crop insurance protects farmers against any form of loss caused by crop failure, while credit institutions provide much-needed credit to them, to purchase technologically advanced products and utilize their efficient inputs.
Adjuvants are primarily used in the agricultural industry to improve the performance of insecticides, pesticides and herbicides, which further improve the effectiveness of the crop protection chemical and help in providing better distribution and drift reduction. As per a report by BIS Research, the global agricultural adjuvants market is expected to grow from $2.8 billion in the year 2016 to $3.6 billion by 2021 at a CAGR of 5.5% from 2016 to 2021. Companies such as Adjuvant Plus Inc., DRO AGRI, Helena Chemical Company, Wilbur Ellis Company LLC, Solvay AG, Nufarm Ltd., Momentive LLC, Akzo Nobel Inc., BASF SE, Evonik Industries, and Elkem Silicones, are the key players operating in the agricultural adjuvants market.

The potential of adjuvants and formulations to reduce spray drift can be judged by measuring spray droplet sizes at different concentrations. Thus, ensuring the selection of the correct adjuvant for spraying though UAV’s is one of the main practices adopted to reduce the negative effects of spray drift.

Downsides of UAV Delivery System for Spraying Purposes

One major downside of deploying UAVs on farms for spraying or other purposes is the exceptional high cost of fully equipped UAVs, including sensors, radars, and related hardware and software. The high prices further increase when combined with the cost of acquiring technical skills and knowledge of piloting UAVs. Though cheaper UAV options are also available, these are primarily ill-equipped and inadequate for farming operations. In the majority of cases related to UAV equipment, increases in the performance directly proportional to the rise in prices.

Another key concern for users about UAV’s is privacy. A UAV can gather data without being detected, leading to the risk of breach of privacy. There also exists certain safety concerns while dealing with UAVs, hence, these should be equipped with sensors-and-avoid systems to prevent potential collisions.

Rules and regulations for the use of UAVs for agricultural purposes vary across countries. For instance, the use of UAVs for farming purposes is considered a commercial activity by the Federal Government of the U.S. Farmers need to undergo operator training from the FAA and receive a certification in order to qualify for a remote pilot license. It is mandatory for remote pilots to adhere to a specified altitude for UAVs flights, failure to which can lead to heavy fines and penalties.

According to Pest Management Regulatory Agency (PMRA) by Health Canada, spraying a pesticide with the help of a drone/UAV in Canada is still not allowed under the Pest Control Products Act. One needs to apply to PMRA with data stating the added hazards and risks, in order to receive approval.

UAV- The Future of Pesticide Spraying

With the help of current advancements in drone technology, spraying is the one application of UAV technology that is currently witnessing unprecedented growth in the agriculture industry. Deployment of drones in the agriculture sector is gaining at a high rate of acceptance by farmers across the globe. Drones have enabled farmers to gather invaluable data to further augment profits and productivity, along with alleviating environmental hazards. As per a report by BIS Research, the global agriculture drone/UAV market generated over $950 million revenue in 2018, out of which the spraying application of UAV’s held approximately 9% of the market value.

The use of drones for various pesticide spraying applications leads to an efficient input of resources by farmers and allows for timely protection of crops from pests. The end users are rapidly identifying the benefits of the efficiency and affordability that drones provide to secure high yields and quality crops. The demand for drones for pesticide spraying is expected to further rise in the upcoming years. However, privacy and safety are still a cause of major concern for farmers. Addressing issues related to privacy, safety, and security can assist in the successful implementation of this technology.

UAV technology has effectively bestowed upon users innumerable benefits, which makes it worth taking a risk. Farmers would be able to save time, energy, and money in crop production, along with drone technology effectively working in tandem with environmental protection and efficient degrees of productivity.

Table 1. Adjuvants Compatible with UAV Application

<table>
<thead>
<tr>
<th>Adjuvant Name</th>
<th>Manufacturing Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siwey Low Drift Adjuvants</td>
<td>Momentive Performance Materials Inc.</td>
</tr>
<tr>
<td>AgRH0 Aero-mate 320</td>
<td>Solvay S.A.</td>
</tr>
<tr>
<td>Mafai</td>
<td>Beijing Grand AgroChem Co., Ltd.</td>
</tr>
<tr>
<td>TIS 331</td>
<td>Jiangxi TianSheng New Materials Co., Ltd.</td>
</tr>
<tr>
<td>Pineye Emulsion</td>
<td>Foreverest Resources Ltd.</td>
</tr>
</tbody>
</table>

*Source: Secondary Sources and BIS Research Analysis*
teri-deakin nanobiotechnology centre: theoretical and experimental procedures for non-nutritive fitness and its application practices

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Introduction

Nanotechnology has the potential to deliver novel products to improve the performance of vistas, especially in agriculture and allied sectors. According to TERI’s press release entitled, “Are Natural Alternatives to Pesticides and Fertilisers by Nanotechnology Safe?” (2018), various industries, from biotechnology, agrochemicals, pharmaceuticals, and health, as well as the food sectors, seem to be on firmer footing to use the cutting edge technology using nanoscience. Considering its wide range of uses, the global nanotechnology market is likely to develop at a CAGR of around 17% during the forecasted period of 2019-2024. This will provide a great opportunity for research institutes to develop and collaborate with industry and stakeholders to seek inroads in the fast growing market, which would garner enormous revenues on the back of commercialization of the technology. However, nanotechnology is a multidisciplinary branch of science and needs groups of experts from several disciplines to deliver complete solutions to varied problems to allow it’s safe, efficient and cost-effective commercialization.

In terms of agriculture, nanotechnology represents a new frontier by offering potential applications in the field of nanofertilizers and nanopesticides, jointly referred to as “Nanonutrifights”. This dissection approach of agri-nanotechnology has not only revolutionized agriculture with innovative nutrients, in the form of nanofertilizers (NFs), but also protects plants from phytopathogens. According to leading R & D analyses, research in agricultural nanotechnology applications has been on-going for much of a decade, searching for solutions to several agricultural and environmental challenges, such as sustainability, improved varieties and increased productivity. Several institutes have shown the growing trend of both scientific publications and patents in agricultural nanotechnology, especially for disease management and crop protection. The nano based delivery system for delivery of “Nanonutrifights” will offer a very cost effective approach, with the enhanced efficacy of active principles. Nano based system in agriculture attempt to reduce the dose of active ingredients, minimise nutrient losses and increase yields through optimised water and nutrient management.

Problems with existing technologies and corresponding solutions

Agrochemicals are the chemical products composed of active ingredients that are used in agriculture as fertilizers and pesticides, to enhance the productivity of plants and management of plant diseases, respectively.

The disproportionate use of agrochemicals in high concentrations has led to the contamination of soil and groundwater by entering in the food chains, causing hazards to humans and animals. In addition, the runoff (or leaching from the soil) of agrochemicals into water resources can cause an adverse impact on the life-cycle of fish and other aquatic animals.

There is a large list of hurdles associated with conventional pesticides, such as non-biodegradability, resulting in long time persistence of pesticides in the field, frequently drift away (due to wind or air convection arrays) from the targeted field, high doses required because more than 30% of effective doses leach out from the soil, off target applications that contaminate much wildlife. Furthermore, conventional agrochemicals might not be helpful under these circumstances, as these have become expensive due to high energy requirements and being environmentally unsafe (Figure 1).

To address these limitations, the exploitation of the nano-based delivery system could be a promising alternative for sustained release of agrochemicals, to maintain the desirable activity and alleviate the potentially damaging impacts on the environment.

Recent translational innovations in the field of nanotechnology have transformed the world with distinctive nanomaterials, such as “Nanonutrifights”, and increased growth and productivity of crops. These forefront applications require the appropriate chemical functionalization of nanoparticles with organic molecules, or their absorption in an appropriate polymer matrix for sustained release. The polymer based nanocomposites material is a ground-breaking product, offering nanofillers dispersed in the matrix of polymers, and has received much attention recently. We have developed biodegradable and biocompatible chitosan-metal nanocomposites with prolonged antimicrobial activities of metals (copper, silver and zinc oxide nanoparticles) and lower toxicity toward mammalian cells. Various attempts have been made to improve the antimicrobial activity of active ingredients, such as structural modification, adjustment of molecular factors, and forming complexes and their sustained release using nano based delivery systems. In practice, agrochemicals have been modified with the help of nanotechnology as “Nanonutrifights”, which are considered alternative routes to conventional fertilizers and pesticides.

Figure 1. Schematic representation of use of nanotechnology innovations helps in the delivery of agrochemicals in plant systems and soil
The National Centre of Excellence in Nanotechnology for Agriculture and Environment and National Facility for Toxicology, Life Cycle and Regulations at -TERI-Deakin Nanobiotechnology Research Centre (TDNBC), supported and funded by the Department of Biotechnology, India, is committed to sustainable activities and practices to reduce environmental hazards of agrochemicals, which is one of the globally defined challenges, and engaged in various research activities, such as synthesis of nanopesticides and nanofertilizers, and their encapsulation using eco-friendly nanomaterial with prolonged activities, providing benefits to the plants beyond basic nutrition. In addition, TDNBC has been developing smart delivery systems loaded with nano-forms of iron and zinc, primarily focusing to reduce the loss of active ingredients in conventional delivery systems due to volatilization or chemical reactions, microbial degradation, etc. Developing such nano-carriers can contribute to minimizing these losses. Furthermore, we have developed plant nutrients from industrial waste and will be the initiator to offer such an innovative approach towards providing sustainable solutions in agriculture around the globe. Also, we are participating in advanced research by developing more stable “nano-emulsions” of pesticides having increased efficacy with lower application rates and controlled release.

**Future development prospects**

In order to improve the prevalent properties of agrochemicals, interactions between agrochemicals and plants can provide vital clues for the development of the translational technology, which can further generate significant benefits to farmers by improving field performance and reducing input expenses, not only in terms of cost, but also by reducing application losses. In the agrochemical sector, there are two main key players, industries and research institutes. Research institutes have robust capabilities to develop “nano-actives” or “nano-formulations” and industries typically deliver the product from research laboratories to the market. Moreover, both players can progress effectively and find better solutions for sustainable agriculture with nanotechnology.

We have also been developing next generation agro-products, such as nano fertilizers, nano-pesticides and nanocarriers, with their complete life cycles, toxicity and regulatory assessments for agricultural use and increasing our research and market capabilities for ongoing growth in the agricultural field. There are various methods and technologies that have been developed by TDNBC for increased production, market access, and promoting sustainable farming practices. TDNBC is looking forward to creating collaborative research platforms which will be ready to translate its knowledge base at the grass root level, together in a coordinated fashion. The collaboration between TDNBC, TERI, New Delhi and industrial partners will create solutions in sustainable agriculture throughout world using nanotechnology.

The TERI-Deakin Nanobiotechnology Research Centre (TDNBC) offers to join in and support the government’s vision to promote and assist further in implementing innovation and translational research". said Alok Adholeya, senior director (sustainable agriculture) at TERI, New Delhi, India.

**Vision**

Research in frontier areas of precision and smart agriculture, through innovative disruptive nanotechnology, might be the most promising step which may replace hurdles of existing agrochemicals. Understanding the development of these technologies and their applications, as well as public acceptance and societal impact in the coming era, will be crucial in bringing nanotechnology to the market to provide better and more sustainable solutions.

**About TERI-Deakin Nanobiotechnology Centre (TDNBC)**

The TERI-Deakin Nanobiotechnology Research Centre (TDNBC) was established in 2011 by The Energy and Resources Institute (TERI), one of country’s leading think-tanks, in collaboration with Deakin University, Australia, with the directive of developing ground-breaking nanobiotechnology centred solutions to address current challenges in the field of agriculture and environment. Conjointly supported by both organizations, the Centre aims to take global platforms through nanobiotechnology interventions in agriculture, environment, and energy, by developing multidisciplinary methodologies, tools and technologies.

Considering the importance of translational research in agriculture and environment, the Centre is uniquely poised to develop disruptive technologies using biocompatible nanomaterials. Such events are being brought together through strategic alliances with Deakin University and partners worldwide.

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**Sulphur Enhanced Zinc Fertilizer**

**FERTIS**

Agricultural Elemental Sulphur 98% - Microgranules

**TECHNO-Z**

World First LOWDENSITY ZINC FERTILIZER

- Trademark Brand Crop Protection & Nutrients, serving Global Farming needs
- One of the world’s largest ultra-modern manufacturing capacity of environmentally friendly, high quality and economically efficient formulations of Zinc, Ga, Cu, Cr, S, & Sa
- A dedicated State-of-the-Art R & D Centre with expertise in developing low-density fertilizer platform technology with global patent Portfolio
- Global Market Presence: Expanding five continents across a robust, versatile network throughout the length and breadth of India
- Fertilizer regulatory team handling global data generation and registrations

**Sulphur Mills Limited**

- Product Branding
- Sulphur Mills Business Segments
- Institutional Business
- Specialty Contract Manufacturing
- Public Health & Household Business
- Nutritional Business
- International Crop Protection Business
- Biological Business
- Pan India Presence
iFormulate: The Challenges of Biopesticide Formulation

Dr Jim Bullock
Director and Co-Founder at iFormulate

Aided by a favourable regulatory climate, as well as by concerns about conventional pesticides, the biopesticide market continues to grow. The global market is projected to grow from USD 3.0 billion in 2018 to USD 6.4 billion by 20231. Alongside continues to grow. The global market is projected to grow from concerns about conventional pesticides, the biopesticide market biopesticide growth.

• To ensure that the product can be used in a way that is safe for the user and the environment, and that it complies with regulatory requirements;
• To provide a robust process by which the finished product

can be manufactured and packed with a low level of manufacturing defects.

So where do the challenges of biopesticides lie, and do these challenges present any barriers to their further growth? Taking the category of naturally derived bio-chemicals and biological extracts first, these can essentially be formulated in a similar way to conventional synthetic chemical actives. The main additional challenge is that these compounds tend to be less chemically and physically stable than synthetic compounds. Peptides and enzymes, for instance, are prone to denaturing when exposed to heat and may readily degrade in acidic conditions. Therefore, for instance, it may be necessary to use formulation technologies, such as microencapsulation, to protect and deliver the active ingredient effectively or to include a UV-stabiliser to protect the active ingredient against photo-degradation.

In all cases, one very critical task is to ensure that any co-formulants used (e.g. surfactants, oils, solvents, carriers, binders, fillers, humectants, preservatives, etc) are chemically compatible with the active ingredient. Stability apart, however, actives in this category of biopesticides can be formulated similarly to synthetic pesticides. The formulator then needs, first, to consider the key physical properties of the active ingredient when selecting the formulation type, e.g.:

• Water-soluble actives may be formulated as soluble liquid concentrates (SL) or soluble granules (SG);
• If a liquid product is desired, water-insoluble actives may be formulated (with an oil if necessary) as emulsifiable concentrates (EC), oil-in-water emulsions (EW) or microemulsions (ME);
• Active ingredients which are solid at room temperature can be formulated as water-based suspension concentrates (SC) or may be combined with co-formulants to produce water dispersible granules (WG) or wettable powders (WP), which will disperse readily in a spray tank. If a fine particle size is required, usually only those actives which are heat-resistant and relatively high-melting can be milled before formulation;
• Actives which are solid but are water-sensitive can be formulated as oil dispersion (OD) formulations which then require further emulsifiers in order to disperse the oil phase in the water of the spray tank;
• As mentioned earlier, actives which need to be protected in some way or where the release needs to be controlled can be formulated as microencapsulated suspension (SC) formulations.

However, the formulator has to consider the categories of biopesticides based on living organisms very differently from the naturally derived bio-chemicals described above. In the case of microorganisms such as bacteria, the objective is usually to ensure that the active organism is kept alive but in a dormant state during manufacture and storage, but on application it must be viable to then reproduce and become effective when applied to crops.

If the organism is not dormant in the formulation, then there is a danger that the culture will rapidly reproduce and consume any nutrients present and die out while still in storage. In addition, a living and growing culture can produce undesirable by-products, gas and odour during storage. For this reason, the simplest approach is often to reduce the water activity of the formulation to a low level, so that the organism will not reproduce on storage. Prior to formulation, the starting point is normally a water-based suspension of microorganisms. This suspension can be dried by methods, such as spray drying and freeze drying, in a way that does not cause heat damage. Then, solid final formulations with a low moisture content, such as granules (WG, GR) and powders (WP, DP), are often preferred. Additionally, to ensure initial microbial growth on application, nutrients such as carbohydrates may be added to the formulation.

On top of these considerations, the compatibility and stability of microbial actives need to be considered in the same way as for biochemical and synthetic chemical pesticides. So, the co-formulants used need to be selected, with aggressive solvents and extremes of pH being things to be avoided.

Protection of microorganisms during formulation and afterwards can be enhanced by the use of encapsulation technologies. There is a huge variety of possible methods to do this, here are just two interesting examples:

• The popular microbial biopesticide Bacillus thuringiensis (Bt) can be encapsulated, using a technique called Pickering emulsions, whereby emulsions are stabilised by solid particles2.

The resulting formulations were shown to perform better than conventional Bt formulations. The co-formulants used for the encapsulation were relatively innocuous, from a safety and environmental point of view (acrylic particles, sunflower oil, iron oxide nanoparticles, ethanol);
• The UV resistance of the fungal bio-insecticide Beauveria bassiana has been improved by the use of feruloylated soy glycerides (FSO), which were subsequently encapsulated in starch3. Additionally, soluble lignin was used as a spray tank adjuvant to protect against UV. Again, the use of environmentally benign co-formulants is favourable for the safety profile of biopesticides.

Increasingly, bio-derived active ingredients are being formulated, together with conventional synthetic pesticides. One example of this is REGEVe™ from STK. The two actives are a biofungicide based on a plant extract (Tree Oil or TTO), as well as diferencozonacil, a conventional synthetic fungicide. The relevant patent4 claims that the TTO is delivered in the form of an oil-in-water emulsion. The patent also claims the use of TTO with a large number of fungicides – so perhaps further new mixtures are to be expected.

Biopesticides and conventional pesticides are also being formulated together in seed treatments. Poncho®/VOTiVO® (now being marketed and sold by BASF) combines the systemic insecticide clothianidin with Bacillus firmus I-1582 in a seed treatment. The clothianidin is immediately absorbed by the roots and the Bacillus firmus I-1582 forms a barrier around the seed. It is claimed that this protects against up to two generations of nematodes5.

In conclusion, the potential incompatibilities between conventional synthetic active ingredients and microorganisms, as well as other bio-actives, can clearly present challenges to the formulator - who may also have to deal with issues, such as UV-stability and the delivery of microorganisms. In addition to dealing with the usual challenges of efficacy and stability that the formulator has to handle for all kinds of crop protection products, it is clear that formulation will have a very significant role to play if the market for effective bio-control products is to continue to grow at a rapid rate.

5. BASF: https://agriculture.basf.com/us/en/Crop-Protection/Poncho-VOTiVO-2-0.html
Stepon: Next Generation Compatibility Agent for Today’s Complex Tank Mix Systems

Over the past couple of decades, it has become increasingly common, if not necessary, to combine multiple crop protection products into one spray application. Beyond the obvious advantages of time savings and reduced application costs, this strategy combats the ever-present challenge of pest and pathogen resistance by employing multiple modes of action (MOA).1 Leading crop protection companies implement MOA by combining several active ingredients into one formulation. In cases of single-active ingredient formulations, growers will tank mix multiple crop protection products to achieve the same desired MOA effect.

Regardless of approach, today, spray tanks increasingly contain more active ingredients than in years past, leading to a delicate system between tank partners. Further complicating matters, growers will often use liquid fertilizer as a carrier in place of water to gain even more efficiency. Given the complexity of modern crop protection strategies, it’s not surprising to see a rise in compatibility issues surrounding tank mixtures.

These incompatibilities can occur between active ingredients, but more commonly arise when formulations are diluted into liquid fertilizer, where hydrophobic organic molecules and water-soluble salts are at odds with each other. These incompatibilities can present in many forms, including the formation of particles or gels that rapidly settle out of suspension, separation of the mixture into layers, or excessive foaming. As one might imagine, spraying an incompatible mixture can result in a loss of efficacy before and/or after they arise. Our research has determined that more than 75% of commercial compatibility agents are based on nonylphenol ethoxylates (NPEs).4 NPEs have been the backbone of compatibility agents for decades and remain dominant in the market due to availability and low cost. However, while NPE-based compatibility agents are effective in simple tank mixtures, they have marginal performance in complex systems. As incompatible systems have become more challenging, innovation has staled in the development of new compatibility agents that can meet the demands of tank mix systems today. Furthermore, NPEs have well-known environmental and health concerns, resulting in their use being slowly phased out across the agrochemical industry.

Considering today’s complex nature of tank mixtures and regulatory concerns surrounding NPEs, Stepan saw a need to develop a next generation phosphate ester compatibility agent. We believe the market has yet to take full advantage of the immense potential phosphate esters offer, given the ability to tune monoester/diester ratios, select from a wide range of hydrophobes, and vary the degrees of ethoxylation (Fig. 1). Thus we launched an initiative to study these parameters in detail to find the optimal phosphate ester, then leveraged our experience in formulation development to further enhance performance with additional additives to produce a top market compatibility agent.

With access to a wide array of hydrophobes, we synthesized and screened more than 70 unique molecules, identifying trends for each parameter. Each iteration was evaluated in nine incompatible systems containing a formulated pesticide and fertilizer. Our screen included a variety of formulation types, including emulsifiable concentrates, suspension concentrates, and soluble liquids. Performance was assessed based on the number of incompatible systems a phosphate ester was able to improve.

The first parameter that we studied in detail was the phosphate ester’s monoester/diester ratio. Phosphate esters with either high monoester or high diester content were evaluated across multiple carbon chain lengths and moles of ethylene oxide. The results demonstrated that high monoester containing phosphate esters were equivalent or better than their high diester counterparts across all systems, regardless of hydrophobe or moles of ethylene oxide (Fig. 2). This suggests that the more hydrophilic nature of monoesters enhances solubility in high electrolyte environments. For the rest of the study, we chose to work with only high monoester phosphate esters.

Next, we studied the effect of ethoxylation across various carbon chain lengths. Performance was found to improve when a lower degree of ethoxylation was employed and was not dependent on carbon chain length (Fig.3). As moles of ethylene oxide were increased, the effect on compatibility became more variable based on a specific incompatible system and phosphate ester molecule. There appears to be a minimum degree of ethoxylation required for water solubility and broad-spectrum performance, beyond which performance begins to deteriorate as ethoxylation levels become too high.

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Last, we evaluated a range of carbon chain lengths at multiple degrees of ethoxylation. An optimal carbon chain length was identified that displayed peak performance for all ethoxylation levels (Fig. 4). Combined, these trends led to a final phosphate ester with high monoester content, a low degree of ethoxylation, and an optimized carbon chain length.

With our top performing phosphate ester defined, we leveraged our formulation expertise and extensive portfolio of inerts to further enhance the compatibility performance. The phosphate ester was paired with an array of secondary components, including emulsifiers, wetting agents, and other compatibility aids. Light scattering measurements were implemented to track instability over time and identify the most stable formulation candidate (Fig. 5). Ultimately, optimized secondary components were identified and found to significantly increase the performance of the phosphate ester, leading to our new tank mix compatibility blend, TOXIMUL® CT.

TOXIMUL CT was tested against commercially available compatibility products (Fig. 6a). The commercial products all contained phosphate esters as their primary component, many of which were NPE based. The results demonstrate that TOXIMUL CT provided superior compatibility performance over current commercial solutions in high electrolyte systems. For situations where incompatibilities between active ingredients were observed, we also saw an improvement using TOXIMUL CT. For example, compatibility is significantly improved in an atrazine/paraquat system with TOXIMUL CT over competitive products (Fig. 6b).

In conclusion, TOXIMUL CT is an excellent option for solving difficult compatibility issues over a wide variety of tank mix systems. In the design of this new blend, we evaluated more than 70 unique phosphate esters and screened more than 2,000 incompatible systems to find the best product. TOXIMUL CT is an innovative solution that can help meet the demands of today’s increasingly complex spray tank mixtures.

References:
Dow: High Performance Oil Dispersion Adjuvant Development

Dr. Wei Lu
Dow Inc., Industrial Solution, APAC

Evan Ren
Dow Inc., Formulation Science, Core R&D, APAC

Oil dispersion (OD) formulation is an emerging formulation in Ag industry, which is claimed as environmental friendly, better pesticide efficacy than water-based formulation. Because the continuous phase is oil, like methyl oleate, methyl soyate, it shows high affinity with plant leaves, thus providing better spreading, wetting and penetration performance. However, the existing OD products have common issues of inadequate long-term storage stability, phase separation and caking in the bottom after several months storage. This hinders the booming development of OD formulation. Therefore, it is of high importance to explore high performance adjuvants of emulsifier, dispersant and thickener, exclusively used in OD formulation, promoting the industry technology progress.

Dow possesses rich product portfolios in emulsifiers and dispersants. How to develop the high performance products to address industrial challenges is our high priority these years. In this paper, high performance OD adjuvant development process had been described, followed by formulation preparation and performance evaluation. Currently, POWERBLOX™ OD products is ready to deliver to the market for formulation trial and performance validation.

Lego Unit Approach

It is well known that the OD formulation is a complex system, even for adjuvants, including wetting agents, emulsifiers, dispersants and thickeners. If all of the factors are considered together in the design of experiments, it will generate a huge amount of experiments and heavy workload. In order to accelerate product development progress, Lego unit approach was utilized to reduce design parameter as shown in Figure 1. At the initial stage, we investigated the performance between thickener and oil and the performance between emulsifier and oil, to select proper thickener and emulsifier. And then, the thickener and emulsifier in oil were fixed as the base system to evaluate the compatibility and stability of screened dispersants. Finally, the active was incorporated into above system to prepare OD full formulations and evaluate their storage stability. The technical hypothesis for this approach is:

- Thickener plays a dominant role in oil phase thickening. The better thickening effect, the higher viscosity of oil phase, little related to active and other additives.
- Emulsifier is decisive to emulsion quality and stability when OD formulation is diluted into water.

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Thickener Performance Evaluation

Methyl oleate is the largely used oil phase in OD formulation. In the following experiments, the methyl oleate was used as received from Wilmar. Various kinds of thickeners from different producers, more than 30, were collected to evaluate their thickening performance to methyl oleate, including organic, inorganic and organic-inorganic combination type. The comprehensive performance was tested, in term of oil compatibility, thickening effect, dispersing effect and cost effectiveness. It revealed that organobentonite was still the best choice in the market. The recommended dosage was 2.0-4.0 wt%.

Emulsifier Performance Evaluation

In the application, OD formulation needs to be diluted into water firstly, prior to spraying. Therefore, emulsifiers play a critical role to get the high quality emulsion, thus affecting drug efficacy. Emulsifiers with various HLB values were selected to evaluate their effect on initial emulsification performance and emulsion stability over time. The emulsifier dosage was fixed at 10wt% in methyl oleate and the dilution was 200 times in water. When oil phase was added into water phase, turned the mixture upside down for 20 times for further emulsion stability observation over time. As shown in Figure 3, the performance of one series of emulsifiers with HLB value from 8.5-13.6 demonstrated that the higher the HLB value, the better the initial emulsification performance and the emulsion stability. However, high HLB value generally means high polarity, it may have compatibility issue with oil phase, which is of relatively low polarity.

Span and Tween were taken as starting emulsifiers to mix in different ratios to get various HLB value emulsifier mixtures, which were used to study the compatibility with methyl oleate. As shown in Figure 4a, with the increase of HLB value, the compatibility and emulsification mixture and oil phase became worse and worse, from transparency and homogeneous to turbid. In Figure 4b, the performance of the screened Dow’s emulsifiers with high HLB value at 12.0-13.0 showed excellent compatibility with oil phase with transparency and homogeneous appearance, which resulted from the specially designed structure. Besides the good compatibility, excellent emulsification performance is the final target. It was shown in Figure 4c1, the mixture of oil and emulsifier with mediocre emulsification ability was added into water; as a result, the oil droplets couldn’t be emulsified spontaneously, but fell to the bottom still as oil droplets. When the mixture of Dow’s emulsifier and oil phase was dropped into water phase, the oil could be emulsified quickly with fine emulsion and excellent stability.

Dispersant Screening and OD formulation Development

Dispersant is used to disperse and stabilize pesticide particles, providing OD formulation long-term storage stability and ensuring sufficient shelf life. After thickener and emulsifiers were confirmed, dispersant was screened firstly by verifying its compatibility with oil and then by formulation development and optimization via altering the ratio of each components. As mentioned above, the components were complex in OD formulation with wide changing range, it was of high workload and time consuming. Dow high throughput platform could prepare a large amount of formulations in short time, facilitating to performance comparison and formulation optimization. Through scientific experiments design to get a lot of formula, the high throughput process was utilized to prepare target formulations as seen in Figure 5, more than 200 formulation within 1 week. Followed by, the excellent formulation could be screened out, on the basis of performance evaluation.
Taking 2.5wt% penoxsulam OD formulation development as example, 12 formulations had been selected out of all of the designed experiments, due to superior thermal storage stability to benchmark (seen in Figure 6). After 2 weeks thermal storage, benchmark product (commercially available product and used as received, non fresh sample) had around 8% phase separation. For our developed samples, there was no phase separation by naked eyes, keeping homogeneous system.

In order to differentiate the formulation performance difference caused by dispersant, accelerated stability testing method combining centrifugation and transmitted light scanning was used for performance evaluation to the formulations with good thermal storage stability. As seen in Figure 7 of each graph, the X axis stands for sample bottle height, the left is bottleneck and the right is bottom of bottle. And the Y axis indicates the transparency of the sample in the bottle. The lower the transparency, the better the sample stability. Moreover, the more the high transparency, the better the sample stability. The results demonstrated that the number 12 sample showed best stability, thus providing an optimization adjuvant package to target formulation.

At the same time, to know more clearly the detail difference among each formulation, instability index was introduced to quantitatively measure formulation stability, instability index is a specific value combining with Stokes’ Law and Lambert-Beer’ Law, demonstrating the relative value of the sum of transparency change to the maximum clarification value. Instability index is a specific value combining with Stokes’ Law and Lambert-Beer’ Law, demonstrating the relative value of the sum of transparency change to the maximum clarification value, with the value range of 0.1-1. For the same active particles (same density) in close viscosity, the lower instability index, the better formulation stability. It was seen in Figure 8, the instability index of all of evaluated formulations were not so high, and the value of number 12 was the lowest, indicating the best stability.

In a word, the thorough process had been built-up on adjuvant development, formulation preparation and performance evaluation. The explored high performance POWERBLOX™ OD adjuvant is ready to go to the market for customer trial, addressing the incumbent issues effectively.


4) Dr. Daniela Kruse
Marketing Manager EMEA Surface Technologies at Evonik Nutrition & Care GmbH

Evonik: Sustainable Surfactants for Crop Protection Solutions

The agricultural market is under increasing pressure as consumers ask for food containing lower, or no amounts of residual chemicals, but at the same time growers need to prevent the development of pathogens and pests resistant to active ingredients. Regulators demand less agrochemical input and some chemical pesticides have already been phased-out.

Well-known in the agrochemical market, Surfactants are used in formulations and as tank mix adjuvants. The benefits of adjuvants are important in plant protection products from pesticide formulation to storage, tank-mix dilution, spraying, targeting and finally acting on the pest. In water-based formulations, their main task is to decrease surface tension resulting in better wetting of the dispersed particle in water and more stable formulations. In oil-based formulations, emulsification properties support the quality of the emulsion ensuring higher stability and lower droplet size. In tank mix dilutions for all kinds of formulations, surfactants prolong physical stability as they reduce the surface tension of water. Targeted delivery is the main purpose of surfactants during spraying, which enhances efficacy and decreases the active amount needed. Targeted delivery is achieved by: 1) reducing driftable particles 2) enhancing adhesion and retention of spray droplets on the plant. 3) Improving uptake and penetration of active ingredients, and 4) increasing rain fastness.

However, regulatory pressure is rising with additives like NPE based solutions phased-out globally. With the agrochemical market demanding innovative, more sustainable additives, Evonik has developed benign surfactants which enable a more environmentally friendly plant protection.

New adjuvants that comply with eco-toxicological, safety and sustainability criteria provide solutions to support the plant protection industry. Evonik is introducing sustainable and biodegradable adjuvants in the following four classes: Wetting agents and multifunctional additives based on biodegradable trisiloxanes, polyglycerol esters and sorbitol esters.

Due to their chemistry, the way these novel surfactants work is different. Roughly speaking, the lower the surface tension of spray droplets the better adhesion and retention on the leaf. Water with 72 mN/m gives a strong bounce off of spray droplets. Trisiloxanes help to reach the lowest surface tensions and Evonik has developed readily biodegradable[ method OECD 301 F, OECD 301 A] trisiloxanes based on a unique patented technology. The reduction of water surface tension down to 21 mN/m facilitates the best adhesion and retention of droplets on very difficult to wet surfaces. Due to their special phase behavior in water, they provide superspreading of water, solutions and dispersions to ensure the best coverage of contact actives on surfaces thanks to the contact angle of 0°. This also enables the highest biological efficacy. In contrast to other superspreading trisiloxanes, these biodegradable trisiloxanes have no ecotoxicological classification and are not dangerous goods for transportation.

BREAK-THRU® S 301 is soluble in water and many oils, so it can be used in all kinds of liquid formulations and as a tank mix adjuvant to give excellent adhesion and retention of spray droplets. Commerciially available products with living microbial actives rarely contain surface-active molecules, and alongside the low wetting and low dispersing properties of solid
formulations in water, can often provide low and inconsistent field performance. BREAK-THRU® S 301 can be used as a carrier liquid in dispersion concentrates for increased shelf life of living microbial products. As a tank mix additive, BREAK-THRU® S 301 leads to a better dispersion of microbial actives in the spray solution, and to excellent wetting in the application, helping increase the efficacy of microbial-based pesticides.

BREAK-THRU® SD 260 is developed specifically for use in WP – formulations for chemical pesticides or for biopesticides. The product is the first water soluble, solid trisiloxane to provide humectant properties, and to offer excellent wetting properties as it includes BREAK-THRU® S 301. The addition of 1 - 5% w/w BREAK-THRU® SD 260 to the powder or granules of biopesticides significantly increases the surfactant properties of the final tank-mix dilution. At a concentration of 0.1 w/w-% it reduces the surface tension of water to 22 mN/m and the humectant property supports the field efficacy of the microbes.

Unique readily biodegradable adjuvants based on polyglycerol esters and sophorolipids fulfill modern requirements for all types of plant protection products and consist of a natural carbon source. They reduce the surface tension of water down to 30-35 mN/m. Incoming droplets solutions with such surface tensions normally show a strong and fast recoiling effect from the contact line, often leading to bounce off and loss of spray droplets. The new action is based on the interaction of the hydrophobic emulsified droplets with the cuticle leading to a so-called ‘pinning effect’ preventing the droplet recoiling from the contact line of the water droplets. These droplets also stick to the surface so retention is excellent. It’s well-known that polyglycerol esters and sophorolipids lead to a swelling of the contact line, often leading to bounce off and loss of spray droplets. However, due to the novel mode of action BREAK-THRU® SF 420 provides excellent adhesion and significantly higher retention on very difficult to wet species. After drying the remaining film generates with rainwater a gel layer by a hydration effect of the polymeric sophorolipid. This results in excellent rainfastness (see Table 1 and Figure 3).

Taken together, all the features of our sustainable multifunctional surfactants help increase the biological efficacy of agrochemicals and biosolutions. This has already been proven in many field trials around the globe. BREAK-THRU® additives enable microbials as active ingredients to have the lowest environmental impact, leading to a higher acceptance of these solutions by farmers and addresses the need of consumers for food with lower chemical residuals. Approvals for organic farming become more important, even for conventional farming, as it demonstrates the superior sustainability of the products. Therefore, the possibility of getting these approvals is a key criteria for Evonik in the development of new additive products. BREAK-THRU® S 301 and BREAK-THRU® SP 133 are already approved for OMRI, and BREAK-THRU® SP 133 is additionally FIBI registered and thereby the first surfactant for the German speaking organic agricultural market.

At the same time this multifunctional biosurfactant performs very well as a water soluble, low foaming tank mix surfactant by reducing the surface tension of water down to < 35 mN/m. However, due to the novel mode of action BREAK-THRU® SF 420 provides excellent adhesion and significantly higher retention on very difficult to wet species. After drying the remaining film generates with rainwater a gel layer by a hydration effect of the polymeric sophorolipid. This results in excellent rainfastness (see Table 1 and Figure 3).

Figure 1. CLSM study of BREAK-THRU® SP 133 penetration of the pseudo-lipohilic pesticide mimic (RHOdamine® B) into bean leaves [2 HAT 63 x mag.]. Near-surface horizontal and vertical cross-sections

Figure 2. CLSM study of BREAK-THRU® SP 133 penetration of the hydrophilic pesticide mimic (Oregon® Green) into bean leaves [2 HAT 63 x mag.]. Near-surface horizontal and vertical cross-sections

Figure 3. Effect on mean copper deposits (µg/cm²) retained on wheat, cabbage and bean foliage - Post Rain Analysis

<table>
<thead>
<tr>
<th>µg/L</th>
<th>Ingredient</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>383.0</td>
<td>Copper hydroxide</td>
<td>Active ingredient</td>
</tr>
<tr>
<td>75.0</td>
<td>BREAK-THRU® SF 420</td>
<td>Dispersing and wetting agent</td>
</tr>
<tr>
<td>3.0</td>
<td>BREAK-THRU® AF 9903</td>
<td>Antifoam</td>
</tr>
<tr>
<td>3.3</td>
<td>NaOH (20% solution)</td>
<td>Neutralization</td>
</tr>
<tr>
<td>2.5</td>
<td>Xanthan gum</td>
<td>Thickener</td>
</tr>
<tr>
<td>50</td>
<td>Propylene glycol</td>
<td>Antifreeze</td>
</tr>
<tr>
<td>q.s.</td>
<td>Water</td>
<td>Solvent</td>
</tr>
</tbody>
</table>

Table 1. Evonik Cu-formulation: Copper hydroxide 383 SC
Huntsman: Solvents as Solutions for Formulations

When a formulator begins a project on a new active ingredient, the appropriate solvent is one of the early considerations. Since many pesticide actives have aromatic characteristics, back in the 1960s, the formulator might use any number of aromatic hydrocarbons or halogenated solvents. As we began to understand the potential environmental and health impacts of various compounds, the field of choices naturally began to narrow. During the 1980s, N-methylpyrrolidone (NMP) became the choice for otherwise difficult formulations. Upon further study, however, it became clear that NMP was not the savior everyone had thought it would be.

The movement in the 1990s and 2000s to more environmentally responsible and, lately, to more sustainable ingredients, has changed the available choices. Paraffins are currently preferred if a hydrocarbon is needed, but they need help solubilizing aromatic actives. Aromatic hydrocarbons are still available, but with stricter regulations may not be a sustainable ingredient for the future, which leads them to be rarely, if ever, considered in a modern formulation. The future alternatives may very well be weaker solvents for the actives or not sustainable long-term.

The modern developer of a formulation to be used locally, regionally, or globally must consider an array of regulations that sometimes severely limit choices. The available choices are usually limited to a menu provided by regulatory authorities from which formulator must choose those solvents that may be compatible with the active. In addition, the other ingredients, such as wetting agents, compatibility agents and other ingredients, generally further narrows the available choices. Also, the company may have a particular solvent of choice for a particular class of ingredients.

The job of the solvent is to carry the active in liquid form in the container to primarily provide a stable environment for the rest of the ingredients. Solvents provide flowability and ease-of-delivery, two characteristics that make liquid formulations highly desirable.

The challenge is to choose the right solvent from the available menu. Modern solvents can include ingredients derived from both petroleum and biological sources. Biological sourcing is important for many companies, due to their environmentally responsible and sustainable credentials. Farmers, formulators and applicators around the world have understood, and integrated the need for environmental responsibility for many, many years, and so have naturally dialed into their thought and decision processes.

Since environmental factors are built into the choices by companies and governments, the primary key to making the right choice of solvent is driven by the core purpose of the solvent. The choice must be made from the available menu based on how well the solvent provides a stable liquid environment for the active and the other ingredients.

While solvents like paraffins and methylated vegetable oils (MSOs) are available, they tend not to solubilize the most difficult actives very well. In addition, MSOs can have temperature and other stability challenges. Other, more exotic choices may be available, but tend to be expensive.

“Aromatic” solvents tend to dissolve aromatic actives. JEFFSOL® AG 1700 solvent and JEFFSOL® AG 1705 solvent are two effective “simple” choices. Their aromatic character makes them compatible with various active ingredients. The simplicity of the molecules gives them a low freezing point with JEFFSOL® AG 1705 being able to remain liquid by itself down to -50°C.

When aromatics are not the answer, but rather a more polar solvent is needed to bring in polar molecules, the formulators are recommended to look at carbamates as an alternative. They are available in a variety of forms, such as JEFFSOL® AG 1555 solvent. JEFFSOL® AG 1555 solvent is both polar and has a high degree of biodegradability. Used in non-aqueous systems, JEFFSOL® AG 1555 solvent has been useful in a variety of formulations where NMP and other polar solvents may no longer be used.

Now, as ever, the choice of solvent is critical. However, with the environmental and toxicological limitations driven by today’s regulations, those choices are more and more limited. Choices of solvents may vary in the market, but “simple” solvents with low melting points can help with a diversity of performance needs, such as cold tolerance, viscosity and stability. Overcoming challenges such as these by using modern solvents, such as those mentioned above, will help bring success to your formulations.
Agrovista Steps Up Marketing of Spray Application Aids Into Europe

After two highly successful decades building a multi-million pound market around its range of Discovery spray application aids in the UK, agronomy company Agrovista is using its sector-leading expertise to accelerate its marketing drive into continental Europe.

Target regions include Central Europe, Russia, Ukraine and Turkey, which have the potential to greatly increase company revenues, says Peter McDonald, Agrovista’s Head of Commercial Strategy & Discovery Europe.

“Discovery products are an increasingly important part of Agrovista’s business, and the brand has the potential to become very significant.

“These application aids improve the performance of plant protection products. Pesticide efficacy is reduced by water quality, poor application and inadequate coverage, retention and uptake on the target surface. Discovery products overcome these challenges, improving the level of control and increasing yields.”

Many leading UK growers now use Discovery products to maximize the potential of their agrochemical applications. McDonald believes farmers in the target regions will soon be following suit.

“We have had a presence for some 10 years in north-west Europe, and two to five years in the target countries. European revenues have the capacity to be five times that of the UK, perhaps more in the longer term.

“Regardless of where they farm, growers are facing tight profit margins. They need to make use of every tool in the box to help them achieve maximum yields and returns.”

Comprehensive trials across continental Europe have demonstrated the value of Discovery products in improving the efficacy of plant protection products (Figure 1). Underpinning findings from up to two decades of research work and commercial use in the UK and, more recently, northwest Europe.

“By enhancing the effects of agrochemical products, our Discovery range can deliver significant increases in yield for a relatively modest outlay,” noted McDonald.

“We believe they offer significant benefits at any time, and particularly when returns are being squeezed. Growers don’t have to take our word for it – they can see the impressive results the Discovery range has achieved in trials. These products are proven across a range of crops and climates.”

As legislation tightens and pest, weed and disease resistance increases, some active ingredients will disappear, while others will be subjected to tighter dose restrictions. “This strengthens the case for using Discovery products - growers need to extract maximum performance from remaining chemistry,” said McDonald.

Three products are spearheading the European campaign. Companion Gold, the most popular spray application aid in the UK, is a multi-functional adjuvant and pod sealant most often used with glyphosate. Remix is an additive that improves the performance of residual herbicides and Velocity is designed to improve the coverage and uptake of fungicides (see panel).

“Each Discovery product has completed a multi-year pan-European R&D screen to ensure efficacy,” said McDonald. “This comprises laboratory studies and high quality replicated field trials across a wide range of geographical locations, soil types, climatic conditions and crops. Physical chemical, environmental and regulatory studies are completed to ensure consistent product performance.

“We also put great emphasis on conducting quality trials with our distribution partners and respected research organizations in each country we market. And our ground-breaking spray application trials explore the relationship between plant protection product, application technique and tank mix additive, giving a unique insight into performance on farms.”

Discovery products are manufactured by Agrovista UK, which can trace its roots back 60 years. The business is part of Agrovista BV, a leading European organization in the field, itself part of the international Marubeni Corporation, which has representative offices and is well known in all of the countries where Agrovista is looking to expand.

“We work very closely with Marubeni in these new markets,” he added. “Most people will not have heard of Agrovista, but being part of Marubeni, prospective clients will know we are a reliable and trusted partner they will be comfortable doing business with.”

Figure 1. Agrovista’s Discovery products are trialled extensively across Europe

Peter McDonald

Head of Commercial Strategy & Discovery Europe at Agrovista

E-mail: peter.mcdonald@agrovista.co.uk

Figure 1. Agrovista’s Discovery products are trialled extensively across Europe

Discovered R&D

Each Discovery product is put through a multi-year pan-European R&D screen to ensure they perform to the optimum in all market locations.

Tests include laboratory studies and high-quality trials conducted at sites throughout Europe that encompass a wide range of soil types and climates, as well as key crops for different areas, such as cereals, maize, oilseeds, pulses, sugar beet and potatoes.

To ensure maximum performance, Agrovista has designed and developed its own self-propelled sprayers, enabling researchers to test products and methodology under replicated farm conditions.

Research is carried out and evaluated by Agrovista’s own trials team, universities, government research institutes and leading contract trials organizations.

In addition, Agrovista works in conjunction with the world-renowned Silsoe Spray Applications Unit to optimize practical spray advice.

Discovery range

- Spray application aids
- Tank-mixed spray additives and adjuvants
- Designed to enhance efficacy of plant protection products
- Targeted formulations, focused by pesticide requirements
- Improved spray application
- Supported by pan-European R&D program
- Comprehensive efficacy data to support use

Key Discovery products

Companion Gold is the perfect partner for glyphosate and can also be used as a pod sealant in oilseed rape and legumes.

This multi-function adjuvant is a tallow-amine-free formulation containing...
a blend of drift-reducing polyacrylamide polymers, pH buffers, water conditioners, antifoam agents and humectants.

Companion Gold has been proven over many years to significantly enhance the performance of glyphosate. More recent trials suggest those benefits could be even greater when using the new tallow-amine-free glyphosate formulations, which Agrovista trials suggest may be less effective at controlling grass weeds under challenging timings.

Remix is designed specifically to enhance the performance of residual herbicides. It contains a unique blend of highly refined paraffinic oil, hexaethylene alcohol ethoxylates and long-chain fatty acids.

The product reduces spray drift, ensures even deposition of the spray over the soil surface and increases adsorption to soil particles, reducing crop effects while increasing residual weed control.

Over the past 10 years, the addition of Remix to a residual herbicide stack has improved black-grass control by 11% in Agrovista trials.

Velocity is designed to enhance fungicide application and efficacy in a range of crops. It also reduces spray drift, ensuring accurate spray deposition over the target surface.

Organosilicone surfactants ensure complete coverage, while humectants slow droplet drying. Fatty acid methyl esters improve penetration through the outer waxy layers of the leaves.

Results from eight fully replicated trials across Europe over a four-year period using the label dose have shown that adding Velocity can reduce fusarium levels by half, compared with straight fungicide when applied at the key early flowering spray timing.

Adding Velocity also allows spray volumes to be halved in certain situations without loss of efficacy.

* For further details on Agrovista’s Discovery range, please go to www.discovery-eu.com

Made in Britain and supported by a pan-European R&D programme, our targeted adjuvant and additive formulations improve efficacy and increase yields.

The Discovery range
Roller - Provides even coverage and excellent crop safety
Velocity - Improve disease control and increase yields
Remix - Reduce drift & enhance deposition of residual herbicides
Companion Gold - 6 way mode of action adjuvant and pod sealant
KryptoN - Advanced foliar nutrition
Nelson - For use with Sulfonylurea and fop and dim herbicides
Stingray - ph buffer and water conditioner

For more info: Tel: +44 (0) 115 939 0202 Email: peter.mcdonald@agrovista.co.uk www.discovery-eu.com

Improving Performance
Adjuvants & spray additives

Spray application aids

Improve the performance of your plant protection products

The Discovery range
Roller - Provides even coverage and excellent crop safety
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www.discovery-eu.com
Tradecorp’s ADJUSTAR Adjuvants Range to Revolutionize the Adjuvant Market

Javier Bernabéu, Marketing Director at Tradecorp - International Division

What is an adjuvant? How do they work?

A. An adjuvant is a product that optimizes the efficacy of another, mainly: herbicides, insecticides and fungicides, and ultimately reduces limiting factors during spraying of Crop Protection (CP) products.

B. Limiting factors for a successful application of CP products:
   - Climate/weather
   - Water quality
   - Specific CP management
   - Droplets
   - Sprayers
   - Etc.

Adjuvants offer solutions for farmers in three beneficial areas:

1. Technical benefits:
   - a. Limiting factors for successful treatment
   - b. Modern spraying:
     - Increasing application speed
     - Reducing water volume (Figure 1)
   - b. Modern spraying:
     - Decreasing water volume (Figure 2)

2. Economic benefits:
   - a. Better CP treatment balance cost/ha
   - b. Better CP application management
   - c. Sufficient product effectiveness

3. Environmental benefits:
   - a. Better applications focused on pest/diseases targets
   - b. Less CP product waste:
     - Reduced soil loss
   - c. Sufficient product effectiveness

ADJUSTAR RANGE, will revolutionize the adjuvant market. Some features include:

- Super spreading and leader adjuvant on market for pre-emergence herbicides
- High capacity of soil penetration
- Ensures horizontal and vertical herbicide distribution on the ground, improving coverage with less water volume
- Triple use adjuvant, combining:
  - spreading
  - retaining
  - penetrating
- High performance on hydrophobic leaves and safer for crops than classic oils
- The first multifunctional organically-sourced vegetable product
- Made from sunflower (oil properties) and sugar beet (adjuvant properties)
- The dual-action adjuvant, water corrector + adjuvant
- Helps to solubilize pesticides in mix tank
- Safeguards compatibility and stability
- Increase half-life by lowering pH
- Stick adjuvant containing pine terpene
- Ultra-concentrated stick adjuvant
- Low dose rate of 0.05% (2.8-4 times lower dose/ha compared to competitors)

Figure 1. Foliar spraying coverage comparing different volumes of water vs water + adjuvant

Figure 2. Differences between a drop water and a drop water (left) + adjuvant (right)

Figure 3. Drop effects on a hydrophobic leaf surface; Right leaves show only water, left leaves have adjuvants

Adjustar is Tradecorp’s new range of adjuvants, specially designed to help farmers optimize management of plant protection products.

Customized solutions for your needs today

Innovating for the challenges of tomorrow

Did you know...?

Adjustar is Tradecorp’s new range of adjuvants, specially designed to help farmers optimize management of plant protection products.

During the spraying process, they give the treatment broth physicochemical characteristics. This calls for a more precise and controlled spraying. The main features are described below:

- Spreading, reduces the surface tension of droplets (Figure 2)
- Penetrating, facilitates passage of active ingredient from phytosanitary product into plant tissue
- Retaining, prevents runoff and losses of a.i into the soil
- Sticking, sticks contact products to the leaves
- Moistening, captures humidity from the air and extends droplet lifespan
- Diffusing, facilitates plant translocation
- Drift control, improves the performance and precision of spray applications
- Anti-leaching, protects from rainfall
- Persistence which improves efficacy
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- Retaining, prevents runoff and losses of a.i into the soil
- Sticking, sticks contact products to the leaves
- Moistening, captures humidity from the air and extends droplet lifespan
- Diffusing, facilitates plant translocation
- Drift control, improves the performance and precision of spray applications
- Anti-leaching, protects from rainfall
- Persistence which improves efficacy
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The Application and Development of Pesticide Precision in Japan

Shoichi Yuki, Ph.D
Head of Planning Development Sector at Yamabiko Corporation

The agricultural working population has been decreasing in Japan. On the other hand, the average age of farmers has been increasing. These factors have caused farmland to be consolidated, though agricultural management hierarchy is becoming polarized. To solve these problem, a national project in the agricultural machinery field, entitled “Smart Agriculture”, has been started. The purpose of “Smart Agriculture” is to increase working efficiency and reduce labor costs by using robotic techniques, as well as information and communication technology.

Yamabiko Corporation is one of the leading companies manufacturing crop protection equipment in Japan. Yamabiko Corporation has been encouraged to create smart agriculture by producing crop protection equipment, such as spraying equipment for UAV’s and self-propelled boom sprayers for paddy rice.

The main crop in Japan is paddy rice, occupying 38% of the cultivated areas. It’s very important for the Japanese agricultural machinery manufacturer to take care of paddy rice cultivation. Many types of machines are used in rice fields. In small fields, farmers use knapsack type sprayers and power sprayers. In this case, farmers need to spray by hand. Farmers who have big fields, for example, the size of some 5 ha, want to use high performance machines, such as self-propelled boom sprayers and industrial multi-rotors. Helicopter applications offer the most efficiency for spraying applications. Recently, farmers were willing to use multi-rotors for spraying applications, since multi-rotors are cheaper than helicopters and easier to use.

Japanese agricultural began using UAV’s in 1990. Yamaha motor began to sell the single rotor helicopter R50 in the Japanese market. Some 30 years ago Yamaha motor modified aircraft introduced the latest technology. The latest generation YF380 and FAZER are driven by 4-stroke gasoline engines, and implement the turn assisted system and auto-cruise control system. Before using UAV’s, manned aircraft were used for agricultural spraying in Japan. And then, aerial machines switched to unmanned helicopters for spraying applications for paddy rice fields. In 2018 May, the number of certified helicopters in the country is 2,788. The number of licensed operators is about 10 thousand. Regarding the share of helicopters, 40 % of paddy rice fields are sprayed by unmanned helicopters in Japan.

Regarding industrial multi-rotors, there are a variety of multi-rotors produced by the Japanese and Chinese manufacturers. The multi-rotors is a new technology for spraying applications, and the practical use in the agricultural field is just starting. Japanese farmer are very interesting for using this unique aircraft in their field. The number of the certified multi-rotor in 2018 May is 889, and the number of operators who have license is over 3,600.

In the current solution for self-propelled boom sprayers in paddy fields, Yamabiko self-propelled boom sprayers use GPS assisted guidance systems and automatic steering systems for the vehicle. In the paddy field, it is difficult for farmers to drive the vehicle to avoid driving on rice rows. Auto steering systems handle steering automatically by using GPS signals. This high performance system will contribute to optimize spray operations and saving labor by farmers. To use very high accuracy GPS signal by RTK system, tracking accuracy will be 2 - 3cm during spray operations. Self-propelled boom sprayers can drive and trace pre-programmed tracks automatically, which greatly improve spraying efficiency and productivity. Farmer can also use LCD touch panel monitors. The area sprayed is displayed on the monitor and is effective in preventing duplication or skipping. Turning points are shown on the monitor and helps to achieve smallest turns.

The benefit of the auto steering system for self-propelled boom sprayers is that the sprayer can drive automatically from point A to point B, which are set in advance, without steering. Sprayers can drive according to rice rows, thus avoid damage to rice. At the end of field, farmers steer the handle wheel, sprayers can drive to the next truck by watching the sprayed area on spray monitors. Auto steering systems for self-propelled boom sprayers can realize easy operation of vehicles during spraying operations with high efficiency, high accuracy and high performance.

Japan has a variety of types of high performance self-propelled boom sprayers. Farmers can control all the boom movements, such as tilt up/down, lift up/down and flapping out/in. Japanese boom sprayers have unique structures in their “telescopic boom”. Farmer can adjust the working width according to field shape by using switch lever operations from 9.3m to 15.9m. Basically, sprayers have boom control systems to maintain the boom horizontally. Self-propelled boom sprayers can turn at a minimum rotation cycle of 2.5m at the end of field.

Self-propelled boom sprayer has kind of flow rate control system. This can realize to keep the flow rate per area constant. Thanks to these high quality functions, sprayer can realize very high working efficiency. If farmer use knapsack type sprayer in the field with 30 area, it takes 60 minutes to work. Regarding self-propelled sprayer, it takes only 8 minutes.

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Growth opportunities using Vive Crop Protection’s Allosperse technology

Jordan Dinglasan
VP Product Development at Vive Crop Protection

Vive Crop Protection makes proven products cutting edge using the Allosperse® Delivery System. Allosperse is a nanotechnology “shuttle” that enables active ingredients to mix better – with liquid fertilizer, other chemicals, micronutrients and hard water. This allows farmers to use these products in new ways to increase efficiency, crop quality and yield.

AgroPages has recently had a dialogue with Jordan Dinglasan, VP Product Development at Vive Crop Protection, who shared his viewpoints about Allosperse® delivery system and its application situation, as well as their future plan etc.

What do you see for the future of applying nanotechnology-based agrochemicals?

This is an interesting question because there’s some misinformation out there about what nanotechnology can do. Nanotechnology doesn’t change what a chemical does – it just changes how it behaves in its environment. Nanotechnology brings incremental – not revolutionary - changes to ag chem.

For example, Vive developed Azteroid FC 3.3 fungicide that contains azoxystrobin. Our use of nanotechnology doesn’t change the azoxystrobin properties – it still controls diseases and increases plant health like any other azoxystrobin would. In this case, nanotechnology allows azoxystrobin to mix with other things in the spray tank or irrigation pivot, which wasn’t possible before. Any performance benefits come from azoxystrobin – our technology just allows the product to be applied in different ways and at more beneficial times in a crop’s life.

Tell me more about Allosperse - what is it?

The Allosperse Delivery System is a nanoscale, polymer-based delivery system with extremely high ‘tnability’. We can produce many different types of polymer encapsulation particles with different internal and external chemical properties. The inside can be tuned for optimal association with an active ingredient, while the outside can be tuned for whatever behavior is desired - miscibility, targeted mobility, stability, etc.

So is Allosperse technology the future?

We view Allosperse as a critical component to innovation in agriculture. Industry consolidation and increased regulatory barriers mean that fewer new active ingredients are being developed each year. We, as an industry, need to find new techniques to improve existing active ingredients, to help them be used in new ways. Delivery systems that help improve how active ingredients behave can provide new life to older chemistry, as well as improving environmental impact. Allosperse technology can be readily applied across multiple crops and/or active ingredients.

Is Vive doing this alone or in partnership with other companies?

We work with many other agrochemical companies to improve their proven products or new active ingredients using the Allosperse Delivery System. We view ourselves as being the “Intel Inside” in these unique products as they hit the market.

Are any products using Allosperse technology commercially available?

Vive was the first to bring nanotechnology to US crop protection and has two commercially-available products and three more awaiting US EPA approval.

Vive’s Azteroid FC 3.3 fungicide (azoxystrobin) and Bifender FC (bifenthrin) insecticide are worry-free, convenient and easy-to-use products that mix uniformly with liquid fertilizers. They maximize yield and profitability in a broad range of crops including corn, soybean, alfalfa, sugarbeets and potatoes. In fact, Azteroid FC 3.3 has been proven to increase sugar beet yield by an average of 3.1 T/ac and sugar content by up to 6%.

Aryzta Lifescience utilizes Allosperse technology in two commercially available products. Aryzta and Vive received the Agrow Award for Best Industry Collaboration in 2017.

So what’s next?

Vive has a deep pipeline of branded products under development and the ag chem industry is very interested in Allosperse and what it can do - now and in the future. Our next generation of nanotech polymers will improve various active ingredients by improving their ability to reach targets below the soil surface by targeted soil mobility.

The third generation of Allosperse technologies will optimize the adhesion and uptake into foliage to improve retention and residual control of foliar applied products, improve viability of formulated biologicals or improve stability of formulations for moderately soluble active ingredients.

All of these are designed to help growers do more with less and create new ways growers can use and benefit from existing active ingredients.
Interagro (UK) Ltd

Interagro was formed in 1994 and has since then been at the forefront of the development of surfactant chemistry as in-tank adjuvants. It continues to be the pioneering organisation it set out to be, developing and marketing a wide range of innovative products to optimise the performance of agricultural and horticultural inputs.

Today, Interagro boasts over 100 products in 30 international markets, making it one of the leading lights in the specialist spray adjuvant business throughout the EU, Eastern Europe and North Africa.

Interagro work closely with a number of collaborators to be able to offer farmers and growers even more cost-effective performance of crop protection products.

http://www.interagro.co.uk/
info@interagro.co.uk

IntraCrop

Working in partnership with leading universities, research institutes and independent scientists, IntraCrop develops and distributes specialty crop inputs throughout Europe. With significant financial backing, we focus on producing adjuvants, bio stimulants and seed treatments that help agronomists and farmers improve productivity and reduce the unit cost of crop production.

www.intracrop.co.uk
admin@intracrop.co.uk

Nouryon

We are a global specialty chemicals leader. Markets worldwide rely on our essential chemistry in the manufacture of everyday products such as crop protection formulations, pharmaceuticals, personal care items, paper, plastics and building materials items. Building on our nearly 400-year history, the dedication of our 10,000 employees, and our shared commitment to business growth, strong financial performance, safety, sustainability, and innovation, we have established a world-class business and built strong partnerships with our customers. We operate in over 80 countries around the world and is a leading supplier of specialty surfactants, polymers and solvents.

Our agrochemical portfolio of industry-leading brands includes Monwets® (wetting agents and dispersants), Advise™ adjuvants, Agrifine® dispersants, Armal® solvents, Ethyl® and Ethozone® (alcohol and amine alkoxyates). As a global company, with local presence and a robust supply chain, we can ensure support and delivery wherever you are. Every Day.

www.nouryon.com/agriculture
agro@nouryon.com

Innospec Active Chemicals

Innospec Agrochemicals offers a diverse range of surfactants, emulsifiers, rheology modifiers, chelating agents and specialty solvents for the agricultural market. We supply formulation additives for crop protection, home & garden, animal health, fertilizers, micronutrients, and tank mix adjuvants.

Established Innospec brand names such as NANSA®, EMPICOL® and EMPLAN® are well known in the industry as time tested and high quality products. Combined with the newly established ENVIOX™ brand, the full product line offers effective components and co-formulants for optimizing formulations and enhancing active ingredient performance and delivery.

Innospec believes in close customer collaboration, commitment to continual innovation and product development contributing to a sustainable environment without compromising on performance.

www.innospecinc.com
agrochemicals@innospecinc.com

Battelle UK Ltd.

Battelle is the world’s largest nonprofit independent research and development organization. Battelle’s AgriBusiness provides comprehensive registration services for agrochemicals and biopesticides, from individual safety studies to turn-key projects and regulatory support. Battelle is distinguished through its technology offering including an independent service for the development of new formulations.

Battelle can help you accelerate your agricultural formulation development schedule, gain access to new markets and maintain your competitive edge. We provide an integrated approach to research, development and regulatory compliance to help you move to market quickly and reliably while controlling costs and risks. We offer customized research studies and full registration programs throughout Europe and NAFTA. Among the services and technologies available are:

Development Services
Develop and test new agricultural products and complex co-formulation mixtures, or modernize your existing products by replacing potentially hazardous ingredients.

- Development services
  - Feasibility studies
  - Quality control
  - Stability testing

Formulation Technology
Update your product mix with cutting-edge formulation technologies for better performance and stability:

- Bioformulation of proteins, enzymes and bacteria
- Capsule suspensions
- Controlled-release systems
- Emulsions and microemulsions
- Seed dressing
- Ultra-fine sub-micron suspensions
- Water-dispersible granules
- Wettable powders

www.battelle.org
j.groome@battelleuk.com

Victorian Chemical Co. Pty. Ltd.

The Victorian Chemical Company (Vicchem) is a specialist manufacturer and global marketer of agricultural and industrial chemical products that is based in Melbourne, Australia.

We provide our customers with friendly, professional service and reliable, high performance products that have been manufactured according to an accredited quality management system ISO 9001.

Vegetable oils are used widely in our manufacture, with the resulting products being typically non-hazardous to both end user and the environment.

Vicchem has a well-equipped laboratory that is used in formulation development and quality control testing.

Our agricultural products include spray adjuvants, wetting agents, surfactants, insecticides, growth regulators and biocontrol products. Applications include broadacre cropping, horticulture, cotton and pastoral.

Vicchem has strong business relationships with all key Australian distributors of agricultural products and works with industry partners and customers in North and South America, Europe, Asia, The Middle East and Africa.

www.vicchem.com
products@vicchem.com

Agrovista

Agrovista is a leading supplier of agronomy advice, seed, crop protection products and precision farming services. With the most comprehensive integrated arable trials programme in the UK, we can ensure that the evidence-based advice we provide you is unrivalled in our marketplace.

With depots and regional agronomy centres throughout the UK, we are your local crop care experts, committed to helping you farm more effectively and more profitably.

Agrovista Discovery spray application aids improve the performance of plant protection products. Pesticide efficacy is reduced by water quality, poor application and inadequate coverage, retention and uptake on the target surface. Discovery products overcome these challenges.
Adjuvants Unlimited

Adjuvants Unlimited, LLC, develops formulation solutions for the adjuvant market. We also bring new and unique adjuvant chemistries to market to complement existing technologies. We offer state-of-the-art production of adjuvants offered in bulk and packaged goods, as well as surfactant blends and pesticide additives.

http://www.adjuvantsunlimited.com/
sales@adjuvantsunlimited.com

Biosorb Inc.

Biosorb Inc. is a bio-based company founded in 1998, providing products for rainfastness and weatherability through our patented Microspponge™ technology. One of the main problems in crop applications is the run-off or dilution of applied materials due to rainfall, irrigation or UV degradation. Traditionally, surfactants have been used to aid the spread of applications over leaf/foliage/fruit surfaces; however, these surface-active agents have a tendency to facilitate the dissolution of chemicals in water and wash-off treatment areas.

New natural-based microspunge technology is replacing surfactants in chemical and biological applications due to absorption and adhesion properties, providing better contact time and more efficient delivery. Our products include: Biocar®, TopFilm™, TopFilm-E™, and HydraClear®. Our main focus is providing customers with bio-based adjuvants and inerts, which help lower the toxicity and chemical load on the environment. Private formulation development is also available. Our products can be used with biopesticides, as well as with traditional chemical pesticides.

http://www.Biosorb-Inc.com
BiosorbInc@gmail.com

Adjuvants Plus Inc.

Adjuvants Plus Inc. was built on the premise that innovation with existing chemistry would open up new avenues in the crop protection industry by creating added value for growers. Product innovation can be measured in a number of ways, one of which is whether these inventions are patentable. As a result, Adjuvants Plus has built a very exciting, specialized product portfolio that has utility in North American and in global markets. Our technology provides growers with new tools to improve crop yields and increase returns in a sustainable manner.

http://www.adjuvantsplus.com/
info@adjuvantsplus.com

Borregaard LignoTech

Borregaard operates one of the world’s most advanced and sustainable biorefineries. As a world leader for Lignosulphonates and modified Humic acids, we take pride in offering the crop protection and the fertilizer industries environmentally friendly alternatives to petroleum and coal based chemicals.

Our wide range of dispersants like Borresperse, Ufoxane and Greensperse can greatly help to produce high quality dry and water-based formulations. We offer also natural performance-enhancing ingredients for Plant Nutrient and Fertilizer Formulators like our soil conditioners BorroGRO and our micronutrients Borrochel.

www.lignotechagro.com
+47 69 11 80 00 for Europe/Middle-East/Africa
+1 715 359 65 44 for America
+65 6778 0008 for Asia

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http://www.Biosorb-Inc.com
BiosorbInc@gmail.com
Corbion

Corbion is the global market leader in lactic acid, lactic acid derivatives, and a leading company in emulifiers, functional enzyme blends, minerals, vitamins and algae ingredients.

We develop sustainable ingredient solutions to improve the quality of life for people today and for future generations. For over 100 years, we have been uncompromising in our commitment to safety, quality and performance. Drawing on our deep application and product knowledge, we work side-by-side with customers to make our cutting-edge technologies work for them.

At Corbion, we live our brand promise “Keep creating”, through our science, clear understanding of the markets we serve, and of course through our creative people.

Corbion’s strategy and every aspect of our operations are built around advancing sustainability and applying high ethical standards, whether this relates to the management of our global supply chains, responsible procurement of our raw materials, or the safety and wellbeing of our people.

http://www.corbion.com/
communications@corbion.com

Dow Crop Defense

Dow is a global solutions provider of inert and additive agrochemical ingredients and proteins with in-depth product performance expertise to meet specific needs of our customers by customized solutions and global supply capabilities.

- Focused on the Agrochemical market: Preservation, In-can Formulants, Tank-mix Adjuvants, Fertilizer Additives
- Nutrition, Agro Intermediates
- Primary product focus – Surfactants, Amines, Solvents, Chelants
- Our newly introduced POWERBLOX™ Products serve as the building blocks for formulation success
- DOW: wide range of additional products for agricultural markets – Rheology Modifies, Preservatives, Polyurethanes and Silicone.

www.dowcropdefens.com
Lwca@ dow.com

Evonik Nutrition & Care GmbH

Evonik is one of the world’s leading specialty chemicals companies. The central elements of our strategy for sustained value creation are profitable growth, efficiency and values. Around 80 percent of sales come from marketleading positions, which are systematically expanding. We concentrate on highgrowth megatrends, especially health, nutrition, resource efficiency and globalization. In 2017 Evonik’s more than 36,000 employees generated sales of €14.4 billion and an operating result (adjusted EBITDA) of €2.36 billion. Around 81 percent of sales are generated outside Germany, providing convincing evidence that our business is global.

BREAK-THRU® - Surfactant technology from Evonik

We are committed to providing specialty additives to the agricultural industry used as spreaders, penetrants, antifoams, emulsifiers and dispersants in tank mix applications as well as in pesticide formulations. With an emphasis on innovative solutions, we offer agricultural chemicals based on both siloxane and organic surfactants under the BREAKTHRU® brand name.

Our formulation experts have merged their knowledge with that of our plant physiologists who link it to performance in the field. In this way, we offer a novel package of products and expertise.

www.evionik.com
break-thru@evionik.com

Eastman Chemical Company

Eastman is a global specialty materials company that produces a broad range of products found in items people use every day. With the purpose of enhancing the quality of life in a material way, Eastman works with customers to deliver innovative products and solutions while maintaining a commitment to safety and sustainability.

Eastman’s diverse AgChem Intermediates portfolio includes neutralizing agents, intermediates as raw materials, insecticides, fertilizers, herbicides, adjuvants, and a variety of solvents and catalysts. With a rich history of providing targeted, innovative, and sustainable solutions, Eastman remains the cream of the crop.

www.eastman.com/agriculture
cweet@eastman.com

Exwold Technology

Exwold have 5 manufacturing sites in the UK and specialise in contract formulation & processing of Crop Protection products using granulation technologies. Specialising in the following:
- Formulation of Herbicides & Plant Growth Regulators
- Low Pressure Extrusion of Water Dispersible Granules (WDGs) & Soluble Granules (SGs)
- Pan Granulation
- Roll Compaction
- Impregnation and Coating of Granules
- IPCP authorisation for formulation of Herbicide acids into metal salts in-situ
- Formulation of Highly Active (SU) Herbicides in a dedicated facility using extrusion.
- Formulation of Insecticides & Fungicides:
  - Extraction of WDGs/ SGs
  - Impregnation and Coating of Granules

Support Facilities
We have ISO 9001, ISO 14001 & most recently ISO 45001 certificates. We also have Top-tiers COMAH authorization at the Brenda Road site where we handle & store incoming raw materials. In addition, we have a fully equipped laboratory and pilot plant to assist with product scale-up.

Our expert Technical Management team have an innovative approach to finding solutions, which allows us to support new product introduction & add value to your products, making Exwold a strategic partner for our clients.

www.exwold.com
enquiries@exwold.com

Foreverest Resources Ltd.

Foreverest Resources Ltd. supplies pine-based chemicals since 1988. Our ranges focus on modified rosins, turpentine derivatives, polyterpen resins and flavor-fragrance raw materials. On the agricultural market, we supply the natural extracts adjuvants for fungicides, potentiators, pesticides. PINEYE Emulsion is our owned brand for this powerful application.

https://foreverest.cn/products
info@foreverest.cn

GarCo Products Inc.

GarCo Products is an independent manufacturer and distributor of adjuvants and alternative products that enhance pesticide performance and provides a wide range of services.

GarrCo can private label products, develop custom formulations and do research for many different applications.

www.garco.com
info@garco.com
GreenA BV

GreenA is the technology transfer company of the Institute of Physics at the University of Amsterdam. GreenA develops and markets the patented polymer adjuvant and co-formulant Squall to be used with water-based agrochemicals. Squall is typically mixed as a 0.5% solution in the tank mix of spraying installations. Rain fastness improves by 50% and giving a superior deposition of crop protection on the leaves. Adding Squall to in-tank mixtures reduces droplet drift to 5% of the total, compared to 20% seen in standard mixtures of water and pesticides. Squall is widely used already in the Netherlands, Germany, Austria and starting 2018 in Switzerland.

www.squall.pro

p.buis@greena.nl

www.squall.pro

GLOBAL ADJUVANTS

GreenA BV rather than a practical agronomy tool that was viewed as something used by distributors and farmers, so they become a tool for environmental benefit and R&D support, idea generation and development, assistance with commercialisation, and training. Our clients come from the agrochemical and biocides industries as well as all other formulating industries (e.g. pharma, biocides, coatings, inks, food, cosmetics, household, specialty chemicals).

http://www.squall.pro/corporate/ 

a/Home 

kent_shu@huntsman.com

Huntsman Performance Products

Enriching lives through innovation

At Huntsman Agrochemicals, your success is our top priority. We use our expertise in regulatory compliance, state of the art science, manufacturing and global delivery systems to help you drive your business forward. Our portfolio of TERMIX® and TERWET® adjuvants have been proven to improve efficacy by increasing biological activity and / or broadening the spectrum of effectiveness. Adjuvants can increase pestical efficacy by influencing several key physicochemical characters. Adjuvants can be formulated as "built in" or marketed as stand alone “tank mix” adjuvants.

Huntsman’s adjuvant portfolio includes:

- Compatibility Agents – TERMIX® 5270 & TERMIX® 6000
- Drift Reduction Agents – TERMIX® 5920
- Spreader / Sticker Adjuvants – TERMIX® 5890 & TERMIX® 5910
- Wetting Agents – TERWET® 245
- Conditioning Agents – TERMIX® 95-4000
- COC Emulsifiers – TERMIX® 5880 & TERMIX® 5860

http://www.huntsman.com/corporate/ gary@global-adjuvants.com

Ingevity

Ingevity provides specialty chemicals, high-performance carbon materials and engineered polymers that purify, protect and enhance the world around us. As the world’s largest producer of Kraft lignosulfonates, Ingevity is committed to quality, consistency and control in the manufacturing of dispensers and surfactant systems. We offer a range of bio-based specialty inert for plant health and crop protection, and find customers’ solutions by combining quality products and unsurpassed technical expertise. Ingevity’s adjuvant products are sold under the brand names Alatex® and Altastic™. Headquartered in North Charleston, South Carolina, Ingevity operates from 25 locations around the world and employs approximately 1,750 people. Learn more at www.ingevity.com.

www.ingevity.com

chemicals@ingevity.com

iFormulate

Formulate Ltd provides customised R&D and innovation services to companies working in Formulation Science and Technology. We offer consultancy, problem solving, R&D support, idea generation and development, assistance with commercialisation, and training. Our clients come from the agrochemical and biocides industries as well as all other formulating industries (e.g. pharma, biocides, coatings, inks, food, cosmetics, household, specialty chemicals).

www.i formulate.biz

info@iformulate.biz

IMCD Group BV

In addition, inerts for biotechnology allow IMCD to complete it’s product portfolio to overcome today’s environmental challenges. Through our human resources, supply chain expertise and the creation of open and lasting partnerships, IMCD provides optimum tailor-made solutions on formulation, production processes and application for multi-territory distribution management in EMEA, Asia-Pacific and Americas.

Headquartered in Rotterdam, The Netherlands, IMCD achieved a turnover of EUR 2.379 M in 2018 and employs over 2,800 professionals in more than 45 countries. IMCD offers its 37,000 customers a comprehensive and complimentary portfolio of 30,000 products together with expert technical advice and formulatory support.

www.imcdgroup.com

isabelle.jamet@imcd.fr

Ionica

Ionica has a well-recognised presence in the world’s crop protection industry. A custom manufacturer of active ingredients, and intermediates, for many years, the company has established strong relationships with leading plant protection manufacturers and innovators, as well as developing ready-to-use formulations such as the metaldehyde-based AXCEL® slug pellet. As one of the world’s most-trusted suppliers to the pharmaceutical, biotech and specialty ingredients markets. It harnesses science and technology to create products that support safer and healthier living and that enhance the overall quality of life. Its recent launch of VELCIS® provides a new range of formulation ingredients and development services, helping manufacturers to keep pace with new formulation trends, such as biopesticides, added-value formulations of post-patent molecules, and regulatory-driven product reformulations.

www.ionica.com

agroformulation@ionica.com

Lonza

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www.lonza.com

agroformulation@lonza.com

IMC Group BV

IMCD is a global leader in the sales, marketing and distribution of specialty chemicals and food ingredients. The experience gathered over the last 20 years has allowed IMCD to acquire extensive knowledge on regulatory and technical requirements in the crop protection, adjuvants and nutrients market.

IMCD focuses on partnering with prestigious suppliers that offer leading and innovative products into the agrochemical market. The vast portfolio of products available through IMCD’s distribution network provides the industry with a complete range of inert to achieve optimised formulations such as developing more sustainable solvents; adjuvants to optimise the application target; co-formulants to reduce volatility and sensitivity of new active substances.

Over 15 years ionica has been the market leader in Canada & Latin America in the development of safer, cleaner formulations of crop protection, animal health and environmental husbandry products. Our technologies and those of our partners allow us to serve formulators & manufacturers with green adjuvants used in formulation plants to achieve safer, more effective crop protection, animal health and water, soil, seed treatment solutions.

We also have our own line of green "ready to use" on the field products (tank mix, soil protection, water retention, fertilizer & drift control adjuvants, improving the effect of crop, animal health & water treatment technologies sold through AgriJetSolution and EnviroSolution.

Our aim is to provide technologies, technical support and advice for safer, cleaner, more effective solutions in rural areas.

http://myionica.com/indexe.html 
columbus@columbus-gp.com
Lamberti

Lamberti SPA through the Business Unit Agrochemistry, develops and produces, within its technological platforms, molecules and solutions instrumental to generate value in the agricultural market, either as tank mix adjuvants or as additives, for new and better performing formulations of crop protection and nutrition products.

Thanks to continuous innovation and close collaboration with its partners, including consultancy for formulation development, the Company has earned the reputation of a solid technological partner. By combining environmental concern with sustainable development, Lamberti designs agrochemical delivery systems for the industry and the farmers aiming to improve efficacy and efficiency.

www.lamberti.com
agrochemicals@lamberti.com

LEVACO Chemicals GmbH

LEVACO Chemicals GmbH has its headquarters and production site in the Chempark Leverkusen. Our product portfolio includes specialties such as dispersants, emulsifiers, wetting agents and anti-foaming agents. Our products are used in the segments of agricultural chemicals, fibre manufacture as well as paints and coatings. In addition, we also manufacture specialty chemicals for major chemical companies on a contractual basis. We are a member of the Diersch & Schröder Group based in Bremen.

www.levaco.com
info@levaco.com

P

Polaquimia

Polaquimia® offers a wide range of multifunctional chemical solutions with significant competitive advantages in industrial, energy, processes and in the manufacture of raw materials.

In agrochemicals, with own brands and third party manufacturing, we are committed to improve productivity in the field.

In general, products for this sector have an objective: to achieve stability of the different formulations and the easy application of the products. Our solutions are widely used with insecticides, herbicides and fungicides, that require among other characteristics, emulsifying, dispersing and wetting effects.

Our solutions for crop protection include a wide range of herbicides, insecticides, fungicides and adjuvants. Polaquimia Agro solutions are always available in the precise formulation that our clients seek. We have what you are looking for!

• Emulsifiable Concentrates (EC)
• Emulsions in Water (EW)
• Concentrated Suspensions (SC)
• Wettable Powders (WP)
• Soluble Liquids (SL)

With ever-growing demand for environmentally responsible agricultural productivity. Momentive will continue to work closely with our customers. Our reliable, sustainable solutions contribute vital assistance to the agriculture industry, today and into the future.

www.momentive.com
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S

Stepan Company

Stepan Company is a major manufacturer of specialty chemicals including surfactants, antimicrobials, fabric softening quaternaries, phthalic anhydride and polyurethane polyols, as well as specialty ingredients for the food and nutraotical markets. Stepan was founded in 1932 by Alfred G. Stepan Jr. Today, the company has 18 global manufacturing locations, more than 2,100 employees worldwide and over 1,800 product offerings.

Stepan Agricultural Solutions offers a robust pipeline of innovative products and actively seeks to be the strategic supplier of choice for your agricultural chemical needs. Our global research network and geographic footprint is such that we can effectively meet the needs of our customers around the globe.

In addition, our industry-leading, in-house formulation expertise in emulsifiable concentrates, microemulsions, suspension concentrates and dry products provides a value-added service to help solve customers’ most difficult challenges.

http://www.stepan.com/
techserv@stepan.com

Solvay

With an increasing demand and a limited potential of cultivated area the yield increase performance in plant protection and plant growth in a cost effective and safer way is crucial for tomorrow’s agricultural future developments.

All our solutions are expected to provide a wide range of benefits: protection of farmers and of the environment, and enhanced plant quality.

For crop-protection applications, Solvay is dedicated to optimize the use of pesticides while guaranteeing plant vitality and yield per hectare. Our solutions satisfy regulatory requirements and the challenges of sustainable development while simultaneously protecting human health, soil quality and crops.

For fertilizer protection, we provide innovative formulations based on urease and nitrification inhibitors.

www.solvay.com
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Sasol

Sasol is an integrated chemicals and energy group based in South Africa with more than 30,000 employees in 33 countries worldwide.

Our Performance chemicals division is a leading global producer of linear alkyl benzene (LAB) fatty alcohols, isoparaffins, surfactants, waxes etc. We offer the formulator or manufacturer one of the most diversified global portfolios of C6+ alcohols, surfactants and specialty chemicals.

Sasol offers the agrochemical customer and manufacturer many choices from our diversified portfolio of products which can be used as components within a broad range of crop protection, fertilizer & dairy applications. Our portfolio of products can be tailored to the agrochemical application targeted. We can use our extensive alcohol portfolio and LAB production to manufacture a fully integrated surfactant portfolio from DOBSA to various anionic and nonionic surfactants.

The Sasol agriculture team leverages our manufacturing operations around the world to offer solutions to our customers. Since Sasol offers makes many of the same products in different regions of the world we can help our customers overcome many of the challenges of a global business.

http://www.sasol.com/
Paul.filler@us.sasol.com

Schneider Formulations Consulting

Schneider Formulations Consulting is an enterprise founded and owned by Dr. Rudolf Schneider and specialized in supporting agrochemical companies in development of crop protection formulations. We are based in Basel, Switzerland.

Profile:
Dr. Rudolf Schneider is a renowned expert in formulation of crop protection products. During his career with multi-national companies he has acquired extensive knowledge in formulating a wide range of active ingredients. He has developed a number of successful market products and has re-formulated many products to meet new regulatory
Vive Crop Protection

Vive makes proven products cutting edge using the Allosperse® Delivery System. Allosperse is a nanotechnology “shuttle” that enables active ingredients to mix better – with liquid fertilizer, other chemicals, micronutrients and hard water. This allows farmers to use these products in new ways to increase efficiency, crop quality and yield.

Allosperse is used in a number of fertiliser-compatible insecticides and fungicides on the market, including partner brands. Vive works with various companies to improve formulations to improve shelf life, mixability and longevity (in the case of biologicals). Vive’s lead products are AZteroid FC 3.3 fungicide and Bifender FC insecticide.

www.vivecrop.com
products@vivecrop.com
Guar Derivatives
Unlock the Power of Your Formulation

Function:
- Increase droplet size (drift reduction) and improve deposition rate (improved efficacy) in aerial application
- Enhance water and nutrient uptake in seed caring & fertilization

Origin: Based on green chemistries
- Guar gum bio-polymer
- A cold-water-soluble polysaccharide derivative

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