



**Towards zero plastic soil management
agricultural practices**

Replicability and Transferability Plan

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1. The LIFE AGROPAPER project

The **LIFE AgroPaper®** project is focused on the reduction of plastic mulch use in agricultural practices. The solution proposed is a paper mulch 100% biodegradable and compostable totally environmental friendly.

The main objective is to verify whether paper mulch is effective with a wide variety of agricultural crops. For that aim the paper will be proved in different crops and in different climatological areas through trials of two years of duration.

To verify that the paper mulch works correctly, the paper has been tested in a variety of crops. The project leader is Smurfit Kappa, accompanied by Florette, Floréale and Grupo AN carrying out the field demonstrations of the different crops in Spain and France, and CEBAS-CSIC and SEAE, in charge of the following up and validation of the sustainability of the process.

2. Why a Replicability and Transferability Plan?

The Replicability and Transferability Plan of the **LIFE AgroPaper®** is a core part of the project as one of its main goals is to reduce or eliminate the use of plastic mulching and replacing it by 100% bio-based and biodegradable mulches, as for example long fibre paper mulching obtained from Forest Stewardship Certified (FSC) pine-trees.

The need of replication and transfer of the project's methodology, results and products to other contexts, regions, pedoclimatic farming conditions or even for different social-cultural backgrounds of farmers, is crucial for moving forward in sustainability in our food systems.

The environmental impact of the use of plastic mulches includes GHG emissions for its manufacture, 265.000 tons of CO₂ per year are generated throughout the production process of the 100,000 tonnes of plastic mulch used in the European Union. It also includes the waste that is then irreversibly left in the environment; soil, water and living beings. Plastic mulch has direct contact with the soil and the crops we will eat, and only 32% of plastic mulch used is collected at the end of use, with the rest being either landfilled, left in soils, or burnt. This means that 68,000 tons of plastics and microplastics, are added yearly to the European agroecosystems.

Products derived from the disintegration of plastics have toxic and altering effects on living beings, including humans, and with plastic mulching, they enter the food system from the very beginning. The presence of plastic and plastic derived products has led to the decrease of soil fauna, such as mites, worms or insects, and compromised the fertility of the soil. The toxic chemicals released from plastic degradation, such as phthalates and Bisphenol A (BPA) enter the food chain causing harmful effects, disrupting the hormone system, causing inflammation, or traversing cellular barriers, and even the blood-brain barrier or the placenta, where they can trigger changes in gene expression and biochemical reactions, among other things.

The more projects that are developed aiming the same purpose, and the more the use of paper mulching is spread, the more we will contribute to conservation efforts by avoiding the use of single use plastic covers and the liberation of plastic particles and microplastics to soil and environment, using practices, methodologies and actions already successfully implemented in this project. And the healthier our societies will be.

Definitions:

According to the National Academies of Sciences, Engineering, and Medicine:

- **Replicability** is obtaining consistent results across studies aimed at answering the same scientific question, each of which has obtained its own data. Replication means that when the same methods, techniques, prototypes or practices used in the project are developed again in the same way and for the same purposes in other projects by other entities, consistent results are obtained given the level of uncertainty inherent in the system under study.

- **Transferability** is a term used for something transferable or exchangeable. The methods, techniques, prototypes or practices developed and/or used in the project are used in a different way or for different purposes. In research, however, the term is used for reliability.

3. Tools to enable transferability and replicability

This document lays down a list of actions needed to replicate the **LIFE AgroPaper®** (LIFE 19 ENV/ES/000404) project and includes applicable recommendations for developing the interventions made under the scope of the project elsewhere. A first draft of this document has served as a guiding document throughout the project implementation as many of its actions aimed for the exchange of knowledge and networking with similar projects. Learning from their feedback, but also aiming for transferring the knowledge generated through the LIFE AGROPA-PER project and the replicability of the use of AgroPaper™ mulch.

The Replicability and Transferability Plan relies on five pillars:

- I. **A systematized production process**, with detailed protocols for each different type of **AgroPaper™** mulching sheets, according to the different grammage, width, colour and screen prints.
- II. **Protooled field trials**, with specifications based on the type of the pedoclimatic conditions of the fields, the crop for which it is used, the farm management and the tools used for installing the mulching.
- III. **Systematized and protocolized laboratory essays and analysis** characterize the paper used, it's impacts on soil fertility, carbon and organic matter content and biological activity.
- IV. **Engagement with farmers, technicians and researchers** that have used **AgroPaper™** in their greenhouses, farms and plots outside the project, to gather complementary information and identify bottlenecks for replicability and transferability.
- V. **Engagement with the different stakeholders involved in the food-chain**, through seminars, trainings and meetings, some individually and others in small and wider groups, to expand the network, disseminate the project and its results and enhance its replication as much as possible.

And consists in the following tools:

A. Specifications for all Scenarios

The project has helped delivering different kinds of paper mulch that cover different crop needs, managements and environmental conditions. Protected crops have different needs than if they were grown outside, but also the weather and environmental conditions affecting the mulch are different.

The main parameters to be considered when choosing a certain type of mulching will be whether the crop was grown outside or in a greenhouse, how the paper mulch will be installed (manually or mechanically), the life cycle of the crop (less than 2 months, between 2 and 6 months, more than 6 months), the exact crop for which it will be used, the weather conditions (such as wind exposure, humidity, rainfall and temperature), the type of irrigation system (sprinkler, drop or none) and, of course, the range of adventitious plants to be controlled.

The performance of the AgroPaper™ mulch will be influenced by the following parameters:

- **Grammage:** weight of paper per unit area (g/m^2)
- **Cobb60:** amount of water absorbed (g/m^2)
- **Gurley's Porosity:** air permeability ($\text{s}/100\text{ml}$)
- **Burst index:** tells about the property of the material to bear the stress when an external pressure is applied to it ($\text{kPa}\cdot\text{m}^2/\text{g}$)
- **Tear index:** force required to continue the tearing on an initial cut in a single sheet of paper: machine direction or cross direction ($\text{mN}\cdot\text{m}^2/\text{g}$)
- **Tensile strength:** maximum stress to break a strip of paper sheet (kN/m)
- **Wet strength:** percentage of conserved resistance of the paper after its immersion in water for 1 hour. (%)

A full range of **AgroPaper™** of different grammages between 50 and 90 g/m² were tested, to identify which one had better performance controlling adventitious plants, humidity and temperature. The resistance of the paper mulch is highly relevant, especially for certain crops, so, the refining of the paper was kept low, to let fibres remain long, resulting in a porous and resistant paper mulch.

The direction in which fibres are structured will have consequences on its response to tension. The exposure to moisture and temperature changes in the area of the paper that remains on top of the soil, will need increased strength in the cross direction (CD) while when installed by machine, tensile strength in the installing direction (MD) will also be important to avoid tearing.

Another target was to find a paper with the minimum possible water absorption, to avoid tearing. After noting that applying natural inks for temperature regulation, helped decrease water absorption, **AgroPaper™** versions were either covered with ink (when needed) or varnished, with natural raw materials based products, also compostable and biodegradable.

To increase the resistance of the borders of the paper sheets, that remain buried since the very beginning of its installation, to be digested by soil microbiome, the solution was to apply Polylactic Acid coating (PLA), that also fulfills the following criteria:

- It comes from **renewable sources** (it is not a bioplastic) → It is obtained from corn or cassava starch fermentation.
- TÜV AUSTRIA **OK Biobased** certification.
- DIN CERTO certification as **compostable under industrial conditions**.
- **Biodegradable** in CO₂, water and biomass by microbial digestion.
- Suitable for **food contact** (EU and FDA regulations).
- Good **mechanical resistances**.

AgroPaper™ can be manipulated by farmers manually or mechanically. The SXWS paper version have been selected as the best options for outside crops grown under adverse weather conditions and the SX/70 + PLA version of **AgroPaper™** is also an optimum alternative for these managements and crops, since the PLA layer provides an important protection to the paper, avoiding water absorption and improving resistances.

TYPE OF PAPER	PLACE	INSTALLATION	CROP	CYCLE	IMPACT OF WEED GROWTH	CLIMATE	TYPE OF IRRIGATION
SX70	GREENHOUSE	MANUAL	Various crops	Short- Medium	Poor- medium	Dry	Sprinklers, Drip, None
SX70 BLACK	GREENHOUSE	MANUAL	Various crops	Short- Medium	High	Normal	Sprinklers, Drip, None
SX90	OUTDOOR	MECHANICAL	Various crops	Short- Medium	Poor- medium	Normal	Sprinklers, Drip, None
SX90 T+B	OUTDOOR	MECHANICAL	Various crops	Medium- Long	High	Normal & Extreme	Sprinklers, Drip, None
SXWS90	OUTDOOR	MECHANICAL	Various crops	Medium- Long	Poor- medium	Normal & Extreme	Sprinklers, Drip, None
SXWS90 T+B	OUTDOOR	MECHANICAL	Various crops	Medium- Long	High	Extreme	Sprinklers, Drip, None
SX70+PLA	OUTDOOR	MECHANICAL	Various crops	Medium- Long	High	Extreme	Sprinklers, Drip, None

This information is available to all potential customers who are interested in the use of **AgroPaper™** for their crops. Taking all these information into account, the different types of **AgroPaper™** will be satisfactory in the indicated conditions, although it may be affected by external variables that do not depend on the product itself. Therefore, in scenarios such as those included in the table, and complying with the variables, a satisfactory performance of **AgroPaper™** should be replicated.

AgroPaper™ fulfils all the requirements set for inputs to be used in organic farming according to Regulation (EU) 2018/848 from the European Parliament and Council, of May the 30th 2018 on organic production and labelling.

B. Guidelines on how to grow crops using paper mulching

These guidelines can be found in Spanish and in English and have detailed explanation on the different types of **AgroPaper™** mulch available and their suitability for each type of crop and agri-climatic conditions, as well as the recommendations for its use and implementation, as well as the requirements of the machinery and tools used during the process. They can be downloaded at:

<https://www.lifeagropaper.eu/life-agropaper-publishes-manual-for-farmers-to-learn-how-to-lay-paper-mulch/>

C. Technical documents to influence in agricultural and environmental legislation (only useful for Europe)

Including 3 different kinds of technical documents depending on the target administration:

- One for agrarian administrations, aiming to ensure that pine tree long fibre paper mulch **AgroPaper™** is included in current legislation for mulching and, also, asking for funds from the Common Agricultural Policy to be allocated for accompanying farmers with the use of these kinds of mulching, for the ecological transition.
- Another one for the environmental administrations, asking them to promote the use of paper mulch **AgroPaper™**, made from FSC pine tree's long fibre, in their Strategic Plans, Strategies and Policies, for Climate Change Mitigation and Adaptation, Environmental Protection and Conservation, Water Regulation.
- And a third technical document for competent authorities on Organic Farming, aiming to ensure that, as soon as the legal framework for biodegradable mulching is set at the EU level, and it becomes included in a category of fertilisers, mulching like paper mulch **AgroPaper™** made from FSC's pine trees long fibre, they are also included in the organic legislation.

D. Participatory methodologies used throughout the project

Participatory methodologies are a form of qualitative research and are made up of methods and techniques that encourage the members of the study group to take ownership of the research topic and enrich it with their experiences, thus promoting people to share information, Learn from each other and work together on common topics.

They consist in research methodologies that conceive the participants of the project or workshop as active agents in the construction of knowledge, and not as passive agents. Promoting that all participants actively contribute to the teaching and learning process, instead of passively receiving information from outside experts, who sometimes may not properly understand the specifics of the role of the different stakeholders.

The participatory methodologies used throughout the development of the **AgroPaper™** project have been:

- **Participatory Rural Appraisal (PRA)** covers a wide range of methods that allow a local population to analyse their own realities as a basis for planning, monitoring and evaluating development activities. Use focus group exercises to facilitate information sharing, analysis and action among stakeholders. In the case of the LIFE AgroPaper™ project, it has been used to address the realities of each subgroup of stakeholders: prescribers, replicators, especially farmers, and retailers.
- **Opinion of the beneficiaries.** Beneficiary feedback systems seek to capture the views of key stakeholders on the quality and impact of a development agency's work.
- **Key informant interviews:** In the development context, key informant interviews are a methodology that can be used as an intermediate indicator of the results of a research or social development project, either as an alternative or complement to full impact evaluations. In this case, interviews with farmers and farm technicians who have used Agropaper have been crucial.

A survey using a semi-open format to obtain information as relevant as possible was completed including aspects such as the main motivation/s for using mulching (Weed control, Conservation of soil moisture, Temperature regulator, Soil protection, etc.), the main motivation/s for trying **AgroPaper™** (Environmental concern-coherence, to guarantee no-plastics are incorporated in soils to accomplish with CAP conditionality, on-field compostability and biodegradability, costs, etc) and also data for cost analysis and evaluation of results and improvement suggestions.

4. References

- Regulation (EU) 2019/1009 of the European Parliament and of the Council, of 5 June 2019 laying down rules on the making available on the market of EU fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009.
- OK COMPOST HOME Certification (TÜV Austria), that guarantees its biodegradability through the domestic composting process, which means, at environmental conditions, without the need of being exposed to the temperatures used in industrial composting.
- Regulation (EU) 2018/848 from the European Parliament and Council, of May the 30th 2018 on organic production and labelling.
- Regulation (EU) 2021/1165 of 15 July 2021 authorising certain products and substances for use in organic production and establishing their lists.



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