Layman's report - LIFE SMART SPRAYER

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Countries: Germany, France, Hungary, Romania
Coordinating Beneficiary: BASF Digital Farming GmbH
Partners: AMAZONEN-Werke, Robert Bosch GmbH, University of Hohenheim, Bosch BASF Smart Farming GmbH

Rethinking herbicide use in european agriculture

Modern agriculture depends on reliable and effective tools to protect crops from pests, diseases, and weeds. Among these, herbicides are a widely used and valuable part of integrated weed management strategies. They help ensure consistent yields, reduce labor, and enable the cultivation of high-quality crops on a large scale. However, the way herbicides are typically applied—uniformly across entire fields, regardless of weed presence—offers limited flexibility and does not take full advantage of today's digital and technological possibilities.

This standard practice, known as broadcast spraying, has long been the norm in conventional arable farming. It treats the field as a whole, even though weed pressure often varies from one part of a field to another. As a result, herbicides are often applied to areas where no weeds are present, simply because the technology to do otherwise has not been widely available. While this approach is efficient in terms of time and equipment use, it does not differentiate between treated and untreated zones and can result in unnecessary input costs and missed opportunities for more targeted interventions.

At the same time, public expectations for more sustainable farming practices are increasing. Consumers, policymakers, and environmental stakeholders are calling for solutions that reduce the overall environmental impact of farming, while maintaining productivity and profitability for farmers. The European Union has responded with a clear policy direction: the Green Deal and Farm to Fork Strategy include goals to reduce the overall risk and use of chemical pesticides, protect biodiversity, and support climate-resilient food systems.

The LIFE SMART SPRAYER project was created in this context. Its purpose was not to reduce herbicide use for its own sake, but to demonstrate that site-specific application—enabled by digital detection and decision support—can be a more efficient, sustainable, and effective approach. By targeting weeds precisely and leaving weed-free areas untreated, the project aimed to show that it is possible to maintain high agronomic standards while minimizing unnecessary inputs, reducing environmental exposure, and creating added value for farmers.

A vision for smarter spraying

LIFE SMART SPRAYER was launched in October 2021 under the EU's LIFE Environment and Resource Efficiency Programme. It was designed to demonstrate that precision farming technologies could provide a real alternative to conventional herbicide application methods. The central idea was to build and test a "smart sprayer" that could detect and treat weeds selectively, using advanced sensors and artificial intelligence, and to assess its environmental, economic, and practical impact on farms across Europe.

The project was led by BASF Digital Farming GmbH in partnership with leading companies and institutions including AMAZONE (specialists in agricultural machinery), Bosch (experts in sensor and imaging technology), the University of Hohenheim and Bosch BASF Smart Farming GmbH. Together, the partners brought a unique combination of agricultural knowledge, technical expertise, and digital innovation.

The Smart Sprayer developed in the project is a highly advanced machine that replaces the traditional broadcast approach with selective spraying. Mounted on a standard crop sprayer, it is equipped with high-resolution cameras and LED lighting units that scan the field in real time. These sensors are capable of distinguishing weeds from crops based on image analysis. Once a weed is detected, the system automatically triggers the nozzles on the sprayer to apply herbicide only where it is needed. Areas of the field that are weed-free remain untreated.

What makes this system truly innovative is the integration of real-time detection with digital agronomic decision-making. This is enabled by the Xarvio Agronomic Decision Engine, or ADE, which combines field data, weather forecasts, crop growth stages, and weed information to determine the best time to spray at the appropriate dosage. The ADE tailors these recommendations to specific field conditions and crop types, enabling precise, sustainable, and cost-effective weed control.

From concept to field: testing across europe

Between 2022 and 2024, the Smart Sprayer system was tested under real farming conditions in four European countries: Germany, France, Hungary, and Romania. These countries were selected to reflect a wide variety of climatic zones, soils, cropping systems, and farm management practices. In total, the system was tested on over 17000 hectares of farmland. The project focused on crops that are especially common in Europe and typically require high levels of weed control, including maize, sugar beet, sunflower, and soybean.

The field trials were designed to rigorously evaluate the Smart Sprayer's performance in a wide range of conditions. Farmers worked closely with project teams to apply the system in their fields, compare it with traditional spraying methods, and monitor outcomes. Data were collected on herbicide usage, weed control effectiveness, crop yields, biodiversity impacts, and farmer feedback. In parallel, the project partners conducted detailed environmental and economic assessments to understand the broader implications of the technology.

Environmental and biodiversity benefits

One of the key findings of the project was that precision spraying can lead to significant environmental benefits without sacrificing agricultural performance. Across all test sites, the Smart Sprayer system achieved significant herbicide savings compared to conventional broadcast spraying. In some cases, especially under lower weed pressure or in sugar beet, reductions of up to 80% were recorded. In total, 18.4 tonnes of herbicide active ingredients were avoided during the project.

This reduction in chemical use translated into direct environmental gains. Lower herbicide volumes mean less risk of chemical runoff into rivers and lakes, less soil contamination, and lower exposure for farmers and wildlife. The project also calculated a reduction of CO_2 emissions, based on avoided herbicide production, transport, and application. These figures show that smart spraying can play a valuable role in reducing agriculture's environmental footprint.

Perhaps even more striking was the impact on in-field biodiversity. Traditional herbicide spraying eliminates all vegetation in treated areas—including non-harmful flowering plants that provide food and habitat for pollinators and other beneficial insects. In contrast, the Smart Sprayer system preserved these plants in areas without weeds. Field monitoring showed that treated plots often retained four to five flowering species per square metre. These plants support bees, butterflies, and natural pest predators, which are essential for healthy and resilient ecosystems.

A strong agronomic and economic case

In addition to its environmental value, the Smart Sprayer demonstrated strong agronomic and economic performance. Weed control remained effective across all trial crops. In many cases, it was equivalent to or better than the results achieved through standard spraying. In sugar beet, where early-season weed competition can be especially damaging, some fields saw yield increases of up to 20% when using the Smart Sprayer.

From a cost perspective, the system delivered tangible savings on herbicide inputs, with estimated savings ranging from €9 to €78 per hectare depending on crop type, weed pressure, and treatment strategy. While the equipment itself represents a significant investment, the analysis showed that large-scale farms could recover their costs within two to three years. For smaller farms, the cost-effectiveness was less certain, suggesting a need for cooperative use models or public incentives to enable access to the technology.

The system also made daily operations more efficient. By reducing the amount of herbicide needed and allowing for faster and more targeted spraying, the Smart Sprayer simplified logistics and minimized downtime for tank refills. Farmers appreciated the support provided by the ADE, which gave clear, actionable advice and reduced the uncertainty around when and how to spray.

Transferability, future use, and broader impact

Although the LIFE SMART SPRAYER project achieved its technical and environmental goals, the full commercial rollout of the system in the EU was ultimately not pursued. This decision was based on a combination of factors, including the complexity and cost of integrating the full system into mass-market sprayers, limited willingness-to-pay among farmers, and changes in EU policy, particularly the withdrawal of the proposed Sustainable Use of Pesticides Regulation in March 2024.

Nonetheless, the project generated a significant legacy. The Smart Sprayer system demonstrated what is possible when cutting-edge technology is applied thoughtfully in agriculture. The knowledge, data, and experience gained during the project will continue to influence the development of future crop protection tools. Elements of the system—such as the ADE and the weed detection software—can and will be integrated into other platforms. Meanwhile, interest in the system remains strong in non-EU markets such as Brazil and Argentina, where larger farms and different regulatory conditions may support faster adoption.

The LIFE SMART SPRAYER also made a broader contribution to EU policy. It provided a practical demonstration of how digital farming can support the Green Deal and Farm to Fork targets. It offered a model for reducing pesticide use while maintaining food production and economic viability. And it showed that environmental and economic goals in farming do not have to be in conflict—they can be aligned through smart, science-based solutions.

Looking ahead

LIFE SMART SPRAYER proved that a smarter, greener approach to weed control is not only possible, but effective and ready for deployment in the right conditions. By reducing herbicide use, preserving biodiversity, and helping farmers make better decisions, the project contributes to a more sustainable and resilient agricultural future.

As the EU continues its journey toward climate neutrality, environmental restoration, and healthy food systems, projects like LIFE SMART SPRAYER offer valuable lessons and tools. They remind us that innovation in agriculture is not just about producing more—but about producing better, with care for the land, people, and future generations.