

Plastic Additives

Your key components for reliable performance in the agricultural industry



 **BASF**

We create chemistry



/ Adding value to plastics

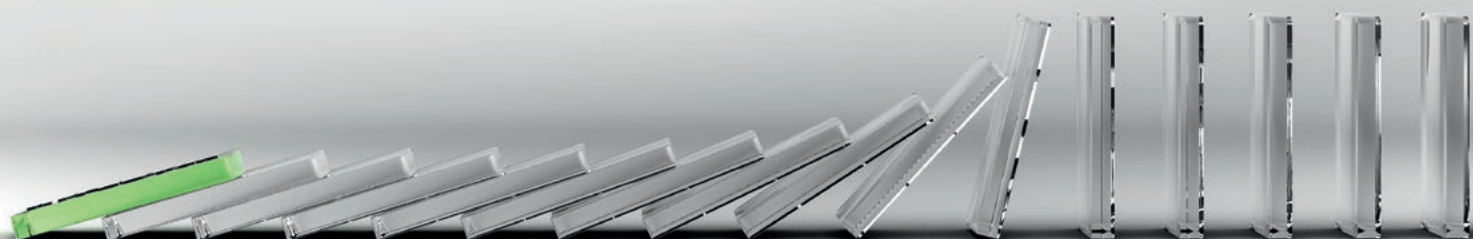
The choice of the best plastic additives is a crucial factor for success in plastic applications. It calls for a reliable partner who not only offers a wide product portfolio but can also provide innovative solutions that can fulfill today's and tomorrow's requirements.

Long-standing expertise and a toolbox approach make BASF the best partner for innovative and customized solutions. New developments and continuous improvement of its portfolio as well as close cooperation with its customers enables BASF Plastic Additives to drive sustainability and reliability in all kinds of plastic applications.

Plastics are valuable materials that offer safe, durable, and cost-efficient solutions. In many cases the use of plastics can be more sustainable than the use of other materials. BASF Plastic Additives offers products that can help to mitigate negative impacts on the environment and also by extending and closing the loop in the circular economy of plastics.

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/ Additives, the enablers for plastic

Plastics are an essential resource in a multitude of applications where they provide outstanding performance in light weighting, ease of use, and functionality. Offering high durability where needed, reliable quality, and safety, they play a vital role in raising living and hygiene standards as well as improving the resource and energy balance.

Public opinion usually associates plastic with single-use products, which might be a reason why plastics have a rather poor image, but plastics are used in many essential applications in various industries. Plastic additives are enablers that can actually contribute to more sustainability when incorporated in the value chain of present and future industries.

Plastics offer features and benefits that other materials do not, and in many cases the alternatives do not have a better sustainability profile. Therefore, the main challenges facing the plastics industry today are to improve sustainability along the entire value chain and to reduce or even eliminate plastic waste in the process.

BASF Plastic Additives supports that process by supplying solutions that contribute to longer product lifetimes, safe and reliable use, as well as resource and energy efficiency. Those properties allow to integrate plastics in a more sustainable way in modern value chains.

Adequately stabilized plastics enable a **very efficient** use of resources, especially during the use phase. At the end of their life, plastics are still very valuable **resources that can be transformed** into new feedstock or into energy.

BASF Plastic Additives help to:

Improve the sustainability profile of plastic products by ...

... extending product lifetimes with solutions that increase durability, and improve resistance to thermal, UV and chemical exposure.

... enabling better processing and performance of recycled plastics with the IrgaCycle® toolbox.



Provide cost-efficient solutions on a global scale by ...

... enabling applications where plastics last longer and require less maintenance than other materials.

... reducing the volume of raw materials and energy needed.

Ensure the safety and reliability of plastics by ...

... reducing exposure to undesirable by-products and residues with high-quality and extensively tested products.

... enhancing the safety of applications which require fail-safe stability and flame retardancy.

... ensuring that BASF's customers can fulfill and meet regional requirements.



/ VALERAS® creating new **VAL**ue for plastics in an **ERA** of **S**ustainability

Join us on this journey. Take a look at our customer stories, featured products, and exceptional services to make sustainable plastics a reality.

Plastics fulfill essential tasks in modern industries, which is why they play a substantial role in the shift towards a more sustainable future. With society and customers becoming increasingly aware of the importance of a holistic view of the value chain and cradle-to-grave approaches, plastics can be seen for what they really are: valuable materials that, with the help of additives, become enablers of more sustainability for many industries.

BASF Plastic Additives aims to promote this sustainability and support its customers with high value plastic additives and solutions to meet market needs. Together we can make plastics lighter, stronger, more durable and safer. It is why BASF Plastic Additives has brought its most sustainable products, innovative solutions, regulatory support, and longtime experience under one brand: VALERAS®. The VALERAS® portfolio includes BASF plastics additives that offer significant sustainability benefits for the plastics industry in many categories including improved durability, energy savings, or by reducing emissions.

Beyond that, BASF promotes the acceleration to a circular economy by developing new and innovative solutions to extend and close the loop. Ensuring that the required

properties of plastics are maintained over a longer product lifecycle helps to keep them in the loop and thereby save valuable resources. Innovative products such as IrgaCycle® enable recycling of plastics and by enhancing the quality of the resulting material to help close the loop.

BASF also provides support when it comes to compliance with regulatory requirements. RegXcellence® for plastic additives is part of the VALERAS® portfolio and offers targeted access to comprehensive global regulatory support for BASF customers.

BASF offers the Product Carbon Footprint Service for its additive solutions, providing insights into how these materials impact carbon emissions. This service includes selected products available as a premium service via the myBASFWorld online portal, with free registration.

In addition, BASF offers biomass balance additive solutions under the BMBcert® range, made from certified renewable feedstock, to reduce fossil resource consumption and lower the CO₂ footprint while ensuring high performance and quality.

VALERAS® by BASF Plastic Additives
enables customers to achieve their
sustainability goals.





Plastic additives for the agricultural industry

Plasticulture must constantly adapt to the challenges farmers face worldwide. On the one hand, consumer demand for variety in vegetables and fruits has increased. On the other hand, there is the demand to reduce plastic waste and enhance recycling. Availability all year round, as well as tasteful and improved fruits and vegetables quality, are aspects that are becoming more important to consumers today.



To fulfill those demands while finding sustainable ways to use plastics for farming innovation, additives are used to protect and enhance the properties of agricultural plastics. Agricultural plastics are exposed to very high levels of UV radiation, thermal stress, and chemicals such as chlorine used for soil disinfection. Other sources of exposure include sulfur-based agrochemicals or elemental sulfur applied to avoid and treat pest invasion and fertilize soil. Improper protection of the agricultural plastics can lead to their early degradation, resulting in unexpected expenses for the farmers who must replace the damaged plastics. Plastics breakage incurs the risk of pest invasion and, as a result, crop losses.

Therefore, the use of durable plastics in agriculture is a way for farmers to ensure an increase in yield and protection of their crops while saving costs in resource consumption. Plastic additives contribute to ensuring the quality and functionality of these plastic applications.

Protecting and saving resources creates value

With its long-standing expertise and the adaptation of products, BASF offers original solutions for its customers worldwide and delivers outstanding protection as well as exceptional durability and optical properties to agricultural plastics.

The use of agricultural **films** will extend to regions not involved in food production before.





VALERAS®

Creating value for plastics used in the agriculture industry

Extending and closing the loop on plastic circularity

Plastic waste management has become one of the most pressing environmental issues for the agriculture industry – hence inviting the industry players revalorize such valuable material. Plastics have an exceptional role to play in sustainable farming, for example by saving water in especially warm regions and converting non-cultivable land into arable land. In the future, it is feasible that this valuable material can be recycled on a wider scale. In practice, this valuable material can be recycled after its first intended use and reused. The tide of the linear “take-make-dispose” culture in plastics is turning towards extending and closing the loop. A circular economy is the way to move forward.

BASF Plastic Additives with its innovative product portfolio enables its customers to contribute to more sustainable farming by helping to increase the durability and recyclability of plastic materials used in agriculture.

How BASF Plastic Additives add value to your products

✓ Durability

It is crucial for agricultural plastics to be of a high quality so that applications such as greenhouse covers have a longer lifetime. In some cases, the lifetime of films can be increased by over 50% compared to those containing alternative additive solutions.

✓ UV light, heat, and chemical resistance

BASF’s wide range of light stabilizers protect agricultural plastics during their service lifetime against increased UV radiation and heat caused by climate change. They also offer an outstanding resistance to the chemicals used in agriculture.

✓ Safe for pollinators

Honeybees and bumblebees play a vital role in ecosystems. The growth of fruits and vegetables in intensive horticulture depends directly on their pollination activities. BASF supports the hard work of these pollinators with bee-friendly UV absorbers that do not interfere with the insects’ activities.

✓ Reduction of film thickness

Thickness reduction is one of the major trends in plasticulture thanks to new polymer grades and more efficient equipment. Downgauging of agricultural films results in an increased sulfur and chlorine intake. BASF NOR® HALS enhance the protection against such higher chemical contamination and extend their durability.





Serving the sustainable market trends in agriculture

With challenging conditions around the world ranging from an increasing population to climate change, raw material scarcity and more demanding consumers, two trends have emerged in the agricultural spotlight: sustainability of agriculture systems and organic farming.

Plastic additives help to reduce agricultural plastic waste by protecting plastics against premature degradation. They also enable optimum light to ease the natural activity of bumblebees, honeybees and auxiliary insects and increase production.

Top sustainable uses of plasticulture:
Plastic waste reduction, water management
and longer food storage.

Increasing requirements in agricultural plastics

Robust formulations, multilayers, improved polymeric structures and downgauging are increasing requirements in agricultural plastics. Furthermore, compliance of agriculture plastics with organic farming standards is a must-have requirement involving optimum light for crops, profitability for farmers, and exposure of plastics to critical levels of chemicals (sulfur, chlorine).

The journey towards sustainable agriculture is challenging and one which BASF Plastic Additives is dedicated to support. Its unique stabilization systems directly address current and future market needs.

BASF's light stabilizers and UV absorbers support all agricultural plastic applications. The latter benefits range from the protection of fermented high moisture fodder to feed livestock with reinforced silage films, water saving with protected drip irrigation pipes, to the reduction of plastic waste by extending the lifetime of greenhouse covers, even if critical levels of chemicals are present.

Case Study

Sustainable farming with NOR® technology

BASF's plastic additives solutions for the agriculture industry not only help to meet increasingly challenging conditions around the world but also the rising demands set by governments and consumers.

Sustainability is a global and cross-industry requirement that is also becoming increasingly important in the agricultural sector. Those requirements involve not only sustainable management of resources and combating climate change, but also making a positive contribution to the economy.

Safe and long-lasting greenhouse films

Farmers globally are facing increasingly extreme weather conditions. Droughts and heat waves are threatening crop yields, increasing water scarcity and decreasing arable land. To function economically and ecologically, greenhouses must produce fruits and vegetables year-round. In addition, increased and more intense UV light leads to premature degradation of greenhouse films, resulting in a loss of their mechanical properties. The decomposition is exacerbated by crop treatment with sulfur and disinfection with chlorine, which ultimately leads to film breakage. This can imply that farmers not only lose their crops but, in the case of organic farming, also may lose their certification after a 3-year inspection period. BASF's NOR® technology helps farmers to overcome these challenges.

NOR® technology improves the mechanical properties of agricultural films by enhancing their durability, supporting optimal light transmission, and increasing their resistance to chemicals. This lowers costs for farmers as the extended lifetime and durability of the films reduces film replacement and thus plastic waste. This can also prevent revenue loss and the need for recertification for organic farmers. Maintaining the mechanical properties of agricultural films qualifies them for recycling at the end of their useful lifetime.

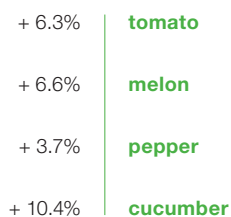
Optimal light transmission in greenhouses

Optimum light transmission is crucial for greenhouse films. While light stability must be guaranteed for the plastic, sufficient sunlight must enter to favor efficient crop growth and promote the activities of pollinators and auxiliary insects inside the greenhouse. BASF, in collaboration with Estación Experimental Cajamar, conducted agronomic tests in Almería, Spain, monitoring the quality and commercial yield of vegetables and fruits. The tests used a NiQ-based film and a NOR®-based film.

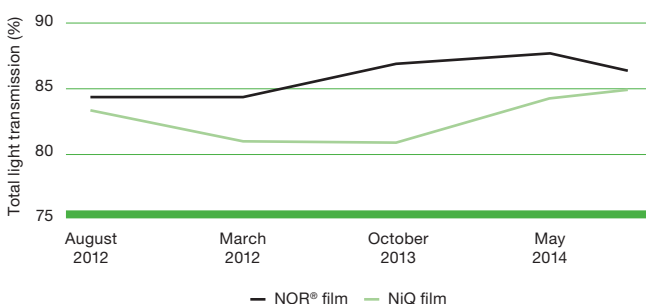


Optical properties of films and impact in solar radiation (%)
Agronomic trials at Cajamar Station comparing NOR® film and NiQ film

Increased solar radiation under NOR® film
 (% per crop)



Total light transmission upon weathering
 (films washed to eliminate white washing effect)



NOR® film with higher transmittance through the whole exposure time

Both films had the same characteristics (polymers, layers, targeted duration, thickness, fillers) and were exposed to the same conditions. Focusing on cucumber, tomato, pepper, and melon grown inside the greenhouses produced the following results:

While the NiQ-based film could not withstand the thermal stress and broke prematurely, the NOR®-based film showed higher resistance and maintained a good condition until the end of its theoretical lifetime. An average increase of

7% solar radiation within the greenhouses with the NOR® technology was measured, which in turn had a positive effect on plant growth. Peppers were harvested earlier, and tomatoes showed a higher sugar content. Overall, commercial yield grew by an average of +7.8% and earnings by € 3,900/ha.

BASF Plastic Additives' continued collaboration with Estación Experimental Cajamar includes many projects linked to agricultural plastics, agricultural practices and trends.





Recommended NOR® HALS and HALS for all agriculture plastic applications

BENEFIT	Greenhouse & tunnel films	Floating covers	Silage films	Protective nets	Bale wrap nets
Processing stabilization	Irganox® B215/225 Irganox® B900 To ensure minimum damage to polymer backbone during processing to the final article				
Resistance to critical/severe levels of sulfur and chlorine	Tinuvin® NOR® 356 Tinuvin® NOR® 211				
Resistance to severe levels of sulfur (>1500ppm) and chlorine (150ppm)	Tinuvin® NOR® 211				
Resistance to severe levels of sulfur (<1500ppm) and chlorine (100ppm)	Tinuvin® NOR® 112 Tinuvin® 494 AR		Tinuvin® NOR® 112		Tinuvin® NOR® 112 Tinuvin® 494 AR
Resistance to moderate levels of sulfur and chlorine	Tinuvin® NOR® 112 Tinuvin® 111 Chimassorb® 2020 Chimassorb® 944				
Optimum optical properties/ light for crops and natural pollinators	Tinuvin® NOR® 356 Chimassorb® 2020 To optimize UV and visible light management				
Low interaction with article pigmentation			Tinuvin® NOR® 356 Tinuvin® NOR® 211 Tinuvin® NOR® 112 Tinuvin® 111 To avoid loss of efficiency of the stabilization system		



Terminology

- ABS** Acrylonitrile Butadienestyrene
- EBA** Ethylene Butyl Acrylate
- EVA** Ethylene-Vinyl Acetate
- HDPE** High-Density Polyethylene
- HIPS** High-Impact Polystyrene
- LDPE** Low-Density Polyethylene
- LLDPE** Linear Low-Density Polyethylene
- LS** Light Stabilizer
- LTTS** Long-Term Thermal Stabilizer
- PA** Polyamide
- PBT** Polybutylene Terephthalate
- PC** Polycarbonate
- PE** Polyethylene
- PES** Polyester
- PET** Polyethylene Terephthalate
- PMMA** Polymethylmethacrylate
- PO** Polyolefin
- POM** Polyoxymethylene
- PP** Polypropylene
- PS** Polystyrene
- PS** Process Stabilizer
- PU** Polyurethane
- PVB** Polyvinylbutyral
- PVC** Polyvinyl Chloride
- TPO** Thermoplastic Polyolefin
- TPU** Thermoplastic Polyurethane
- UVA** UV Absorber

BENEFIT	Mulch and soil disinfection film	Drip irrigation pipes	Non-woven	Twines, clips & substrate bags
Processing stabilization	Irganox® B215/225 Irganox® B900 To ensure minimum damage to polymer backbone during processing to the final article			
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