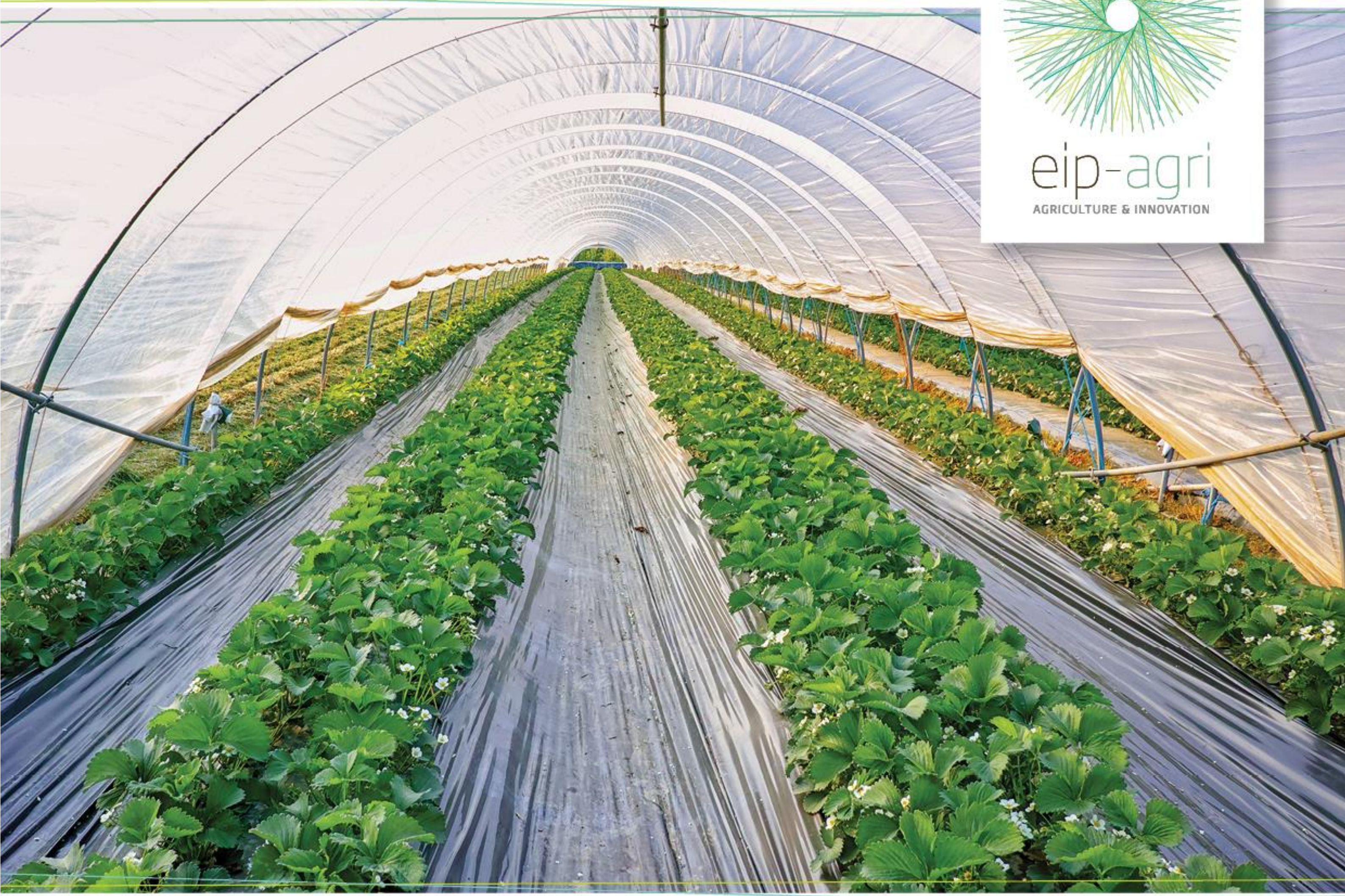

EIP-AGRI Focus Group

Reducing the plastic footprint of agriculture

February 2021

Minipaper B: The agri-plastic end-of-life management

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Introduction

Agri-plastics waste management is difficult for the farmer to handle due to financial and technical reasons. Agricultural non-packaging plastics have usually a poor value. Therefore, the End of Life (EoL) is not always ensured for farmers due to the lack of information and technical references. The objectives of the mini-paper is to provide general guidelines to farmers and advisers to improve the actual agri-plastics end of life management and enlarge their view on experience already achieved in Europe.

1 End of life management: farmers needs and expectations

1.1 Quantities and characteristics of plastics used in Europe for agriculture.

Plastic in agriculture is used in a wide range of applications, both for vegetable and animal production. Most of the 28 million of farmers in Europe are using plastics in their activities either for soil or crop protection, increasing yield by favouring root and plant growth, while reducing input consumption such as pesticide, fertilizers, or water use. The total volume of new plastics put on the market is estimated at 713KT[1], where 76% of which is films. More recently developed, biodegradable products, for mulching films and horticulture twine application, accounts for less than 1%.

Non packaging plastic products used in agriculture:

Categories	Products	Polymer[2]
Vegetable production:		
Films	*Greenhouses, small tunnels, mulching, flat cover*	4 LDPE, 05 PP
	Biodegradable	Bio based
Protective nets	*Anti-hails, insect-proof, etc.*	2 HDPE
Irrigation	*Pipes and tubes*	4 LDPE
Twine	*Horticulture twine*	05 PP
		Biobased
Animal production:		
Films	*Silages and stretch*	4 LDPE
Net	*Bale net*	2 HDPE
Twine	*Bale twine*	05 PP

[1] Excluding oxo degradable

2 Low density polyethylene (LDPE), High density Polyethylene (HDPE), Polypropylene PP

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1.2 Characteristics of agri-plastics after their useful life.

After use, agri-plastics keep most of their original characteristics. For most of them, their useful life can be measured in weeks or months. Only a few of them, such as greenhouse films or anti-hail nets, may have a durability of a few years. However, depending on their application, use and thereafter the method of their removal, agri-plastics waste is sometimes heavily contaminated by exogenous materials (soilage), such as minerals, sand, organic matter, pesticides, and water. Hence, the weight of the agri-plastics waste can be the equivalent of 3 or 4 times the weight of the original plastics especially mulch films. In such cases even a fully recyclable product may become difficult to recycle or at least at a very high cost.

European market survey	Tons New	Soilage Coef.	Tons Used
Greenhouses	120 000	1,25	150 000
Small tunnels	56 000	2	112 000
Mulching	83 000	3	249 000
Bio based	5 000		-
Oxo	8 000		-
Irrigation pipe <400µ	20 000	1,2	24 000
Tube with driper	20 000	1,2	24 000
Non woven	8 000	2	16 000
Protective net	4 500	1,1	4 950
Vegetable Production	**324 500**	**1,79**	**579 950**
Silages	121 000	1,5	181 500
Stretch film	146 000	1,5	219 000
Bale net	50 000	1,5	75 000
Twine	80 000	1,5	120 000
Animal Production	**397 000**	**1,50**	**595 500**
Gran total	**721 500**	1,63	**1 175 450**

The average soilage content across all products is estimated to have a coefficient of 1,63, resulting in 708K[3] tonnes of new agri-plastics, becoming 1,175KT of waste. One third of this additional volume (462KT) comes from products dedicated for animal production and two third from vegetable productions.

Biodegradable films are not removed and collected after use. Degraded, they are left in the soil and digested by micro-organism. Therefore, biodegradable will not be discussed in this document. For further information please refer to Minipaper C.

The soilage content may be easily measured in term of rate (%) or coefficient (X):
Soilage rate SR = (weight of used product – weight of new product) / Weight of used
Soilage coefficient SC = weight of used product / weight of new product

1.3 Farmers, essential for the plastic end of life management

Plastic use on farm would have no negative impact on the environment if all weight going in go out at the end of the process. The decisions of farmers about how to use and to remove agri-plastics play a vital role in the end-of-life of the product.

- **Design: a buying criterion.** Farmers can check with their suppliers if a product is recyclable and eligible to a collection scheme.
- **Usage:** Farmers can use plastics that may be used in reduced amounts.
- **Waste reduction at source:** Farmers can use best practices known to reduce soilage content during usage and improve waste quality.
- **Optimizing waste collection:** Farmers can use technologies that help with preparation of waste for removal, storage, and transport.
- **Collection scheme:** Farmers are dedicated to collaborating with collection schemes and to their improvement.

[3] Excluding biodegradable and oxo degradable

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1.4 Preparation at farm is determinant for the recyclability

Waste quantities at farm may be very different depending on the size and the activity of the farm. In horticulture (fruit and vegetable production) the total weight may varies from few hundred kilos to several hundred tons (vegetable production), when, in livestock production, agri-plastics waste account for few hundred kilos per farm. After usage, agri-plastics could have a second life: they can be grouped, transported, cleaned, and extruded in a new plastic granule to be incorporated in a new product. The farm is the starting point of this complete value chain. All agri-plastics are recyclable but, depending on the waste preparation, it will be recycled or not.

The preparation on farm will pay attention to the product's cleanliness and, a selective grouping by type of polymer and colour. Some products (stretch, net wrap, twine) will be packed in a transparent PE bag, 30kg maximum easing manipulation, storage, and transport. Recommendations are specific to each agri-plastic:

Categorie	Activity	Products		Recommendations
Films	Horticulture	Greenhouses	Clear	Cleaned & folded or rolled out without core
		Large tunnels		
		Small tunnels	Colorless	Cleaningf during removing operation manually of mechanicaly to reduce the soilage content. Rolled out without core
		Flat Cover	Colour & Colorless	
		Mulching		
	Livestock	Silage		
		Stretch		Clean and packed in a PE clear bag
Net		Net Wrapp		
Twine		Twine		
Pipe		Flexible		Clean and folded in fagot
Protective net		Anti-hails, insect-proof...		Clean, without accessories, folded or rolled out without core

Quantities and volume grouping, soilage rate, transport & distances, pre-treatment, and treatment are the different steps the products may go through. The value chain of the end of life management give a good illustration of these steps:

- After preparation at farm, products will be grouped in a selective manner (polymer and colour) to reach a minimum quantity for an optimized transportation scheme. If this minimum quantity is not achieved by one farm and, products will have to be delivered to a grouping centre.
- Selective collection (type of product, polymer, etc.) and massification of flows on grouping centre
- Transport in bulk for pre-treatment, recycling or landfill.
- Pre-treatment (baling, shredding, cleaning)
- Transport baled for recycling

1.5 Recycling or landfill end of life management costs

We consider collection cost from the farm, after preparation to the destination of the waste. This cost may be very different depending on the country, the region, the type of product, the waste quality and the available infrastructure and equipment (collection, recovering and recycling). For example, a mulching film with a soilage rate of 70% will require 155 truckloads to transport the equivalent of 1000 tonnes of clean polyethylene, when only 50 is required for waste with a soilage rate of 30%[4]. Moreover, the cost of the logistic will depend on the specific route followed by the product and geographical distances.

[4] The soilage weight is determinant in the cost structure, as well as the recycling conditions

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Average monitored costs, nationwide, have been estimated in France[5] as follows:

From 70 to 100 €/T	Greenhouses, tunnels, mulching, silage
From 100€ to 200€/T	Stretch, Twines, irrigation pipe
From 200 to 300€/T	Protective nets, bale nets

It must be noted that most of those costs are generally hidden costs and the user is not aware of. In absence of collection scheme, collections companies will directly invoice the farmers. Unfortunately, depending on global economics conditions the collection companies may, or may not, provide the service to the farmers and, therefore the sustainability is not ensured.

1.6 The plastic waste value chain: a collaborative network

In the absence of a relevant waste management system, agri-plastics can have a negative impact on the environment. Beside technical reasons seen above, there can also be geographical, or financial reasons why farmers do not always manage their agri-plastics waste properly. Furthermore, for some crops it is technically not possible to remove 100% of the plastics once used.[6] Nonetheless, bad practices, such as dumping, burying, or burning agri-plastics waste damage the environment and should not be an option. Farmers and growers deserve to be provided with solutions to these issues. Collaboration between all stakeholders of the value chain (farmers, distributors, converters) has shown high technical and economic efficiency, with significant collection and recycling rate: it is encouraging to see the positive reaction from farmers and growers when a collection scheme is offered to them. In countries with national collection schemes, bad practices have been almost eradicated. (See Part 3).

Conclusion
Without solutions for the end-of-life management, the impact of agri-plastics on the environment is negative. Moreover, the farmers play an important role in the recyclability of the plastic waste by a proper preparation at farm and their participation in collection scheme. Farmers deserve solutions from good practices, technical references, and collection schemes for a sustainable end of life management

2 Agri-plastics end of life management for farmers: Legal aspects and Barriers

2.1 Legal aspect: Extended producer responsibility and changes in national legislations

a) **Agri-Plastic waste management.** After their useful life, agri-plastics are considered as industrial waste, from non-hazardous economic activities. In absence of any specific legislation, agri-plastics waste falls into the general waste legislation. On the farm, they are the responsibility of the farmer, as well as their elimination under the concept of "**the polluter pays**". If there is no specific national legislation for non-packaging plastics in agriculture, farmers are still not allowed to bury or burn their waste on farm. Because of its nature as professional waste (clutter, manipulation, soilage…), agri-plastics cannot be managed in the same way as household waste.

b) **Extended Producer responsibility (EPR).** The principle of extended producer responsibility was laid down at European level by directive 75/442/EEC of 15 July 1975 amended: "*In accordance with the*

[5] 2019
[6] Pineapple, cotton

principle of 'polluter pays', the cost of waste disposal [...] must be borne by the holder who hands over waste to a collector or a company [...], the previous holders or the producer of the waste-generating product. » Which means that plastic producers and distributors share the responsibility with the farmers for the plastic end of life management. For plastics without recycling solution, the 2029 SUP directive aims to achieve zero plastics in landfill by 2025. Therefore, some plastics products will be banned or heavily taxed. In addition, all products will have to be under the EPR.

c) **At national level.** A recent survey has not identified any specific legislation, except in Sweden or Ireland, which established mandatory national collection scheme under the Extended Producer Responsibility. Other countries (Germany, France) have developed national collective and voluntary collection scheme, under the ERP framework. In Finland, the Central Union of Agricultural Producers and Forest Owners (MTK) has set up and supported a voluntary national collection system that delivers agri-plasticwaste for recycling. In Spain and UK, such a scheme is being implemented, when it is in development in Poland, Belgium and Italy. In Greece, a mandatory scheme is implemented.

In all those cases, the producer responsibility is considered as a shared responsibility between all economics actors (farmers, distributors, and converters). The scheme's governance is also shared between stakeholders

2.2 What are the barriers for the development of collection scheme?

- Waste management is a collective responsibility shared by all economic actors: farmers, distributors, and converters. Their individual and collective involvement generate technical and economic efficiency. It is a business-to-business relationship where, all together, implement adapted solution for farmers, depending on the specific situation and constraints to face. This type of organization has shown remarkable results everywhere it is applied. However, this collaborative approach requires an organisation of different stakeholders, which can be challenging to achieve.
- Waste management is expensive, and the market has never been able, so far, to sustain it because of the lower price of new materials.
- The third issue is the accessibility of technical references and good practices by farmers and growers, gage of technical efficiency and therefore cost reduction.

Conclusion

European legislation, and most of national legislation, provide legal disposition with the Extended Producer Responsibility to implement sustainable scheme on a mandatory or specific way since farmers are not always able to handle it alone. The development of the shared responsibility among stakeholders provides solutions and results when applied. Nevertheless, many challenges must be addressed to ensure sustainability.

3 Existing collection schemes in Europe

3.1 Identified countries with collection schemes

The survey (C&S CPA Agri WG) currently performed shows that nine countries have a national collecting scheme: Sweden (SvepRetur), Germany (ERDE- RIGK), Ireland (IFFPG) France (APE-Adivalor), UK (APE UK), Spain (MAPLA), Norway (Grun Punt) and Iceland. Representing a total of 62% of the total volume put on the market in the EU. Collection rate, depending on the type of product and the scheme's development, varies between 30% and 100%. The implementation is progressive and, after 5 years of existence, the collection rate is over 75% in all the countries studied. Those schemes are financed by the cost internalization (the EoL management cost included in the selling price). A major part of the collected material is material for recycling (e.g. 80% for France), the remainder, without recycling solutions goes to landfill.

- **Italy,** 17% of the total market in the EU, has no national scheme, collection operations are made at regional level and the collection rate is difficult to evaluate without monitoring system. Recycling and landfilling are also difficult to rate.

- **Finland, Netherlands, Belgium**, accounting for 8%, have a rather efficient collection system without national organization, due to the country size and the proximity of recycling facilities.
- **All other 14 countries** (15% of the total volume estimate) do not have any national collection scheme. Collections are still made on local initiatives by the private sector and the cost is directly applied to the farmer, for landfill or recycling if there is a close facility. In those countries, the EoL management has not be specifically identified, neither measured.

3.2 Financial aspects of the EoL management

Economic changes on virgin raw material influence directly the recyclers' profitability. This situation jeopardizes the sustainability of the end-of-life management service to the farmer. Existing schemes, with additional financial means, allow to compensate the market instability and bring sustainability. When the prices for virgin plastic are high, collection and recycling are financed and the collection rate increases. When prices for virgin plastic are low, waste have a negative value and, therefore, collection as well as recycling decrease. This is a reason why, to maintain the sustainability, additional financial means are necessary.

According to the extended producer responsibility and the cost internalization's principles, market producers finance the EoL of the product they put on the market. Following the SUP directive, and the subsequent changes in national laws agri-plastics without EoL solution are submitted to the threat of the banning or heavy taxes[7].

Existing national schemes have incorporated in the selling price the EoL cost, and therefore, are able to maintain the service to the farmer despite bad economic situation. Depending on the product and the scheme age, the levy applied on the new product is between 25€ and 270€ per tonne of new products. For this amount, the farmer avoids any taxes and the service's sustainability is ensured. However, the levy applied on the new product may not cover 100% of the collection cost. In addition, the famers may have then to pay an additional cost for collection.

Conclusion
Providing a collection service adapted to the local situation, with technical recommendation and financial means, is the prerequisite for a sustainable end of life management and, therefore, a plastic footprint reduction. Dissemination of good practices and collection scheme eradicate bad practices, implementation of relevant collection scheme for used agri-plastics will reduce the environmental impact of the agricultural production.

4 State of play for recycling: mechanical, energy recovery and chemical recycling

By 2025, **plastic waste will be prohibited in landfills** in several northern countries. The preferred solution is the material recycling, the most common way to valorise agri-plastic wastes. The on-farm burying or burning is forbidden in many countries. According to the EU waste hierarchy there are four steps to manage waste streams: to prevent, to prepare for re-use, to recover and as the last option to dispose.

- **Chemical recycling** is "*a process that modifies the chemical structure of plastic waste by converting it into shorter molecules ready to be used for new chemical reactions* [8]». Development of chemical recycling is crucial for meeting the ambitious circular economy targets in Europe aiming at increase recycling rate of all plastics. Chemical recycling means chemically or thermochemically processing waste plastic into raw material for the chemical industry. Waste plastic is liquefied in a thermochemical liquefaction process, which turns it into a material similar to crude oil. Chemical recycling can complement mechanical recycling by utilizing waste plastic streams that currently have no or low value in recycling. Although the technical requirement is high and the necessity for a mass flow (300 000 tonnes) on long distance may not ease the footprint.

[7] See 2.1b)
[8] PlasticsEurope 2020

- **Agricultural plastic waste conversion into energy carriers and valuable products.** There are three possible routes for after plastics utilization, which are namely recycling, landfilling and energy recovering. In many cases recycling is difficult to be performed due to the cost involved in this process including transportation, cleaning, shredding, and mixing operations. Their conversion into valuable products including energy carriers maybe an economic way. There are new technologies which allow processing of different kind of dirty agricultural plastics into valuable products. One of them is the microwave technique for converting wastes into gas and char. The waste agricultural plastic must be shredded into small parts and then fed into microwave pyrolysis reactor in which it is converted into producer gas, which consists mainly of hydrogen and carbon monoxide. This gas can be burnt in place for producing electric energy or it can be used for running gas engine coupled with the power generator. The char can be used for producing activated carbon or other valuable products. There is also another advantage of using above mentioned technology which is a possibility of co-pyrolysis of agriculture plastic waste with another waste occurring in the rural area which could be the waste tires or organic matter e.g. poultry litter or waste from slaughterhouses.

Another emerging method which could also be used for converting agricultural plastic waste into valuable products is the plasma technique. However, there are still problems to be solved for using it commercially and this technique may not compensate the investment cost nowadays.

5 The need for R&D and innovation

The technical and economic efficiency for EoL solutions to farmers depend upon an ambitious R&D program to increase efficiency, ease sustainability, and decrease the plastic’s footprint. R&D may be applied for each step of the waste route:

- To the farm, by providing innovative technology to the farmer: mechanical cleaning and removing device on field to increase waste quality (RAFU)[9]. Provide alternative to conventional plastics (as biodegradable). See **minipapers C and D**
- With the collector with an adapted equipment: mobile containers with grapple, efficient shredding, and cleaning equipment (Cleanflex)[10], baling, etc.
- With recycler for adapted recycling line allowing a high-quality product easy to integrate.
- Integration of post consumers regenerated granule (PCr) is the final objective. R&D projects are needed to keep new products’ characteristics, while incorporating PCr, the performance needed. Then a close loop may be achieved.
- Extend the life useful of agricultural plastic to prevent the waste-generating

[9] Rafu: R&D projects reducing mechanically soilage content during field removing operation.
[10] CleanFlex: R&D project in France to shred and clean agri-plastics waste, offline from recyclers, next to the consumption area.

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6 Recommendation for public policies

Existing national schemes have proven their effectiveness and the positive experience gained should be used to encourage the implementation of similar schemes where none yet exists, whilst considering any national differences. It will be necessary to support financially and technically, through a transfer of knowledge, any new scheme, to accelerate its implementation. A transition phase will be needed to give time for all players in the value chain to implement the best national collection schemes and so that Member States that do not have yet a coherent and efficient scheme can get organized.

Any new regulatory legislation should not limit existing initiative but, on the contrary encourage them, enable farmers, distributors, and processors to be engaged collectively in the governance of it.

CONCLUSION: plastic neutral farms
Zero plastics to nature and 100% recycled plastics are achievable, any plastic weight in farms should be out on a proper way to get a Plastic Neutral Farm. 100% recycling requires dissemination of good practices, collection schemes implementation and innovation is needed to make the best use of plastic waste. New industrial processes are needed to sustain the production of recycled plastics. The production of energy carriers is an alternative when the material recycling is not profitable.

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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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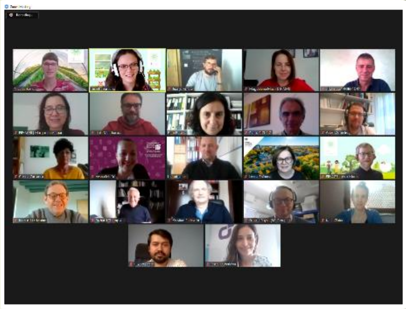

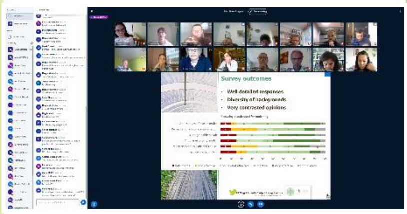

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