EIP-AGRI Focus Group

Reducing the plastic footprint of agriculture

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Minipaper D: Agricultural management, on site practice to reduce plastic use and the contamination in the environment

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Introduction

The use of plastic for several decades on European farms allowed farmers to increase and improve their production. The uses are diverse e.g. greenhouses, low tunnels, mulching, irrigation, silage wraps etc.

The economy of a lot of rural territory in EU and economic sectors depends on plastic and it is essential for many farms. But, like other inputs in agriculture, (e.g. pesticides, fertilizers, fuels), plastics can cause damage to the environment. Policymakers, environmentalists, researchers, industries, farmers organizations have to work together to find a good balance between economic interests and environmental challenges.

To reach the goal of "Reducing footprint of plastic in agriculture", we have to work at all the levels of the life cycle of plastic, in particular at the farm level. This is the subject of this minipaper, as is the main objective of this focus group.

We present in this document concrete measures and examples which can be put in practice in farms. Those best practices are currently implemented and could be developed on a larger scale across EU. We focused on five topics:

1. **reduction of plastic use**
2. **collection of plastic waste from the farm**
3. **plastic waste storage at the farm**
4. **use of biodegradable plastic**
5. **communication about the good practices**

The optimization of the use of plastic on the farm is not easy to implement in many situations (lack of time, difficulty to invest in a good equipment, lack of information, and other priorities on the farm). At the same time, the recycling of used agricultural plastic is a great challenge. This document aims to respond to a part of this problem, with a simple and concrete approach. It aims to present some solutions, which can be cost-efficient for farmers and relatively easy to put in practice. In addition it identifies a more modern approach to communicate based on social media.

1. Plastic reduction

To face the issue of plastic at the farm level, one way is to reduce the use of plastic; this can be achieved in different ways:

- **Try to reduce or avoid the packaging of the inputs of the farm**: for example, prefer bulk fertilizer to fertilizer in bags or big bags.
- **Prefer an agricultural technique that does not use plastic or reduce its use in the process of production**. For example: replace silage by hay in cattle production.
- **Reuse the plastic on the farm:** if used correctly, without damage, the tarpaulins can be reused from one year to the next. Sometimes plastic products cannot be used again after the first use for the same function but can be used in other activities on the farm. For example, in Poland, film from covering silage for dairy cows is very often reused as a protection in grain handling and storing. Generally, farmers could be very successful in reusing plastic containers and foil for use in daily farm routine. However, the capacity to reuse the plastic on the farm is limited. Due to this fact we should be focused on large scale solutions, which could be adopted in every farm, regardless of the region or farm's size.
- **Change the cropping system**: in some cases cover crops, or crop diversification can replace some functions of the plastic films.

All those alternatives are more or less easy to implement on the farm. Some of them are cheap and cost-efficient, but some others need more investment, e.g. a change to the production system: in these cases, reducing the use of plastic is an economic risk.

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2. Best practices for plastic collection: the case of plasticulture and greenhouse productions

When establishing best practices for collecting plastic wastes in the field, we must take into account the different types of crops and the type of plastic they need. Here are some examples in vegetable production:

2.1 **Plastic mulching,** common in horticultural products, can be handled in different ways**:**

2.1.1 Plastic mulching in tomato cultivation

During harvest, the plastic film is damaged and, for this reason, the use of biodegradable plastics is strongly recommended because the farmer can save large management and labour costs. A thickness of 60 gauge (15 µm) is recommended. Before harvesting, it is recommended to remove the irrigation belts to avoid the harvester getting stuck. When the harvester passes by, the plastic ends up being broken together with the plant remains. As it is biodegradable, it will not be necessary to collect it and it will be sufficient to pass a chisel to finish tearing the plastic and leave it in small pieces for biodegradation.

Figure 1: Tomato field before and after harvest

2.1.2 Plastic mulching for other vegetables

There are other examples of the use of machinery and techniques in the mulching of horticultural crops: e.g.: pepper, eggplant, zucchini, pumpkin. A thickness of 80 gauge (20 µm) is recommended for the conventional plastic mulch to be removed. Before removing the plastic, a brush cutter can be used to cut up the plants so that the plastic can be easily removed. Sheep can also be used to eat the rest of the plant. It is recommended to check the soil moisture and if needed to water a few days before removing the plastic to ensure that the soil is in good condition and soft enough. With less tension and friction the soil does not slow down the progress of the tools. Mechanical removal is the best option as in one pass all the plastic mulch can be removed from the surface. The tool that is normally used consists of a blade parallel to the ground that passes under the plastic and digs out the sides leaving it loose. After this, a bobbin attached to the machine rolls the plastic up to the end of each row, where it is deposited and later loaded onto a trailer.

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Figure 2. Picture of tool used to remove plastic mulch. A blade parallel to the ground that passes under the plastic and digs out the sides leaving the plastic on the surface

Once all the plastic is at the edge of the plot, with the help of the tractor's shovel and a trailer, the plastic will be taken, differentiating between watering belts and plastic mulch, to an authorised manager for recycling. Due to the characteristics of the equipment and the work methodologies, very little plastic remains in the soil, thus reducing the environmental risks with this technique.

2.1.3 Plastic films for asparagus cultivation

The cultivation of asparagus requires plastic both for the padding covering of the ridge and for the irrigation strips. The plastic recommended for this crop is two-coloured, thick (250-300 gauges) and with pockets on both sides where soil is placed to fix the plastic onto the field.

Figure 3. Plastic film used for growing asparagus outdoors

The use of soil biodegradable plastics is not recommended because the plastic must be able to resist the weather for several seasons. To remove the plastics at the end of their life cycle, the pockets are cut open so that they are emptied of soil when they are lifted. The removal of the mulching plastic can be carried out mechanically using a machine that rolls the plastic onto an axis and at the end of each row allows the plastic to be deposited on the edge of the plot together with the axis or stored to avoid permanent contact with the ground. In this way the plastic can be reused the following year in good conditions.

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Figure 4: Asparagus mulching plastics rolled up at the edge of the plot and awaiting collection

2.1.4 Tree nursery

The removal of plastic is done mechanically using tractors and specific machinery. It is necessary to cut out the vine plant before the removal of the plastics to prevent it from being damaged and to facilitate the removal. A machine can be used which is anchored to the rear of the tractor and allows the cutting of the upper part of the plant. An operator goes behind the tractor to re-hitch the plastic when it breaks to facilitate the work in a mechanical way and to make the tractor stop as little as possible. When a row is finished, the plastic padding is tied to the next row so that the tractor does not have to stop at the end of each row. The tool used consists of a reel that winds up the plastic as it moves along the row of crops. In a first pass, the central plastic part covering the ridge is removed together with the watering tape.

In the second pass, the sides of the ridge are removed. This removal removes the adjacent sides of two ridge (Figure 5). When the end of each row is reached, the plastic spool is released. This already wound plastic, on which the watering tape is located together with the mulch, is left on the edge of the plot until the work is finished, then with the help of the tractor's shovel it is put on a trailer.

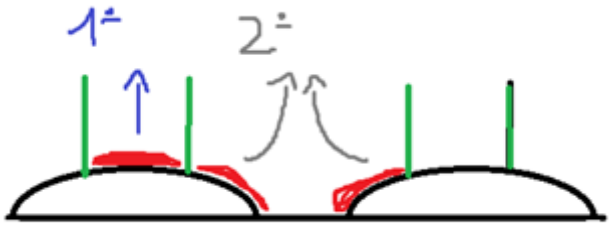

Figure 5. Diagram of the mulch removal process in the nursery.

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Figure 6. Tractor collecting the plastic film covering the sides of the ridge in tree nursery row.

These videos show the machines working
https://www.youtube.com/watch?v=ZAH0tkhOdmA&feature=youtu.be
https://www.youtube.com/watch?v=obiC3oIzHco

2.2 Other plastics

In case of greenhouse films, it is recommended to use highly durable plastic. By using plastics of good thickness, approximately 800 gauge (200 µm), it will be possible to extend their useful life to 5 years or more.

In most cases, indoor crops (e.g. lettuce, chard, spinach) use plastic mulch for the soil in the greenhouse. The recommended type of plastic is a two-coloured plastic (black-white), of good thickness (400 gauge, 100 µm). These are called plastic blankets.

It is recommended to use two plastic blankets of half the size of the greenhouse so that they can be easily collected from the sides of the greenhouse for a later reuse. It is recommended that the plastic is put aside for the harvest (Figure 7).

Figure 7. Plastic blankets put on the side in a greenhouse for the harvest

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2.3 Short review of the machinery available for the removal of plastics in the field

The machines used for collecting plastic from the field consist of a system that lifts and "picks up" the plastic from the ground and rolls it to a bobbin, which, as the tractor advances, coils it until it reaches the end of the row where the bobbin can be removed and the plastic left on the ground to be picked up later with a trailer. You can see **at this link** a video of this machine in operation: the lifting machines only dig out the edges of the plastic that are buried and leaves the plastic on the ground so that it can be easily removed. This consists of two tines with pallets at the bottom that allow the plastic to be lifted.

Figure 8. Four pictures of tools used to remove plastic mulch from the filed

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Collection of irrigation tapes

Irrigation belts are sometimes the only plastic on a farm. Their collection is simple and is done with a winding machine for storage and later reuse.

Figure 9. Tools for the collection of irrigation pipes

3. Best practices for plastic storage on the farm

Farmers usually do not have specialized storage dedicated for plastic. However, it heavily depends on the size, location and type of production of the farm. It is much easier to manage plastic on large farms, due to better infrastructure. Plastics can be stored outside or in a dedicated building - an old barn for example. When materials are put outside, it is important to protect them from the wind. To reduce the volume of plastic, one solution could be to use a press on the farm, and this method could be useful for the whole recycling chain.

Best practices of storage at the farm are based on two levers: sorting and keeping the plastic waste clean.

- **Sorting the plastics** could be an easy and cost effective solution for the farmers. Currently, standards or information related to sorting plastic waste on the farm level are not always available. Additionally, recyclers or processors are often not taking up information related to recycling plastic waste on the farm level. Farmers are often not aware of rules related to recycling the plastic, and most probably would not start to recycle the plastic, if the benefit of such activities is not properly addressed. One of the biggest problems of recycling is the logistic minimum and scattered structure of entities storing plastic waste. Farmers are usually producing a few hundred kilos of plastic waste per year, when the logistic minimum profitable for recyclers amounts to around 23-27 t of plastic waste. If we consider logistic minimums per various types of plastic waste collected on the farm level the problem could be even bigger. On the other hand, storing plastic on the farm, due to their small amounts, is not dangerous for the farmers. At the same time, a long period of collecting plastics on the farm until reaching the logistic minimum demanded by the recycler could lead to decomposition of the plastic by UV, wind, temperature and other factors reducing the quality of the plastic waste as a resource for recycling. We can sum up main problems and good practices related to the sorting in following way:

- **Problem**	- **Good practice**
- Impact of UV and water	- Storing plastic waste under cover
- Mixing of various types of plastic	- Putting plastic in right big bag for waste just after use
- Waste is contaminated by dirt and organic matter	- Cleaning or brushing plastic waste just after use, before putting in the right big bag.
- Recyclers demand large quantities of plastic as a logistic minimum	- Organizing groups of farmers in order to meet logistic minimums, implementing national collection schemes.

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Figure 10. Example of improper storage of plastic at the farm level. However farmers usually have to store plastic in this way, due to a lack of alternatives

- Proper collection and storage could reduce problems with recycling agriplastics. Agriplastics gathered from farms are usually very dirty. Up to 30% of the total weight of plastic waste could be unwanted waste like soil, dirt or straw. It gives additional costs per tonne of pure plastic and generates many problems related to cleaning processes. To read more in detail about plastic end of life management please see **minipaper B**.

3.1 Example of practices to collect plastic in a breeding farm

Plastic management in breeding farm is a relevant concern. In France, a remarkable initiative has existed for 20 years. It is called **Adivalor** and it brings together businesses from upstream agriculture, cooperatives and private traders, representative structures of farmers, and recycling industries. Today, the Adivalor collection concerns 300,000 French farmers, in all types of systems. The collection works well in cattle farm, for example, to recycle nets and twines used for the conservation of straw, and silage. It is important that the collected plastic first needs to be cleaned at the farm. Without previous cleaning plastics cannot be recycled correctly.

Storing outside: store plastic films carefully and for a short time to avoid wind.

Do not store the nets for a long time, otherwise they will be too damaged for recycling. It is preferable to store inside.

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When nets are removed from bales, try to clean them and separate organic material from plastic. In the right picture a lot of straw residues are collected with the net.

In this photo, the net is correctly removed from the bale with only few straw residues in the net.

After use, the nets are put in a large bag. In this example, the bag will be collected and brought for recycling.

A bag of used plastic cans, that will be collected for recycling.

Figure 11. Example of management of plastics on a breeding farm

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4. How to use biodegradable plastic on the farm

Mulch contamination with soil hinders the possibility of recycling conventional mulch. For that reason, biodegradable mulch can be a sustainable solution to reduce the use of plastics on agriculture, while other agricultural plastic used for example in greenhouses or silage can be more easily recycled.
Biodegradable plastic is now frequently used for mulching, for example in vegetable production. Despite the environmental advantages of those materials, they are not always ideal for farmers and the biodegradability is not always efficient. For more information look at **Minipaper C.** The Innovative Farmers Network in UK has developed a field lab to test alternatives to conventional black plastic film. See a video of their experiment here: **https://youtu.be/HnlZGH56dGI**.

Compared with the performance of conventional plastics, the introduction of biodegradable films in agriculture brought new expectations to end users. Nevertheless, these new materials rose concerns among farmers regarding not only to crop yield and quality but also in relation to the changes in the common agriculture practices needed.

Farmers expect that biodegradable plastic mechanical performance during the crop season would be similar to conventional plastics but at the same time completely degrade, in contact with microorganisms in the soil.

It is important to understand the difference between biodegradable, compostable and oxo-degradable materials and to recognize that biodegradation can occur at different conditions; the materials must be chosen for the particular application and end of life treatment.

Biodegradable

The definition of biodegradable is that a material is capable of undergoing biological anaerobic or aerobic degradation leading to the production of CO_2, H_2O, methane, biomass, and mineral salts, depending on the environmental conditions of the process. Microorganisms, which are present in the environment and feed mostly on organic waste have an important role to play in biodegradation. However the term biodegradable does not specify the degradation time and conditions. Thus, it is very important to specify the environment where biodegradation is intended to take place. The CEN norm EN 17033 on biodegradability of plastic mulch in soil foresee a biodegradation threshold of 90% in 2 years.

Compostable

Composting is the process of breaking down organic waste by microbial digestion to create compost. Compost has many beneficial uses including improving and fertilizing soil. To go through a composting process, organic waste requires the right level of heat, water, and oxygen. In a pile of organic waste, there are millions of microbes that consume the waste, transforming the organic materials into compost. Composting can be done on farm with a pile of organic waste (also referred as home compost) or in a compost plant with mechanical stirring and optimal moisture, temperature and oxygen levels (also referred as industrial compost). In order to claim that a product is fully compostable, the product has to meet all the requirements in the European Norm EN 13432 and/or the US Standard ASTM D6400. Both specifications require that biodegradable/compostable products completely decompose in a composting setting in a specific time frame, leaving no harmful residues behind.

Biodegradable plastics products for agriculture currently on the market, are mostly derived from or blended with plant starch. For example Eco-Flex® (BASF, Germany), F Blend C1200 is a biodegradable polyester for compostable film and Eco-Bio® is made from Eco-Flex and PLA Ingeo® (NatureWorks, USA) is biodegradable polylactic acid coming from dextrose (sugar), Mater-Bi® (Novamont, Italy) naturally biodegradable and compostable masterbatch and also can be biodegradable but fossil based such as biodegradable plastics based on polybutylene succinate PBS (Japan Pulp and Paper).

Oxo-degradable

These products are made from conventional plastics and supplemented with specific additives in order to mimic biodegradation. These additives facilitate the fragmentation of the materials, which do not fully degrade but break down into very small fragments that remain in the environment – a process that would be more accurately described by the term "oxo-fragmentation".

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For agricultural plastic products, it is important to consider those materials which offer a **biodegradation on soil**, that occurs at field temperatures and without needing industrial composting facilities. On another hand, the certification "biodegradable on soil" (for instance TUV Austria Certification) can give to farmers the assurance that the material bought will biodegrade without causing any damage to soil.

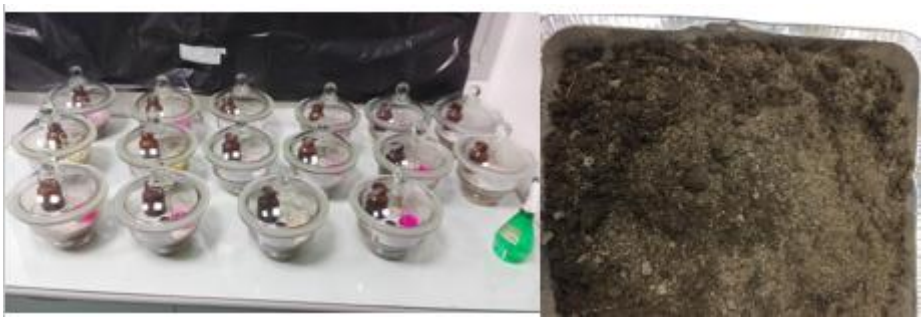

Figure 12. A. Sealed glass containers to measure the gas emission during the biodegradation of plastic in soil **B.** Plastic disintegration on soil at laboratory tests

Conventional agricultural practices can be applied with biodegradable plastics regarding soil preparation and the use of organic and mineral fertilizers without compromising the biodegradable mulch film mechanical integrity. Farmers can use their own machinery without major adaptations whilst not compromising the biodegradable plastic behaviour such as tear resistance and tear propagation during its application.

For instance, this new type of material for mulching also allows for the possibility of using the traditional drip tape irrigation, it does not require additional work associated with preparation, its application and soil incorporation. To read more about the new types of plastic please see **minipaper C**.

Case study: Mulching films substitution with compostable/biodegradable materials – Interreg MED Reinwaste approach

Interreg MED Reinwaste project has faced the challenge of mulching films used in horticultural greenhouse production such as LDPE (low-density polyethylene), which are considered difficult-to-manage waste due to a high degree of degradation and the presence of dirt (vegetable waste and sand). Since high conditioning is needed, waste management companies may not accept them for being considered low profit, presenting risks of abandonment.

To face this problem, two types of biodegradable materials have been tested within Interreg Reinwaste project (Figure 13) as available alternatives to conventional plastic mulching films (LDPE) in **Andalucia horticultural sector**:

1) A compostable mulching film (alternative 1: ECOVIO® by BASF. It is a material certified as compostable and as in-soil-biodegradable. The extra cost derived from its use could be reduced as economies of scale develop, thus assuming a competitive advantage.

2) An in-soil biodegradable mulching film (alternative 2). This product developed in H2020 BIOMULCH project for open-air strawberry, is not yet available on the market. It requires the addition of a kit of microorganisms and enzymes to facilitate the plastic debris degradation, in addition to their incorporation into the soil using agricultural machinery.

Both alternative materials have remained on the soil for almost 8 months of cultivation without suffering significant loss of integrity and offering similar performance to conventional LDPE mulching film. Therefore, alternative materials use would be technically viable. According to the sustainability analysis carried out, both alternatives (compostable, and biodegradable) show better results in the three sustainability dimensions (economic, social and environmental) than the conventional one.

Although overcosts of these alternatives still favour conventional materials for the overall profitability of farms, and the intrinsic product quality, other economic considerations, such as a better positioning and

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competitiveness in the market or diversification of economic activities show better behaviour of these alternatives. The social and mostly environmental dimensions are, without any doubt, better positioned for biodegradable and compostable alternatives. The potential of adoption of biodegradable mulch is higher than compostable mulch.

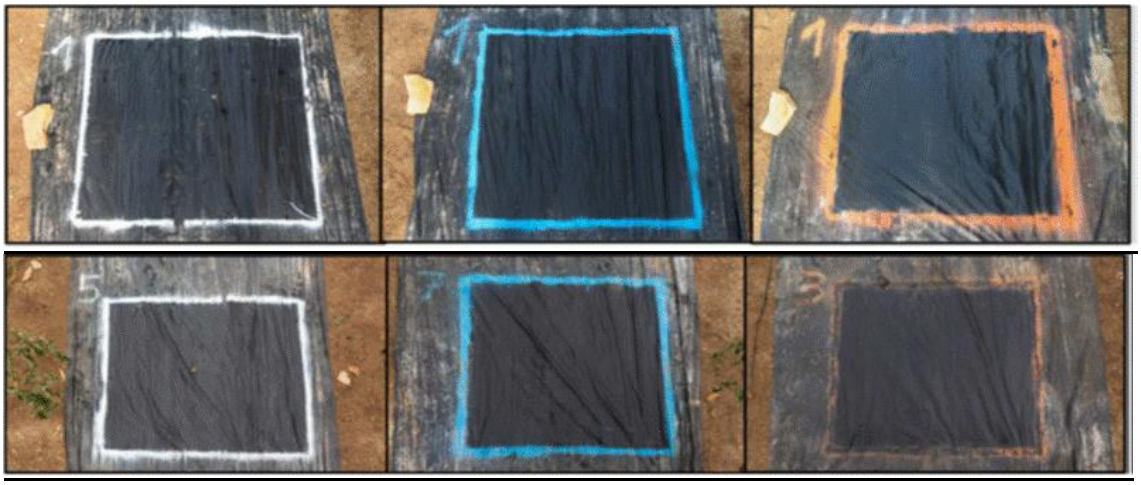

Figure 13. Top row: Control areas in the first row of each type of mulch. From left to right: Ecovio (white), Biomulch (blue), LDPE (orange). **Bottom row:** Mulch status 192 days after placement.
(Image source: IFAPA, Instituto de Formaccion y Investigaccion Agraria y Pesquiera – Junta de Andalucia, Interreg Med Reinwaste Project pilot activities.)

A short presentation video about horticulture in Andalusia, Spain:

https://www.youtube.com/watch?v=yhG5Q82E-8U&amp%3Blist=PLhEHq_mDApPtxQUXt5AXRiY0sLpxbYYcJ&amp%3Bindex=4

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4.1. Agricultural management of biodegradable plastics

4.1.1 Mulch application and planting

Soil preparation to lay is a key operation and an important factor. Good film performance during all crop cycles is assured by correct soil preparation.

The soil intended to be covered with mulch film must be preferably loose and cultivated without stones or residuals from preceding crops which can tear and damage the film. This may result in heat loss and facilitates weed development. Moreover, these films are more exposed to wind action, tearing or holes which can initiate an undesirable early degradation.

Picture 14. LIFE Multibiosol tests with biodegradable on soil mulch film on ecologic cauliflower crop (flood irrigation) in Zaragoza (Spain)

Film application can be performed with the same implement used for the traditional PE plastic mulching films. However, depending on the equipment it is advisable to reduce the tension of the roll during the operation. The location of the irrigation tubes slightly under the soil favours film integrity and provides good protection from heat. But it is important not to damage the structure during its application together with drip irrigation tape. If the drip tape irrigation is pressing the mulch film, the drippers can produce small holes.

4.1.2 Crop growing and harvesting

LIFE Multibiosol project, aimed to demonstrate that the sustainability and efficiency of agricultural practices can be achieved through the manufacture and use of advanced biodegradable on soil plastics. In this sense, films were developed for mulching films with oligoelements, fruit protection bags and clips to close the bags. These products were tested both in the field and in the laboratory on different crops in 3 countries (Spain, Belgium and France). First, **pre-harvest trials** were performed to validate the quality of the crops and bioplastics during the growing season. Later, **post-harvest validation tests** were performed on **vegetables** (with the **biomulching** assays) and on **fruits** (with the **biobags**). Both **small and large-scale trials** were carried out and extensively monitored in order to verify changes in soil and crop quality.

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Picture 15. A. Multibiosol plastic mulch for tomato, pepper and cucumber cultivation. B. Multibiosol fruit biobags (white and red) for apple cultivation
https://www.youtube.com/watch?v=OQQUpo7T2Gw

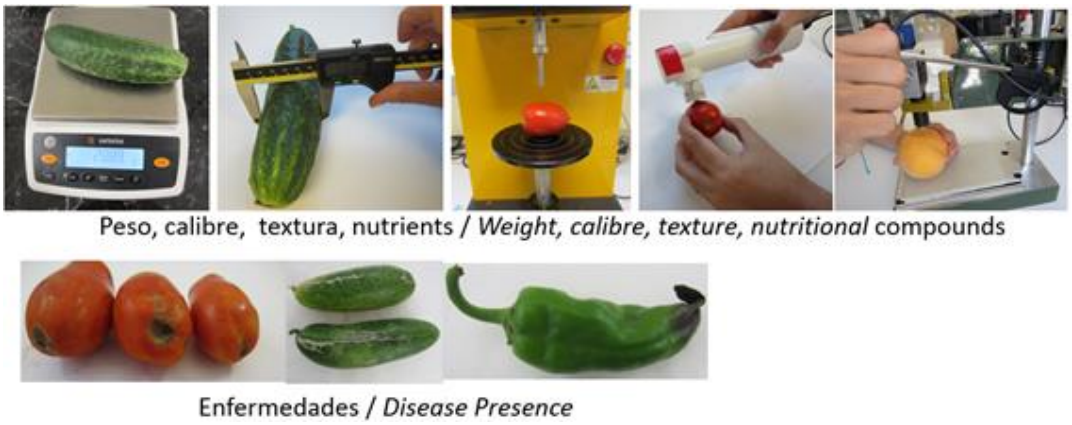

Figure 16. Quality assessment of the products after harvest

Effects of the biodegradable plastics were analysed and compared with the results from crops produced with conventional plastics. Trials included the monitoring of the following effects: on soil (weed control, photosynthetic ability, production efficiency, soil composition and toxicity); on crop production (plant physiology and nutritional state) and on commercial quality (physical-chemical parameters, postharvest diseases and disorders, organoleptic qualities, nutritional compounds).
The biodegradable plastic mulch showed excellent results as a substitute for traditional mulching:

- It maintains the performance throughout the crop cycle.
- The production of the crop is equivalent to that of traditional mulching. In some cases, even the quality is improved (size, maturation ...) and the incidence of diseases and physiological disorders significantly decreases compared with traditional plastic materials.

The biodegradable fruit bags also showed excellent performance as to replace traditional bags (paraffined paper):

- Effectively protect against pesticide residues.
- Maintain the required mechanical performance throughout the fruit crop cycle.
- Reduce reddish tones in peaches, producing a homogeneous fruit external surface.
- Red bags, are suitable for apples, since they produce homogeneous "sunburn" free fruits.

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Film Biodegradation Performance
At the time of incorporation about 2 months after the end of cycle (three months) it was possible to observe some physical degradation in the material.

4.1.3 After harvest

Biodegradable mulch can be incorporated in soil together with crop residues and weeds by conventional implements such as a rotary cultivator or a disc harrow at the end of the crop cycle.

The biodegradable mulch starts to degrade from the first day of application. It is supposed to conserve adequate physical properties until the crop harvest and the degradation will be total only if it is ploughed in the soil. Usually, the soil incorporation is done 2-3 months after harvest. **The best practice would be to plough immediately after harvest.**

This can be done swiftly by a single tractor which is able to cover many hectares per day and therefore not affecting valuable labour needed for crops. This practice can improve in soil biodegradation rate as the humidity in soil is higher and thus microorganism activity is also higher and degradation can begin sooner.

4.2. Technical-economic analysis

Biodegradable films have been studied previously, demonstrating that harvest is statistically the same as obtained with conventional PE[1]. However, market prices of biodegradable films are higher than PE thus reducing its economic attractiveness for farmers in the short-term. In addition, there are no exhaustive studies including economic evaluations of PE and biodegradable materials containing (i) an estimation of plastic removal costs; and (ii) a global consideration of short and long-term advantages and limitations of these materials[14].

Results obtained in the LIFE Multibiosol project showed that the initial cost/kg of the biodegradable material is higher than the cost/kg of the LDPE (conventional) plastics. However, when taking into account the cost of removal of LDPE (200-400 €/ha on average), and also applying the relevant subsidies for biodegradable ones (35% in Spain), the total cost/ha to use biodegradable plastics is similar to the cost of using LDPE. Unfortunately, the legal removal of conventional plastics and associated costs are not required/monitored by law. To encourage the use of bioplastics and achieve the lowest possible price for them, relevant policies (tax on conventional plastics, subsidies for biodegradable plastics) on national, regional and EU levels need to be put in place to support farmers in the transition to the use of biodegradable plastics in agriculture.

If the use of PE with no waste management is considered as a benchmark, then total costs are 8.676 € /ha where the mulching represents 6 % of the total costs for production. The field conditioning costs of "no management" for PE scenario shows that this cost represents 5% of the total when no waste management is carried out. The biggest expenditure of these operations corresponds to crop season operations (mainly transplant and seedlings costs) with 45% and the following is the harvest with 27% because it is a manual task. In case of using biodegradable mulching would be 9.000 € (in average), the materials represents between 7.5% and 15% of the total costs when using biodegradable. By contrast, using biodegradable mulches allows a saving in field conditioning of a 2%.

In the example below, the subsidies are not taken into account. Final incomes were calculated including the subsidies available to cover 35% of the biodegradable plastic cost then that means a reduction of 492,82 € (e.g. when using *Mm Bio 191 (MULTIBIOSOL)*), which means a reduction of 5% in the materials batch. The total costs in this case would be 8.866 €/ha. Therefore, the current level of subsidies (35%) does not seem to be a strong enough incentive for all the biodegradable materials to be adopted by farmers.
An alternative to the current system should provide for compensation to cover the difference in cost with regard to PE. Calculations show that the rate of **subsidy should be higher** to assure these options to be as profitable as PE. **OPFV** would give preference to those biodegradable products **and not oxo-biodegradable** and include more percentage to those materials than for conventional materials.

[1] Miles, C.; DeVetter, L.; Ghimire, S.; Hayes, D.G. Suitability of biodegradable plastic mulches for organic and sustainable agricultural production systems. HortScience **2017**, 52, 10–15.

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Another interesting fact is that farmers have more financial outlays at the beginning of the crop season and at the same time they have the least economic resources available. So an interesting measure would be to make **two payments, one smaller at the beginning and then the second one at the end of the crop season** when they are recovering the financial situation.

Technical-economic analysis of the management costs for the collection of conventional plastics versus the use of biodegradable or bio-based plastics.

Table 1: Aggregated costs (€/ha).

Operations		**Costs (€/ha)**
Field preparation		1,448
Crop season operations		3,931
Plastic mechanical mulching		
Average conventional *LDPE*		548 €
Average biodegradable		1120 €
Mater-Bi®		1,308 €
Sphere®		916 €
Ecovio®		649 €
Groencreatie		1,184 €
Bioflex®		1,075 €
BioVal		*1,318€*
Mm Bio 191 (MULTIBIOSOL)		*1,408 €*
Harvest		2,340 €
Field conditioning non-biodegradable mulch scenario	No waste management	432 €
	Landfill	467 €
	Recycling	452 €
Field conditioning biodegradable mulch scenario		232 €
Total *conventional LDPE*		8 676 €
Total *biodegradable*		9 000 €

Sources: Karl Fonteyne, Groencreatie, Belgium, 2015, LIFE Multibiosol, results from farmer and cooperatives consultations, Spain, 2018.

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5. Communication of the best practices

To enhance the good practices in the use of plastic in agriculture across the EU, different ways of communication are needed. The problem of plastic is not yet a particular concern for farmers. But this issue could be more relevant in the coming years, in particular with the new CAP. So, an ambitious communication about plastic could lead to sharing practices among farmers associations, for example to reduce plastic use or promote good storing by sharing information on the internet and social media or in specialized newspapers etc. Many photos illustrate well the extent of the problem and present case studies from countries where recycling works very well.

For example, the French plastics committee has launched "Plastipédia", an encyclopaedia of agricultural plastics which offers technical, scientific and economic information, in particular for farmers (at a cost of 8 € per year). This media library is an interactive platform for sharing and disseminating initiatives, practices, experiences and research results (**www.plastipedia-agriculture.com**). Translation of such encyclopaedia could be a good idea as we have to remember that not all farmers in the EU can speak foreign languages.

An example of good practice in communication, training and information for farmers: a case from Poland

Systems dedicated for collection, storing and recycling plastic containers for plant protection products could be considered as a good example of communication and training. Usually such systems are developed before general plastic collection schemes in many countries due to more dangerous characteristics of plant protection products, higher concentration of supplying companies and low logistic minimum for implementation of such systems. In case of Poland there are three good examples in communication of the problem:

- Using influencers and existing channels of communication
- Using existing sale channels
- Organizing training in cooperation with other entities

If we think about a successful communication to the farmers, we should consider point of view typical to professional marketers. Cost-effectiveness and ratio of spending per farmer should be leading factors during preparing a successful informational campaign. Such indicators naturally lead to situations, where communication should rely on existing, recognizable channels. Producing own channels, with very small numbers of followers/early adopters is usually very expensive.

- **Using influencers and existing channels of communication** - influencers are strongly recognizable among the target group, especially among younger farmers, usually willing to participate in innovations related to the farms, Influencers are already people with established position, who are used to present crucial information to farmers in easy, affordable and often funny ways. Farmers very often look for productions prepared by influencers, even for fun. In such cases influencers on YouTube could easily attract the attention of wide public.

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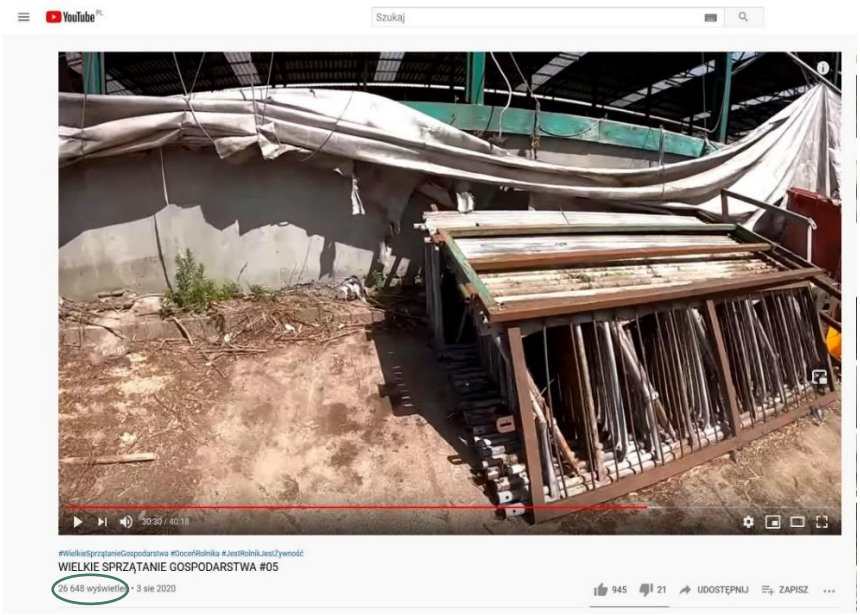
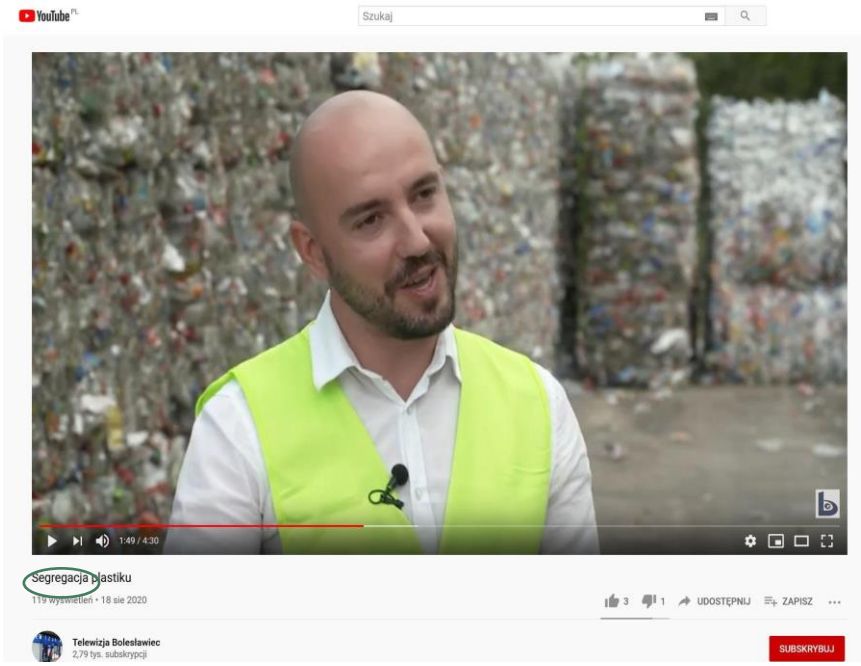


Link: https://www.youtube.com/watch?v=UpeRT5NRzMo

In the above example, an easy, amateur video about cleaning farms gathered over 26,000 viewers (with a base of 11,000 subscribers). There is no professional camera operator, rapporteur or extra staff, only farmer, tractor and GoPro camera.



Link: https://www.youtube.com/watch?v=IbbmR7mED7U

In comparison, local TV prepared professional material about plastic recycling, gathering 119 viewers in a similar period. It is probable that the cost of production of such video is higher than extra payment for influencer, even despite the fact that effectiveness of the influencer is in this case over 200 times higher.

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- **Using existing sale channels**

Already hired people responsible for sales of plastics products help to implement new products and systems in practice. Even the best products, without proper education among workers and sales force could fail. People hired in sales are trained to explain perks, pros and cons of new products, but we have to remember, that sometimes salesmen have a tendency to underline more pros than the cons. What's more, informing about good practices or new solutions is a very good introduction to a sales meeting, because farmers are always interested in new phenomena outside their farm. So in this case, this channel does not require a lot of additional costs and could generate added value for companies in plastic or recycling industries.

- **Organizing training in cooperation with other entities**

Very often local companies like grain traders or agriculture retailers are organizing together one day workshops about many topics related to agriculture. Such workshops are usually connected with sales meetings. Conducting workshops or informative presentations are usually very cost effective, because such events are often organized for larger groups of farmers in periods, when farmers are less occupied with work on the fields. Due to organizing such meetings with other entities (both private and public) it is easier to attract large public - due to many topics covered during the meeting. It is hard to attract a lot of farmers only for short meetings related to the plastic. What's more, such meetings are cost effective, because costs are divided by multiple entities.

Examples of communication good practices related to collection of plastic used for plant protection measures:

Polish system PSOR (**http://systempsor.pl/**) dedicated to collecting plastic containers used for plant protection measures could be considered as successful, especially in terms of communication. Successful practices are the following:

- During purchase of the product farmers are informed by retailers, internet, workshops and leaflets about fact, that they are obligated to return the plastics to a collection point after use
- Retailers of products dedicated for agriculture are working as a collection point. Retailers admit that collection points are an efficient solution for building relationships with the farmers.
- The PSOR system is managed in majority by agrochemistry suppliers in Poland. They included information about the system in their standard marketing, to introduce the positive impact of their activities for the farmers, environment and society.
- PSOR implemented an education program dedicated for schools, especially in rural areas.
- Infographics are shared on social media. System also provides data about collection points. Explanatory videos are also often used.
- The PSOR Website provides all crucial documentation regarding plastic from plant protection products. Documentation is segmented for needs of three target groups: farmers, retailers and suppliers
- Sharing information about the program relies on existing channels and infrastructure instead of creating a new one, implementing sensor-sensitive partnerships

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6. Conclusions

Good practices on the farm are essential to reduce the footprint of plastics on the environment and aim to reduce their use, when it is possible and economically feasible. The storage and collection need to be conducted in the respect of good practices. In particular, the cleaning of materials determines, in a large scale, the efficiency of reusing and recycling of conventional plastics.

In vegetable productions and crops, the collection of plastic in the field is done with techniques and agricultural machines that have proven their efficiency.

To complement this, the LIFE Multibiosol project that was conducted in three countries across the European Union shows that the use of biodegradable plastics is interesting from an agronomic point of view and that it is cost-efficient for farmers, even when compared with conventional plastic.

This minipaper also shows the importance of good communication, as the environmental issues of plastics are not yet a real worry for most European farmers. To improve the awareness of farmers communication about good practices and the economic advantages of biodegradable plastics (shown by LIFE Multibiosol project) should to be further developed. **We propose that the European Union finances and manages such type of communication project in the coming years.**

You can contact Focus Group members through the online EIP-AGRI Network.
Only registered users can access this area. If you already have an account, you can log in here
If you want to become part of the EIP-AGRI Network, please register to the website through this link

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AGRICULTURE & INNOVATION

The European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI) is one of five EIPs launched by the European Commission in a bid to promote rapid modernisation by stepping up innovation efforts.

The **EIP-AGRI** aims to catalyse the innovation process in the **agricultural and forestry sectors** by bringing **research and practice closer together** – in research and innovation projects as well as *through* the EIP-AGRI network.

EIPs aim to streamline, simplify and better coordinate existing instruments and initiatives and complement them with actions where necessary. Two specific funding sources are particularly important for the EIP-AGRI:

- ✓ the EU Research and Innovation framework, Horizon 2020,
- ✓ the EU Rural Development Policy.

An EIP AGRI Focus Group* is one of several different building blocks of the EIP-AGRI network, which is funded under the EU Rural Development policy. Working on a narrowly defined issue, Focus Groups temporarily bring together around 20 experts (such as farmers, advisers, researchers, up- and downstream businesses and NGOs) to map and develop solutions within their field.

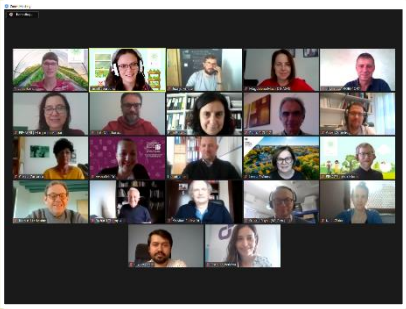
The concrete objectives of a Focus Group are:

- ✓ to take stock of the state of art of practice and research in its field, listing problems and opportunities;
- ✓ to identify needs from practice and propose directions for further research;
- ✓ to propose priorities for innovative actions by suggesting potential projects for Operational Groups working under Rural Development or other project formats to test solutions and opportunities, including ways to disseminate the practical knowledge gathered.

Results are normally published in a report within 12-18 months of the launch of a given Focus Group.

Experts are selected based on an open call for interest. Each expert is appointed based on his or her personal knowledge and experience in the particular field and therefore does not represent an organisation or a Member State.

*More details on EIP-AGRI Focus Group aims and process are given in its charter on:
http://ec.europa.eu/agriculture/eip/focus-groups/charter_en.pdf



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