



MINAGRIS

Deliverable 8.2

Assessment of the European AKIS
for plastic use in agriculture and
user demands



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MINAGRIS - Micro- and NAno-Plastics in AGRicultural Soils: sources, environmental fate and impacts on ecosystem services and overall sustainability– is an H2020 project funded under the H2020 Programme, coordinated by WAGENINGEN UNIVERSITY (WU).

The MINAGRIS project, launched on September 1st, 2021, aims to contribute to healthy soils in Europe by providing a deeper understanding and tools to assess the impact of MP and NP in agricultural soil health. To create an overview on the actual situation across Europe, MINAGRIS will assess the use of different plastic polymers in agricultural systems in 11 case study across Europe and identify the resulting types and concentrations of MPs and NPs. Concentrations of other stressors in soils such as pesticides and veterinary drugs will be additionally assessed. MINAGRIS will provide validated analytical tools that allow the quantification and identification of MPs and NPs in European agricultural soils.

The project, funded by the EU Research and Innovation Programme Horizon 2020 under Grant Agreement n. 101000407, gathers 20 partnering organisations from 12 EU Member States countries with various biogeographical regions and representative of different farming systems and soils across Europe. It has an overall budget of approximately €7 million and will run for 5 years, between September 2021 and September 2026.

More information on the project can be found at: <https://www.minagris.eu>

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EXECUTIVE SUMMARY

This report presents an assessment of the Agricultural Knowledge and Innovation System (AKIS) for plastic use in agriculture with special reference to soil impacts. It draws on farmer survey and interviews, interviews with case study site (CSS) stakeholders, and interviews and a workshop with the project stakeholder forum experts. As such the assessment takes place at the EU, national and regional study site level.

The assessment aimed to;

- consider the current sources of information, knowledge and advice, the key influencers and intermediaries for knowledge, and the mechanisms for dissemination and advisory activities, with respect to plastic use;
- identify how farmers are supported and currently obtain information about potential soil contamination and alternative or best practice techniques; and identify and assess their knowledge needs, and user demands generally;
- identifying current gaps in knowledge, advice and dissemination, examples of best practice, and key principles for effective knowledge exchange in the community of agri-plastic producers, suppliers and users.

The assessment methodology involved four complementary methods: farmer survey and interviews (110), case study stakeholder interviews (27), high level stakeholder forum (51) and high level stakeholder expert interviews (6).

Looking across the analysis of data from the four sources and levels, some key points emerge:

- The AKIS for agri-plastic is multi-layered and complex, and only just merging for soil.
- Looking for alignment in farmer and stakeholder interview responses exposed some knowledge gaps. With respect to farmer and stakeholder responses about receiving and providing information about agricultural plastic use and its impact on soil, approx. half of stakeholders' organisation providing information but only 25% of farmers said they were well informed on the topic, **revealing limitations in knowledge exchange**.
- Furthermore, although the majority of farmers said they would like to receive technical information about the impact of the different plastic products on the soil and on how to avoid the negative impact of the products in order to avoid negative impacts on the soil, only three CSS stakeholders stated that they provide some information specifically relating to the impacts of agricultural plastics on soils, thereby **exposing a knowledge gap**.
- Conversely most of the farmers interviewed said had no access to advice or information regarding **best practice techniques** related to the use of plastic products in agriculture, while a third of stakeholders said their organisations provide information on this subject, suggesting that farmers are **unaware of this information**.
- At the EU level, whilst mechanisms are in place to enable knowledge exchange, networking and alliances between EU level organisations and their constituent members at national level, there are some **barriers to knowledge exchange, communication and understanding** that emerged in the analysis. These include: a long supply chain separating manufacturers and users, a complex agri-plastics landscape, issues of trust and accountability, and some tensions between different actors, which have implications for knowledge exchange.

This analysis will inform the preparation of the MINAGRIS Dissemination and Communication Strategy.

1. INTRODUCTION

This report presents an assessment of the Agricultural Knowledge and Innovation System (AKIS) for plastic use in agriculture. It draws on farmer survey and interviews, interviews with case study site (CSS) stakeholders, interviews and a workshop with the project stakeholder forum experts. As such the assessment takes place at the EU, national and regional study site level. The assessment aimed to:

- consider the current sources of information, knowledge and advice, the key influencers and intermediaries for knowledge, and the mechanisms for dissemination and advisory activities, with respect to plastic use;
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- identifying current gaps in knowledge, advice and dissemination, examples of best practice, and key principles for effective knowledge exchange in the community of agri-plastic producers, suppliers and users.

This assessment is intended to inform the development of the MINAGRIS Dissemination and Communication Strategy (Task 8.3) by identifying current gaps in knowledge, advice and dissemination, examples of best practice, and key principles for effective knowledge exchange in the community of agri-plastic producers, suppliers and users. Critically it will ensure that project's outputs are integrated into existing activities and speed up translation into practice, in line with the aims of EIP-AGRI.

The assessment is underpinned by the AKIS framework, defined as: a system of diverse actors from the private, public and non-profit sectors that links people and organizations to generate, share and utilize agriculture-related technology, knowledge and information (Birner et al., 2009)¹. As such, it is concerned with the people who generate and use knowledge and the knowledge exchange mechanisms, as well as the wider system in which they are situated.

This is the first assessment of the AKIS for agricultural plastic, although knowledge gaps have been identified in previous studies. For example, the Conventional and Biodegradable Plastics in Agriculture report (EU 2021)² identified problem drivers associated with improper collection, low reuse and recycling of conventional and biodegradable agri-plastics, and the technical and non-technical barriers impeding higher recycling and reuse rates. The related knowledge gaps and specific objectives to address them were:

- Ensure widespread understanding and awareness among farmers about the contexts where biodegradable mulch films offer a more desirable alternative to conventional mulch films
- Ensure widespread awareness among farmers as to the agricultural plastic collection schemes available and the benefits of participating
- Exchange of best practices and education of professionals

¹ Birner, R., Davis, K., Pender, J., Nkonya, E., Anandajayasekaram, P., Ekboir, J., ... Benin, S. (2009). From best practice to best fit: A framework for designing and analyzing pluralistic agricultural advisory services worldwide. *Journal of Agricultural Education and Extension*, 15, 341–355.

² Conventional and Biodegradable Plastics in Agriculture. For the European Commission DG. Environment. Project conducted under Framework Contract No. ENV.B1/FRA/2018/0002 Lot 1.

A recent FAO assessment³ also identified several knowledge gaps, including skills. In proposed elements of a new international code of conduct on agricultural plastics it proposed licensing of users will allow regulators to ensure that they have the necessary knowledge, skills and equipment to manage plastic products (especially high-risk products) appropriately, including their end-of-life management. It also highlighted the need for behaviour change which should be supported with education, capacity-building and communications to improve knowledge and understanding of the issues at stake and sustainable practices

³ FAO. 2021. *Assessment of agricultural plastics and their sustainability. A call for action*. Rome. <https://doi.org/10.4060/cb7856en>

2. METHODOLOGY

2.1 Methods

An assessment methodology (informed by Schut et al (2015))⁴ was conducted using four complementary methods: farmer survey and interviews, case study stakeholder interviews, high level stakeholder forum and high-level stakeholder expert interviews (Fig 2.1). The farmer survey and interviews were oriented towards the farmer community, while the other activities aimed to consult a range of stakeholders at country and EU level. These methods allow different experiences and perspectives to be captured as well as triangulation of results. The farmer survey analysis provided insights for structuring (and seeking feedback at) the expert workshop and the CSS stakeholder interviews. Quantitative data from the farmer and CSS interviews/survey is combined with some qualitative data. Some document analysis supports the EU level analysis. An initial stakeholder analysis ensures that there is representation from all levels (farm, region, national, European, international) and stakeholder categories as shown in Table 1.

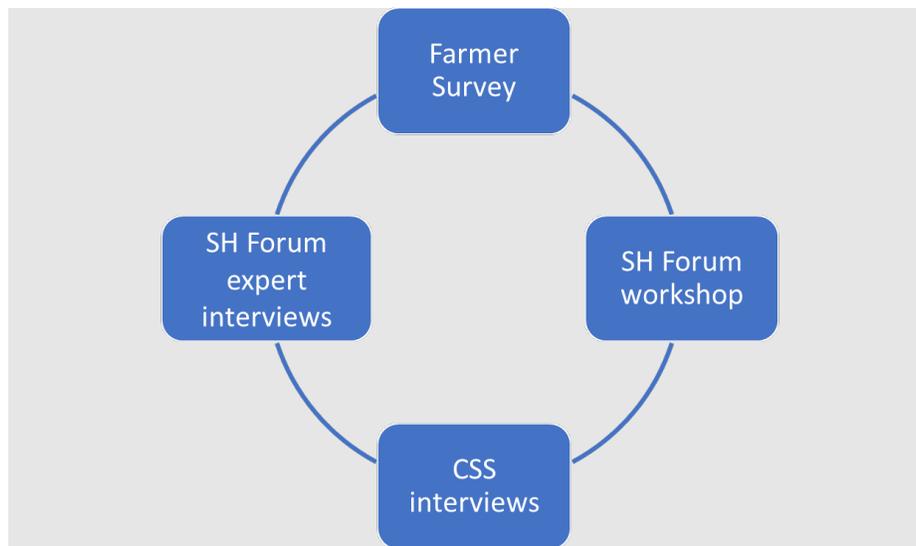


Fig 2.1 Assessment methodology (SH=stakeholder, CSS= case study sites)

⁴ Schut, M., Klerkx, L., Rodenburg, J., Kayeke, J., Hinnou, L.C., Raboanarielina, C.M., Adegbola, P.Y., van Ast, A. and Bastiaans, L., 2015. RAAIS: Rapid Appraisal of Agricultural Innovation Systems (Part I). A diagnostic tool for integrated analysis of complex problems and innovation capacity. *Agricultural Systems*, 132, pp.1-11.

2.2 AKIS Stakeholders

Considering the AKIS, the main stakeholders involved who generate, share and use knowledge are those in the a) agri-plastic value chain and life cycle, b) the farming community who traditionally support and advice farmers, c) the policy making community, d) academia and research sector and e) NGOs and environmental advocacy organisations.

2.2.1 Agri-plastic life cycle stakeholders

In Europe, agri-plastic applications are used for a multitude of purposes across the different life-cycle stages of the agricultural supply chain. According to a recent report (EU, 2021)⁵ the main actors involved across the life cycle of agri-plastics in Europe include:

- Plastic converters: produce and place agri-plastics on the European market taking into account relevant regulatory provisions, in particular the use of certain additives.
- Farmers and growers: end-users of agri-plastics for agricultural production, in charge of the final disposal practices at end-of-life.
- National, regional public authorities: responsible for the transposition of EU legislation, monitoring and enforcement, knowledge exchange and information provision.
- Waste management operators, including plastic recyclers: ensure end-of-life treatment, data reporting, compliance with relevant EOL treatment requirements, etc.

2.2.2 Farming community AKIS stakeholders and activities

These include:

- Research bodies- EU projects, universities, public research institutions, commercial research activities, public foundations in multiple disciplines
- Agricultural advisory services: public and private advisory services, farmer based organisations (chambers of agriculture), environmental NGOs, farmer-led networks
- Grower (sector) organisations and trade bodies
- The supply chain actors and intermediaries- including the plastic product dealers, as well as those involved in sales of unintentional input of plastics (irrigation specialist, sewage sludge, compost and manure providers/coordinators)
- Agricultural policy makers and regulators
- Agricultural education and public and consumer awareness raising

For **Policy making community, Academia and research sector and NGOs and environmental advocacy organisations**, the relevant bodies operate at EU and national level (see section 3.4)

⁵ EU (2021) Conventional and biodegradable plastics in agriculture. *Report for the European Commission DG Environment. Project conducted under framework contract no. ENV.B1/FRA/2018/0002. 1-334.*

Table 2.1 Stakeholders consulted in the AKIS assessment

Farmer survey & interviews	Case study site stakeholder interviews	High level stakeholder forum expert interviews	High level stakeholder expert interviews
110 farmers from a range of farming systems across 11 countries	27 stakeholders across 11 CSS: Waste management 4 Agricultural association 2 NGO 2 Cooperative 2 Scientist 2 Agricultural advisor 6 Plastic industry 3 Farmer 3	51 participants: Academia 24 Farming organisation 3 NGOs 2 Plastic manufacturers 5 Policy maker 5 Public foundation 2 Trade association 4 Waste and recycling organisation 2	6 interviews: EU plastics trade association 2 EU Bioplastics trade association 1 International agricultural company (research, manufacture, supply) 2 EU research project 1

2.3 Farmer Survey in case study sites

In MINAGRIS, there are 11 case study sites that represent the different regions covered by the project consortium. Each case study site is led by a local project partner.

For the survey 10 farmers from each CSS were recruited to participate in the project study and a one-hour interview with each farmer using an online survey developed by FiBL Switzerland (LimeSurvey) was completed to gather information on plastic use on farm. WP8 partners provided additional questions for the survey to complete this AKIS assessment, these covered farmers' awareness, and information use and needs related to plastic use in agriculture. A preliminary baseline questionnaire was answered by 110 farms (although not all of these responded to the survey questions). The response number for the different questions are detailed in the results.

2.4 Stakeholder interviews in case study sites

The 11 MINAGRIS case study sites were asked to carry out 2-3 interviews between 17/03/2022-26/05/2022 with a range of national level stakeholders (see Table 2.1). These interviewees were selected purposely by the case study site leaders to represent different stakeholder categories. In total, 27 interviews were completed, with all case study countries participating (see Table 4.2). These interviews, developed by the CCRI (UoG, UK) consisted of both quantitative and qualitative questions to garner detailed information about the AKIS in each country. The questions were based on those asked in the farmer survey to provide some triangulation. A protocol was provided to case study site leaders to ensure standardisation, and detailed notes and audio recordings were taken during the interviews, with data inputted into an online form (using JISC online surveys). Informed consent was gained from all participants.

2.5 Stakeholder forum workshop

On 28th March 2022, a joint MINAGRIS-PAPILLONS stakeholder forum workshop as held with high-level (international and European level) stakeholders participating. The types of stakeholders who attended are shown in Table 2.1.

In this workshop the results from the farmer survey were presented and following this, an interactive session was held to capture stakeholders' responses to the survey results asking for any gaps and further views about advice and information surrounding agricultural plastics. Four questions were asked and participants responded on a Miro board with their comments and provided commentary and 'chat' at the same time.

2.6 Stakeholder forum interviews

Representatives from different categories of stakeholder (Table 2.1) were selected and invited for interview. The aim was to provide a 'snapshot' across the AKIS, so some areas are not represented (policy, NGOs). These included (ANONYMISE):

- Sustainability Director – in a European trade association and represents plastics manufacturers active in the European plastics industry
- Expert scientist in a European trade association and represents plastics manufacturers active in the European plastics industry
- Head of Environmental Affairs in a European trade association and represents bioplastic manufacturers active in the European bioplastics industry
- Representative European biomass industry association and H2020 research project and lead of dissemination WP
- Global Market Development Biopolymers International manufacturer supplying plastics for conversion to agricultural applications
- Expert scientist International manufacturer supplying plastics for conversion to agricultural applications

3. RESULTS

Figures are aggregated for all case study sites for most of the results, since there was no discernible difference between countries for most questions, with the exception of Figs 3.2 and 3.7.

3.1 Farmer Survey in the CSS

3.1.1 Farmers' awareness/knowledge regarding plastic impact on soil

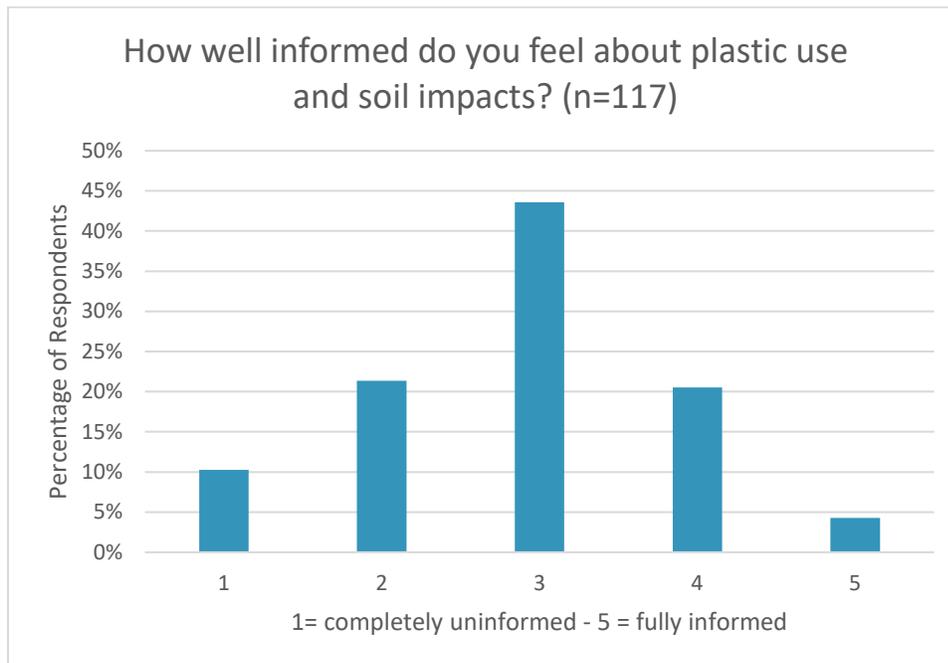


Figure 3.1: Percentage of answers to the question on a scale of 1-5 (1= completely uninformed, 5 = fully informed)

The survey conducted by the CSS leaders during an interview with each farmer started with a general question about their awareness and knowledge regarding plastic use and its impact on soil (Figure 3.1). Out of 117 answers, 32% of farmers interviewed felt completely uninformed or little informed while 43.5% estimated being relatively aware of the topic. And some 25% of farmers said they were well informed on the topic.

Across the participating countries there was some variation in this (Figure 3.2). Farmers in Spain and Italy considered themselves relatively well informed on the impacts of plastics on soil. Meanwhile, participants in Switzerland, France, and the United Kingdom felt least well informed. This might in part be explained by the higher plastic usage in Spain, Italy, and the relatively low usage in Switzerland (EU, 2021).

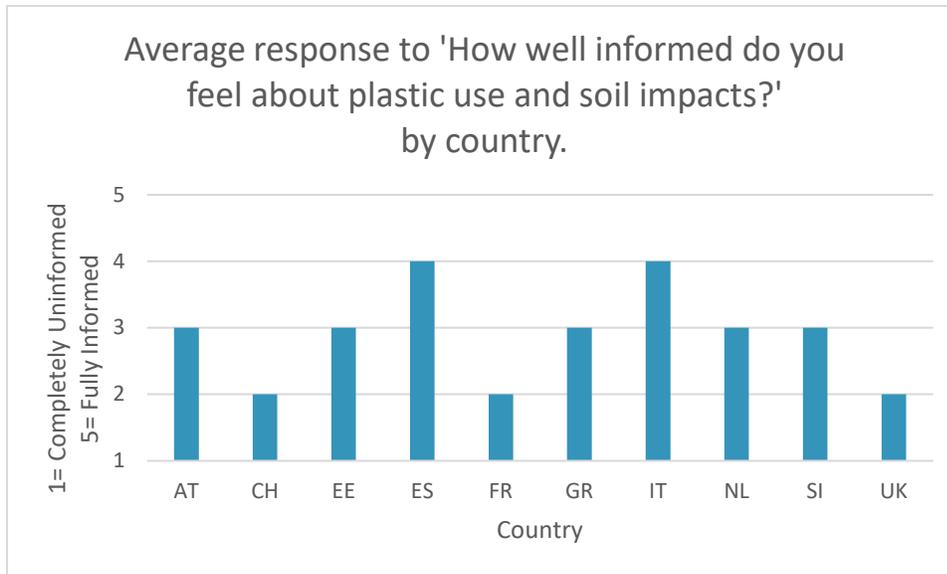


Figure 3.2 How well informed do you feel on soil impacts: average ranking by country

3.1.2 Sources of information regarding plastic impact on soil and knowledge gaps

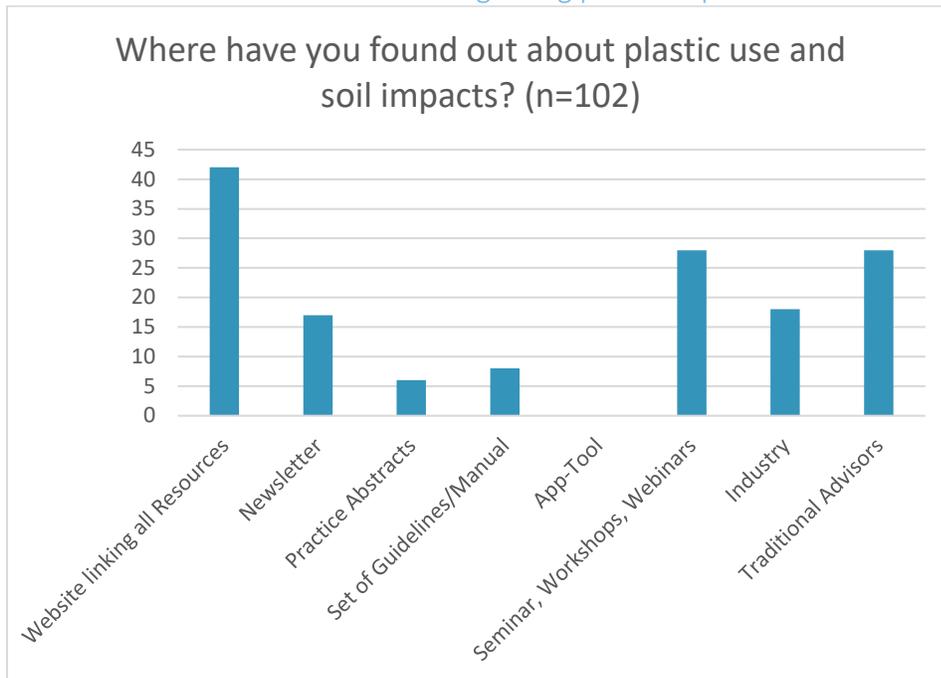


Figure 3.3 Number of answers given for each source of information on plastic use and its impact on soil (multiple answers were allowed)

When asked about sources of (and mechanisms for finding) information on plastic use and its impact on soil, most farmers interviewed said they found information on plastic use and soil impact on websites, in seminars or through traditional advisors (Fig 3.3). The industry and newsletters are also a source of information (mentioned in 20% and 15% of answers respectively) while guidelines, manuals and or plastic abstracts are seldom mentioned as a source. Smartphone applications were not mentioned.

The website sources included: research and development boards, agricultural associations, agricultural newspapers, and private (low and high level) research. Seminar, workshops and webinars attended by the farmers are those organized by research and development boards and farmers' association, and can be general advisory talks or agricultural workshops. Information on plastics came also from traditional advisory services provided by agronomists, farmers' associations or agricultural cooperation and from the industry through research and development boards, farmers' associations, other farmers and the plastic suppliers. Practice abstracts were from EPI AGRI and manuals and guidelines were derived from research and developments boards, agricultural manuals, or product sheets. Radio programmes and news, printed newspapers, social media, documentaries, schools/universities and personal experiences were other sources of information on plastic impact on soils as mentioned by the interviewees.

3.1.3 The type of information farmers would like to receive about plastic use and impact on soil

When asked about the type of information they would like to receive about plastic use and impact on soil, almost 60% of the interviewees said that they would like to receive technical information about the impact of the different plastic products on the soil (Fig 3.4). Around half mentioned their interest in receiving information on how to avoid the negative impact of the products and how to recycle the plastic product in order to avoid negative impacts on the soil. Information on regulation around plastic, and even more on reputable plastic suppliers was the least interesting to the farmers interviewed, although these were >30% and 20% respectively.

Other (40% respondents) information that farmers mentioned they would be interested to receive on the topic includes:

- Degradation of products (how much and how long does it last) and its (long-term) effect on plants, animals and microorganisms
- Health/nutrition impact of microplastic in food
- Plastic compositions
- Sources of microplastic (products but also for example air emissions)
- Alternatives to plastic
- The positive and negative impact of biodegradable products
- Possible negative impact of recycling (i.e., degradation)
- Methods to avoid bringing microplastic into the soil
- Impact of plastic-containing products like organic waste or mulch
- How to remove plastic from the soil
- Amount of plastic in soils in the different regions

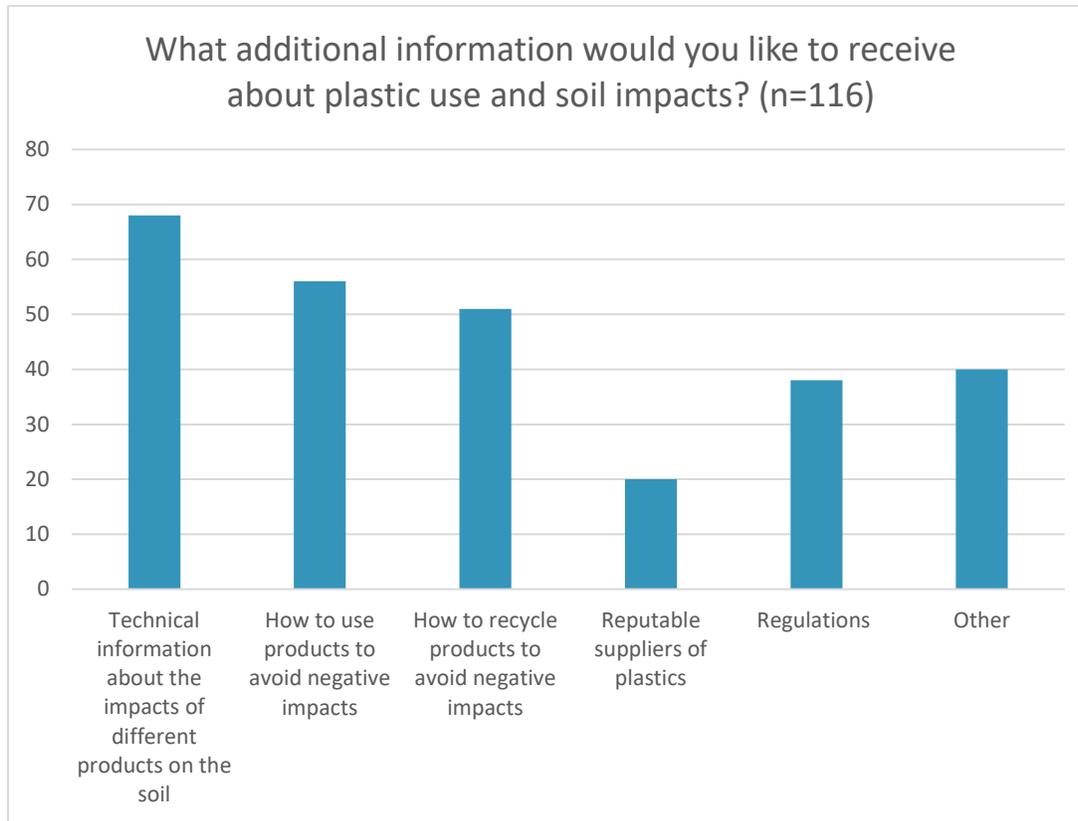


Figure 3.4 Number of answers given for each information farmers would be interested to have access to on the topic of plastic use and soil impacts (multiple answers were allowed)

3.1.4 Preferred mechanisms for providing information

When asked about the preferred mechanisms for obtaining information, websites linking all resources, traditional advisors and newsletters were the most popular (Fig 3.5). Other means such as set of guidelines/manuals and seminar/webinars and workshops were also selected as a desired method for obtaining information. There was little interest in Practice Abstracts, Apps and guidelines or manuals, reflecting the small proportion of these currently available on this topic. With only 8% of interviewees interested in information coming from the industry, it could be argued that industry is not seen as a familiar or trustful source.

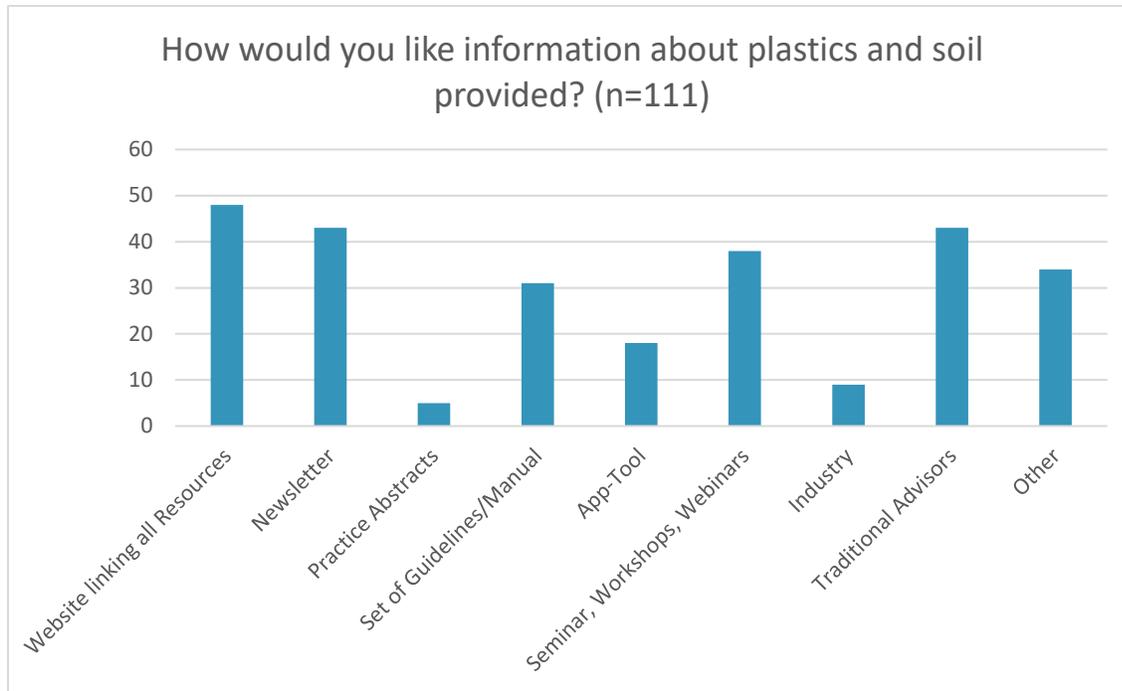


Figure 3.5: Number of answers given on how would farmers like to receive information on the topic of plastic use and soil impacts (multiple answers were allowed)

Other mechanisms (>30%) which farmers listed for receiving information on plastic use and their impact on soil include:

- E-mails
- Case studies
- Farmers' newspaper /agricultural magazines
- Printed info sheet
- Package product-leaflets
- Documentaries
- Scientific papers
- Information related to subsidies

Some of the farmers interviewed mentioned that they would like to receive information on plastic use and impact from the following:

- Research and development board
- Government (e.g., subsidies)
- Relevant stakeholders
- Farmers' association
- Industry and traders

3.1.5 Access to advice about best practice techniques for plastic use in agriculture and sources

Sixty eight percent (68%) of the farmers interviewed (n=112) had no access to advice or information regarding best practice techniques related to the use of plastic products in agriculture. Across the participating countries, those who had not sought or received advice on this outnumbered those who had (Fig 3.6). In Austria, Switzerland and France, no participants had received advice on best practice in plastics. Only in Greece and Italy did participants with access to information on this outnumber those without. Although this might be explained in terms of the amount of plastic usage in Italy (which is high), this does not explain the responses for the other countries (Greece for example has low usage compared to France which is high (EU 2021)).

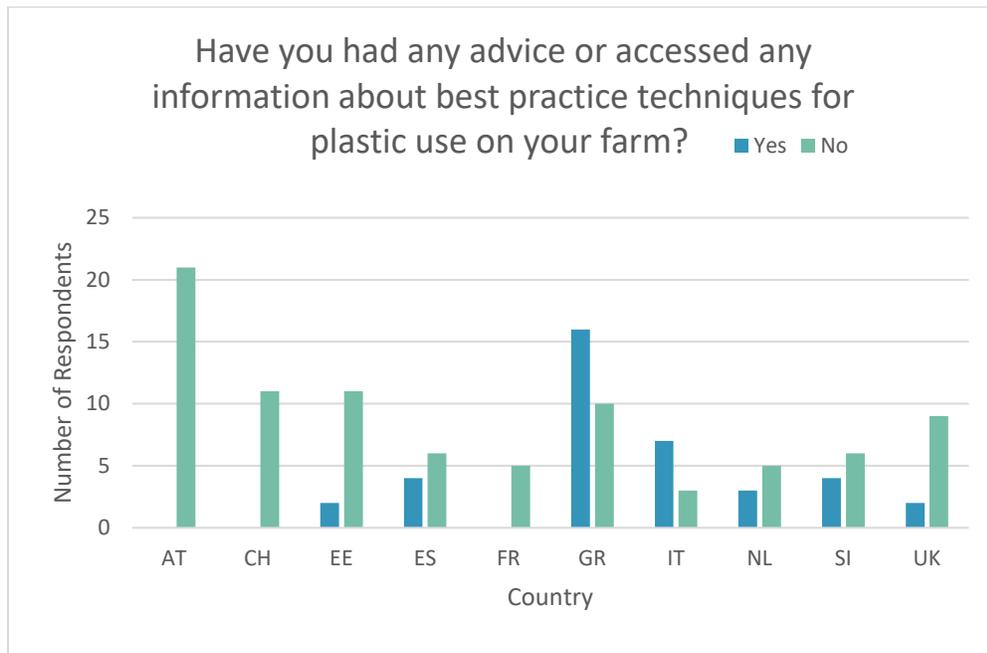


Figure 3.6 Whether or not participants have received advice on plastics, by country.

Sixty percent (60%) of those who had access to information about best practice techniques for plastic use on their farm, received it from advisors among others sources. Plastic suppliers, websites as well as other farmers were mentioned as sources of information on best practice techniques (Fig 3.7).

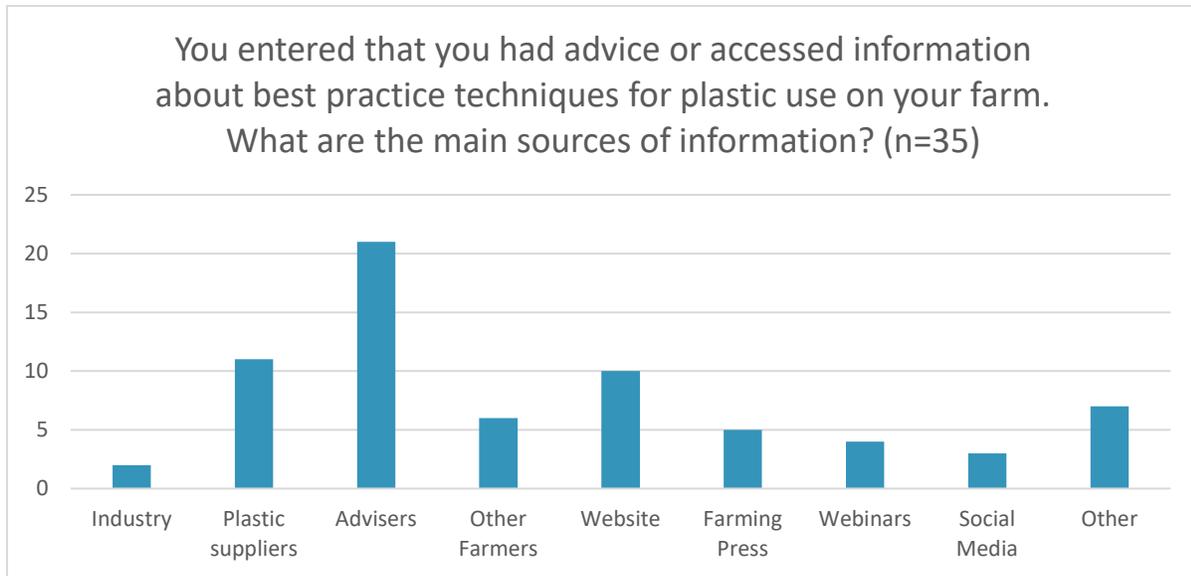


Figure 3.7 Number of answers for each source of information on best practice techniques for plastic use on farm (multiple answers were allowed)

Other cited sources were:

- Agronomists
- Research and development board
- Farmers' association
- Agricultural cooperative
- Certification inspectors
- Recycling agency
- Study clubs
- Participation in projects
- Workshops

3.1.6 Information and advice about alternatives to plastic

In Fig 3.8 participants' sources of information on alternatives to plastics are shown. Plastic suppliers, other farmers as well as website and agricultural publications/press are cited among the main sources.

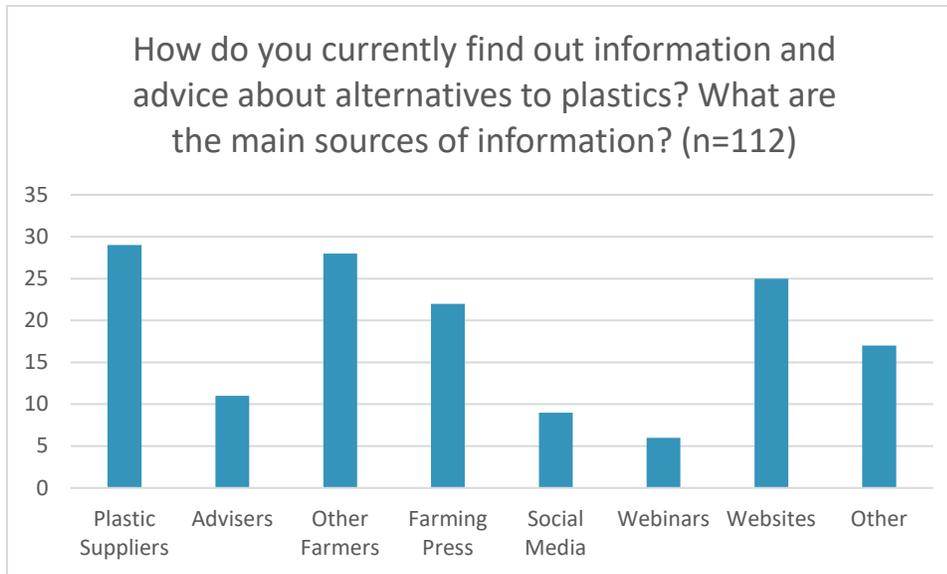


Figure 3.8 Number of farmers finding information on alternatives to plastics from a specific source (multiple answers accepted).

Other sources suggested by respondents include:

- Research centres
- Radio programs
- Cooperative technician
- Cooperatives/Communities
- Customers
- Supermarkets
- Scientific articles
- Research and development boards
- Growers' association
- Fairs/Forum
- Study clubs
- University
- Sales magazines
- Courses

3.1.7 Research or innovative needs mentioned by farmers participating in the survey

A range of knowledge gaps were identified by farmers (Table 3.1). Advice and education (including consumers) featured quite strongly as a future need, as well as more research and information on technical solutions, field techniques, cleaning up processes, impacts, and mechanisms for achieving change.

Table 3.1 Knowledge gaps identified by farmers

<p>Advice and education</p> <ul style="list-style-type: none"> • Advising for knowledge gaps and needs • Make more advice services • Make neutral information accessible • Education of the population about compost • Educational system starting in school • Educate end consumer • <p>Field Techniques</p> <ul style="list-style-type: none"> • Generally, rethink some methods like silo bales • Technical and mechanical solutions • Avoidance of plastic <p>Cleaning up</p> <ul style="list-style-type: none"> • How to clean microplastic-infested soil • Microorganisms for degradation of plastic • How to slow down or accelerate biodegradation • Clean compost • Improve recycling 	<p>Alternatives</p> <ul style="list-style-type: none"> • Alternatives for transplanting trays • Improve longevity of alternative products • Alternatives without residues <p>Impacts</p> <ul style="list-style-type: none"> • Effect on health • How deep do microplastics get into the soil • Microplastic in groundwater and ocean • Effect on soil and its habitants • Monitoring of degradability • <p>Support Mechanisms</p> <ul style="list-style-type: none"> • Financial support for alternatives • Make alternative products cheaper. • New EU regulations • Tax system for the use of plastics • Standardized labelling for biodegradable products
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3.1.8 Summary

In summary, some general observations can be made. Whilst the majority of farmers respondents appear to be being relatively well or well informed about plastic use and its impact on soil, 32% of farmers interviewed felt completely uninformed or little informed. Also, the majority also responded that they had no access to advice or information regarding best practice techniques. They expressed interest in receiving information about technical aspects and any negative impacts of plastic products on soil, as well as how to recycle the plastic products. Advisers play a key role compared to plastic suppliers with respect to general and best practice advice but less so for alternatives, where plastic suppliers and other farmers are more important. A range of information sources and mechanisms were cited as preferred for farmers suggesting individual preferences as well as the different farming systems represented in the survey are important.

3.2 National CSS stakeholder interviews

As aforementioned, 27 in-depth interviews were carried out across the MINAGRIS CSS with national stakeholders. As illustrated by Fig 3.9, a range of stakeholder types were interviewed. Table 3.2 provides a breakdown of the interviews carried out in each of the MINAGRIS case study countries.

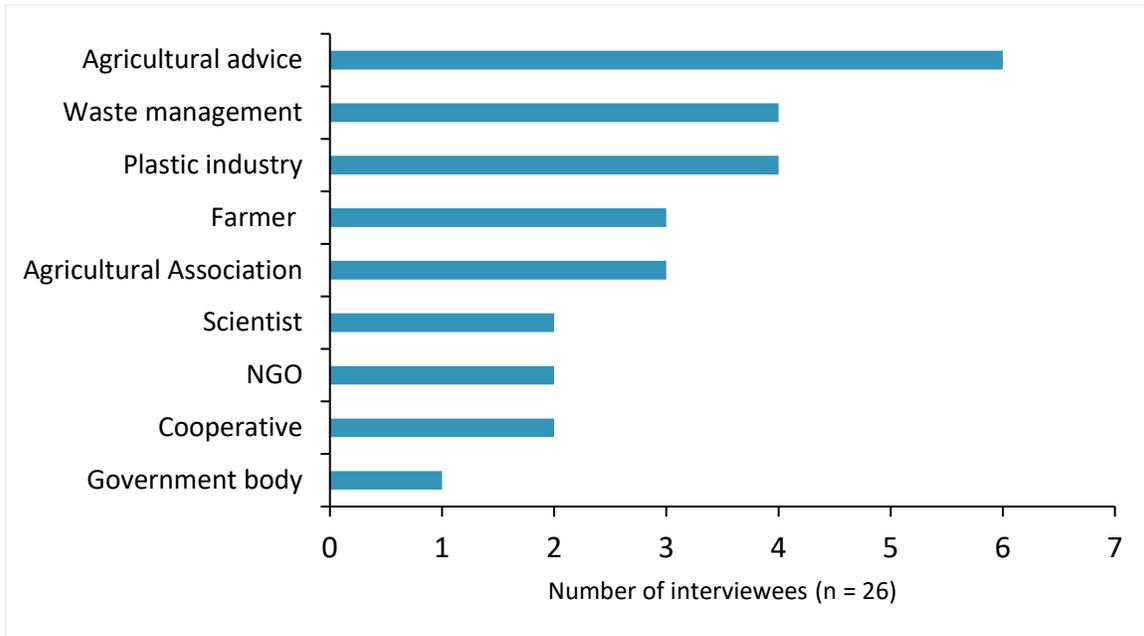


Figure 3.9 National stakeholders interviewed within the MINAGRIS CSS as part of the AKIS review.

Table 4.2 Breakdown of the interviews carried out with national stakeholders in each MINAGRIS case study country.

Country	CSS number(s)	Number of interviews	Stakeholder type(s)
Austria	6 & 9	5	Waste management (2), agricultural association, NGO, cooperative
Estonia	4	2	Scientist, agricultural advisor
France	11	3	Government body, agricultural association (2)
Greece	8	2	Agricultural advisor, plastic industry
Italy	7(a, b)	1	Agricultural advisor
Slovenia	1	4	Plastic industry (2), agricultural advisor, farmer
Spain	10	3	Waste management (2), scientist
Switzerland	5	2	Farmer, agricultural advisor
The Netherlands	2	3	Plastic industry, NGO, farmer
UK	3	2	Agricultural advisor, Cooperative

3.2.1 Provision of information surrounding agricultural plastic use

Over half of interviewed stakeholders are associated with organisations that provide information about agricultural plastic use (54% ; n = 15). Of the remaining 46%, some of the interviewees were farmers themselves, thus did not come from ‘organisations’ per se. It was not, therefore, surprising that they did not provide information surrounding agricultural plastic use.

Once farmers were removed from this analysis, 23 respondents remained. Of these, 43% (n = 10) do not provide any information about agricultural plastics. These interviewees were from France, Austria, Spain, Estonia, Spain, The Netherlands, and Slovenia.

The only countries where no interviewees claimed to provide information was France, where a government body and an agricultural association were interviewed. It should, however, be noted that there may be other relevant organisations in France which were not interviewed as part of this study.

Interviewees were asked whether they knew of any other organisations that provide information about agricultural plastics, of which 17 provided examples. The organisations mentioned (in order of significance) included the plastic industry, farming organisations, researchers, government bodies, and NGOs. Fig 3.10, by combining both the advice given by interviewees and by other industries mentioned, provides an overview of the main organisation types who provide information about agricultural plastics.

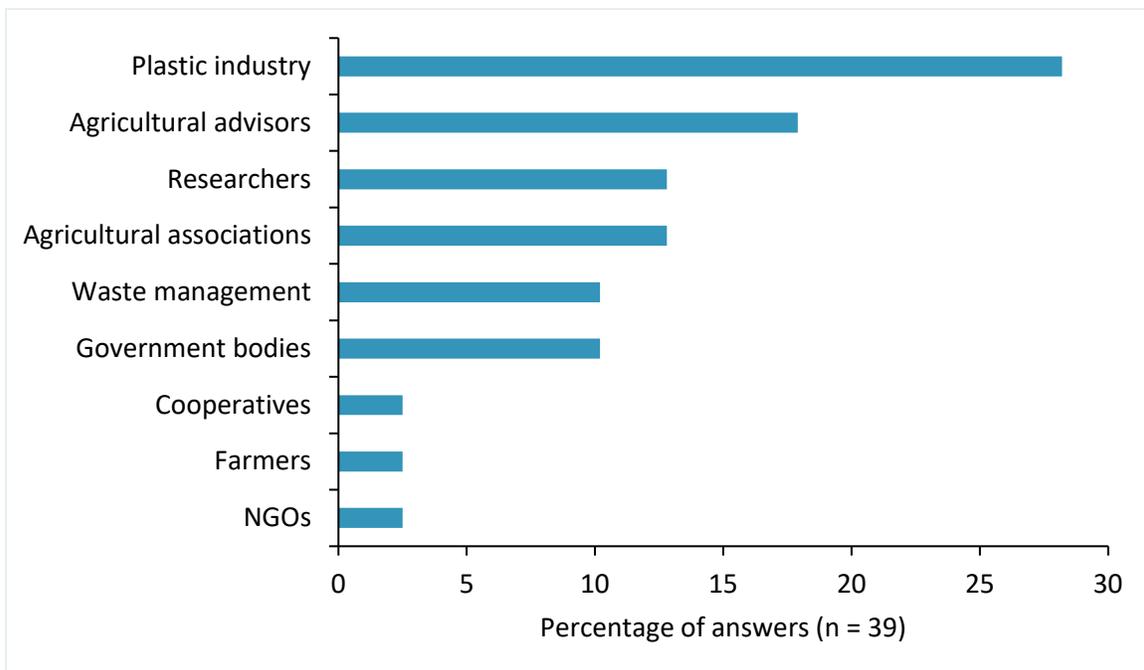


Figure 3.10 Sources of information surrounding agricultural plastics according to the 27 participants interviewed for this review.

One of the UK participants provided in-depth detail about how horticultural grower associations also provide advice to their members. In addition, word-of-mouth appears to be an important way for farmers to hear about plastic recycling schemes, for example:

'Usually, it's word of mouth, 'what you're doing with this?', you know, everybody, every farmer will be, they'll be talking to their neighbour, who'll be talking to their neighbour to find out. And transport companies, because that's what we were doing, we were talking to the guys who we think will be taking product [carrots]. For instance, anybody going up into Scotland to bring product down from Scotland will be talking to them about taking this stuff, you know, filling up empty lorries to go into Scotland. So a lot of it hinges around transport. That's what I'm trying to say. And so it's about word of mouth. So people will be talking to us, and then transport companies will be turning around and going. Actually, we've got lorry going north, have you got anything to go in those lorries? You know, we can take it to the recycling place. So if your polythene comes in, whenever, you know, we can take it there'.

Based on the above, this indicates that farmers may help each other to recycle plastics, with those visiting a plant often showing a willingness to take recycling from other farmers with them.

3.2.2 Provision of information on the impacts of agricultural plastics on soils

Just three interviewees (11%) stated that they provide some information specifically relating to the impacts of agricultural plastics on soils. These participants were from Slovenia, Italy, and Austria and were agricultural advisors or from the waste management sector. This indicates a paucity of information about soils, potentially due to a lack of research which investigates how plastic affects soil health.

Some interviewees (33%, n = 9) were, however, aware of other sources of information about soils and agricultural plastics. These stakeholders were from Slovenia, Switzerland, Italy, and Austria. Table 3.3 provides information on the sources of information both delivered by the stakeholders' organisations and by others. The remaining countries do not appear to have any information sources relevant to the impacts of agricultural plastics on soils.

Table 3.3 Existing sources of information surrounding the impacts of agricultural plastic on soils. Most MINAGRIS case study countries do not appear to have any information on this topic.

Country	Source(s) of information surrounding the impacts of agricultural plastics on soils
Slovenia	Plastic industry, Universities, Institute of Hop Research and Brewing, farm advisors, public bodies, Chamber of Agriculture and Forestry of Slovenia
Italy	Farmer associations (e.g., ASIPO)
Austria	FAO, Bündnis Mikroplastikfrei, BOKU
Switzerland	Farmer associations, Inforama (farmer education centre)

The results suggest that some farmers are adding a range of plastic materials to soil (intentionally or unintentionally) but do not have sufficient information, evidence or awareness about the impacts. For example, a key issue which arose across many interviews was the high levels of plastic within green waste and compost, with participants explaining that they have experimented with it but since deciding to stop due to the amounts of plastics entering their fields:

'They're very hungry for using, you know, organic matter. But they stop using the green waste. They just stopped using it, overnight. Because, you know, there was too much plastic and just too much plastic in it. Because that's coming from, you know, domestic environment. And once it gets into the system, they can't get it out. So a lot of them, about five or six years ago, everybody thought GreenWaste that's gonna be fantastic. We'll get that up high in potassium, you know, high in nutrients, organic matter. Let's get that on. And then all of a sudden they start putting it on the find out there's plastics in there and they go, No, thank you'. – UK, grower association

3.2.3 Main audiences for information surrounding agricultural plastics

According to CSS stakeholder interviewees, farmers are the main audience for the information they deliver about agricultural plastics, mentioned by 79% of the interviewees who answered this question. This indicates the importance of ensuring that information is delivered in such a way that appeals to this key audience. Other audiences mentioned include farmer association members, field technicians, the general public, politicians, other organisations, advisors, and distributors (Fig 3.11).

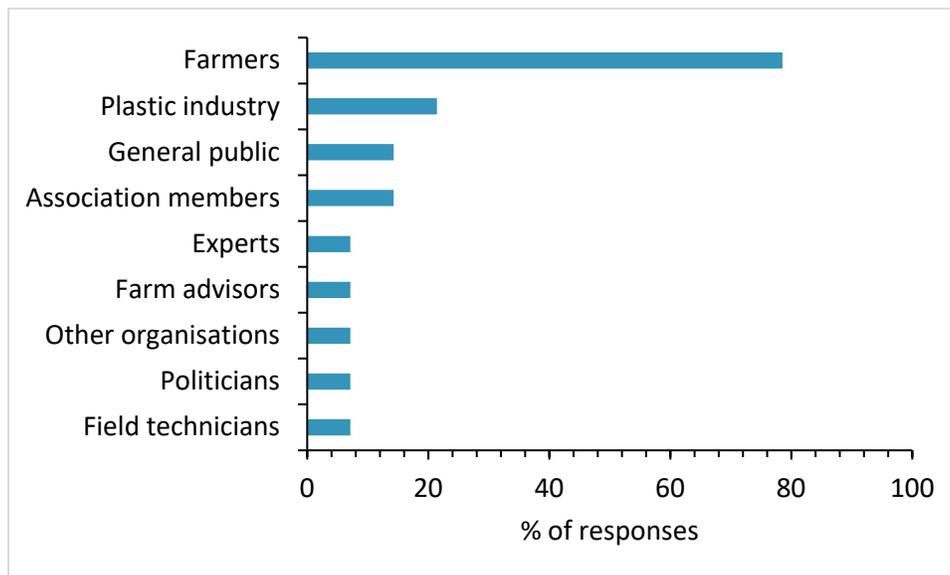


Figure 3.11 Main audiences for information surrounding agricultural plastics from interviewed stakeholders. Percentages do not add up to 100 as several interviewees have multiple audiences.

3.2.4 Current delivery of information

Figure 3.12 provides a visualisation of the approaches stakeholders currently use to deliver information surrounding agricultural plastics. Seminars/webinars, workshops, and organisation websites were amongst the most heavily used approaches.



Figure 3.12 Word cloud displaying the modes of delivering information surrounding agricultural plastics. The largest words depict the most frequently used approaches.

3.2.5 Information sources currently used by farmers

Interviewees were asked which types of information farmers currently use. Some interviewees explained the need to recognise the heterogeneity of farmers: whilst some actively seek out information, others may not. Another interviewee (UK, agricultural advisor) explained that there is not much available information surrounding agricultural plastics, but that farmers are generally aware of the need to recycle.

The main sources and mechanisms that interviewees believe farmers use included: the internet, advisors, farming press, workshops, webinars, other farmers, radio, practical journals, newsletters, and social media. Interestingly, whilst the data suggest that seminars are one of the main approaches used by stakeholders to deliver information (see Fig 3.12 – wordcloud), this does not appear to be a particularly common method used by farmers (section 3.1). This indicates that there may be a need to make better use of the sources and mechanisms that farmers prefer.

Both Spanish interviewees stated that they do not believe farmers seek out or receive much information about agricultural plastics, instead suggesting that they are ‘passive’, thus only gaining information when they are actively targeted, rather than through seeking it for themselves.

Table 3.4 provides an overview of the sources of information stakeholders believe farmers use in each of the MINAGRIS case study countries.

Table 3.4 Sources of information interviewed stakeholders believe farmers use to gather information surrounding agricultural plastics.

Country	Type(s) of information used by farmers (with most frequently mentioned sources mentioned first)	Mention of a lack of sources ?
Austria	Internet, practical journals, face-face advice	Y
Estonia	Internet	Y
France	Public laboratories, website, concise newsletter	Y
Greece	Seminars/workshops, information from the plastics industry, farmer associations, colleagues	Y
Italy	Advisors, internet	Y
Slovenia	Other farmers, internet, advisors, suppliers	Y
Spain	Plastic industry	Y
Switzerland	Radio, farming associations, internet, newsletters, social media, farming press, practice abstracts, videos/podcasts, apps, seminars, workshops	Y
Netherland	Advisors	Y
UK	None	Y

3.2.6 Initiatives for reducing or removing plastics from agricultural fields

Of the 27 interviewees, 59% (n = 16) were aware of initiatives for reducing or removing plastics from agricultural fields. Table 3.5 provides an overview of the initiatives mentioned by country.

Interestingly, there was no mention of the ‘Agriculture Plastics Environment’ (APE) association, a European-wide initiative aiming to bring together those involved in agricultural plastics, with a forum available for discussion surrounding non-packaging agricultural plastics. In addition, APE has initiated several plastic collection schemes operating across several countries, including MINAGRIS case study countries France, Spain and the UK (APE, 2022)⁶. Our research indicates that whilst initiatives may well exist, concerted effort is needed to raise awareness surrounding their existence. This is reinforced with countries like Spain and Greece which are very active in supporting the use of biodegradable mulching films and recycling (EU, 2021).

In addition, there appears to be either a lack of, or a lack of awareness of, recycling schemes. Whilst the EU (2021) state that the biggest barriers to agricultural plastic recycling are the high processing costs and low value recyclate with a limited market, we find that there may also be a lack of opportunities available for farmers to recycle their plastics. In the UK, for example, whilst our interviewee stated that there are several recycling companies in operation, they knew of many farmers who were unaware of these. As a result, a UK-based organisation, FWAG SW, set up their own local recycling company, which has been in high demand. However, when they attempted to expand the initiative into a new region (Cornwall), they found that few farmers used the initiative, with the interviewee recognising that this was largely due to a lack of awareness raising as well as the geographical distances between farms in this particular area.

⁶ Agriculture Plastics Environment (2022) About APE. [Online]: <https://apeeurope.eu/> [Accessed 05/05/2022].

Table 3.5 Local and national initiatives surrounding agricultural plastics identified by interviewed stakeholders.

Country	Local initiative(s)	National initiative(s)
Austria	Plastic mulch producer collects foil from farmers on set dates to help them organise recycling; waste collection schemes organised by local community organisations	Bündnis Mikroplastikfrei; new compost regulation
Estonia	None known	None known
France	Geochanvre – provides hemp-based shelter for young plants (alternative)	None known
Greece	Plastika Kritis campaign for plastic greenhouse cover recycling	Extended producer responsibility policy – organised by the government, manufacturers, and the Association of Hellenic plastics industries
Italy	None known	None known
Slovenia	None known	None known
Spain	Clean sweep, The sea cleaners	None known
Switzerland	None known	ERDE Switzerland – recycling scheme for plastic wrap and nets
The Netherlands	None known	None known
United Kingdom	Recycling scheme organised by a farming advisory organisation (FWAG Southwest)	None known

3.2.7 Experimentation with alternatives to agricultural plastics

We asked interviewees whether their organisations have experimented with alternatives to plastics, finding that 63% (n = 17) have. They were also asked whether they know of any (other) organisations who have experimented with alternatives, of which 52% (n = 14) said yes.

Most of these participants have experimented with biodegradable plastics, including foils and mulches. A couple of participants were doubtful that current alternatives are viable :

“alternative” material contains 35% recycled plastic (still plastic), is 10% more expensive than normal plastic product, and has lower quality (in case of stretch foil) Biodegradable material is not possible in case of stretch foils and cover foils.’ – Austria, agricultural cooperative

One participant also stated that they are experimenting with straw mulch as a cover for silage making instead of using plastic (Estonia - farm advisor and field trial manager).

With respect to advice surrounding alternatives, despite the finding that there is experimentation occurring, there does not appear to be much advice available surrounding alternatives to plastic, with just 33% (n = 9) of interviewees stating that their organisations provide information on this subject. This is also reflected in section 3.1, where the most frequently mentioned knowledge gap was related to viable alternatives to agricultural plastics.

3.2.8 Future sources of information

Participants were asked what additional sources of information they would like to see surrounding agricultural plastics (Fig 3.13). Most interviewees had several suggestions, with just one interviewee, a Swiss farmer, stating that they do not require any further information due to already having enough.

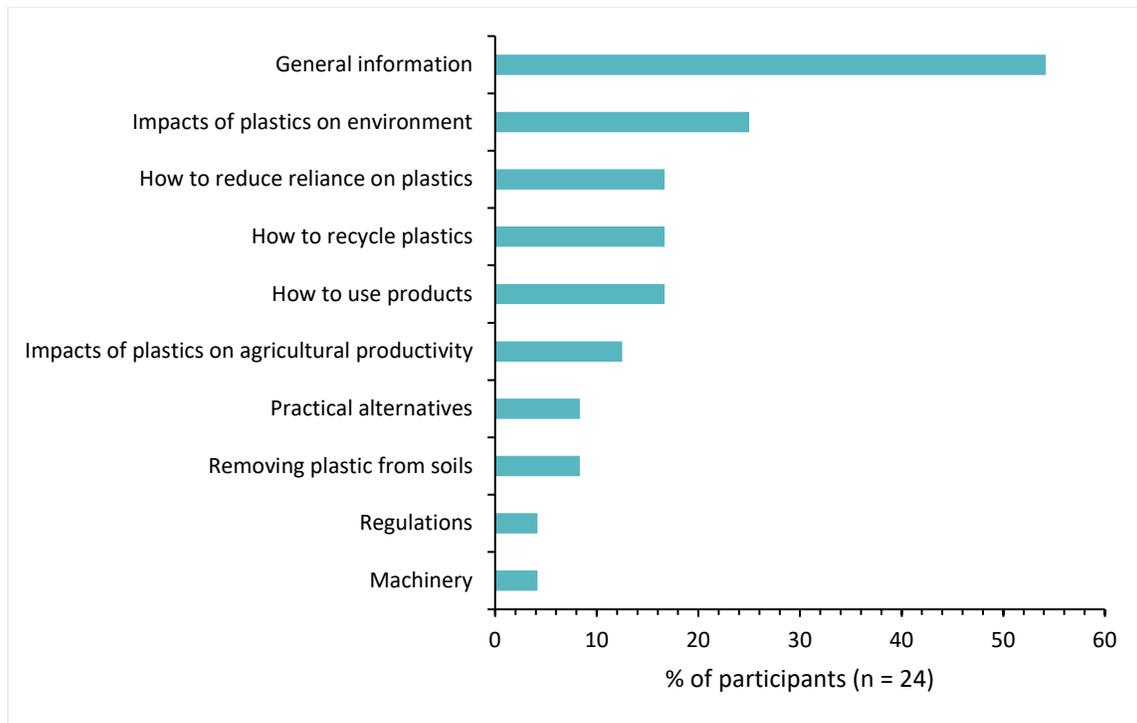


Figure 3.13 Future information needs of interviewed stakeholders surrounding agricultural plastics. Percentages do not add up to 100% as several interviewees provided multiple answers surrounding their information requirements.

Table 3.6 disaggregates each country by their information needs, enabling the reader to identify the specific dissemination gaps in each of the MINAGRIS case study sites.

Table 4.6 Information needs per country identified by stakeholders in CSS

Information need	Country(s)
General information	Slovenia, France, Austria, Italy, Greece, France, Estonia, The Netherlands
Impacts of plastics on the environment	Slovenia, UK, Austria, Switzerland, Spain
How to reduce reliance on plastics	UK, Austria
How to recycle plastics	Slovenia, France, UK
How to use products	Slovenia, France
Impacts of plastics on agricultural productivity	Slovenia, Switzerland, Greece
Practical alternatives	Austria, France
Removing plastic from soils	Slovenia, UK
Regulations	Slovenia
Machinery	Slovenia

Slovenia appears to be one of the countries with the most advice but also with the most interest in receiving further information. For most countries, stakeholders only indicated that they need ‘general information’. These differences will be explored with CSS leaders in the formulation of the Dissemination and Communication Strategy.

3.2.9 Information gaps and knowledge requirements

This research identifies several knowledge and information gaps surrounding agricultural plastics across the case study countries, with almost all interviewees (93%, n = 25) giving specific areas where more is needed. Figure 3.14 provides an overview of the main subject areas which appear to require further information or knowledge.

In Spain, two of the three interviewees stated that the problem is not a lack of information or clear knowledge gaps, but rather that the dissemination of existing information needs to be improved, also suppliers have commercial motivations which mean farmers are not always given transparent information:

At the farmer level there is a significant technical gap, that is, a lack of information. The information is there but it is not transmitted. There are plastic producing and transforming companies that are not interested in the customer knowing everything. There are commercial interests, some companies are interested in selling amount of plastic (because they sell by weight) and sometimes they sell more density than the farmer may need (and more density is not always more resistance). In Europe mulches are usually sold by m2 while in Spain they are sold by weight (it is a bad cultural practice). – Waste management, Spain (SP02)

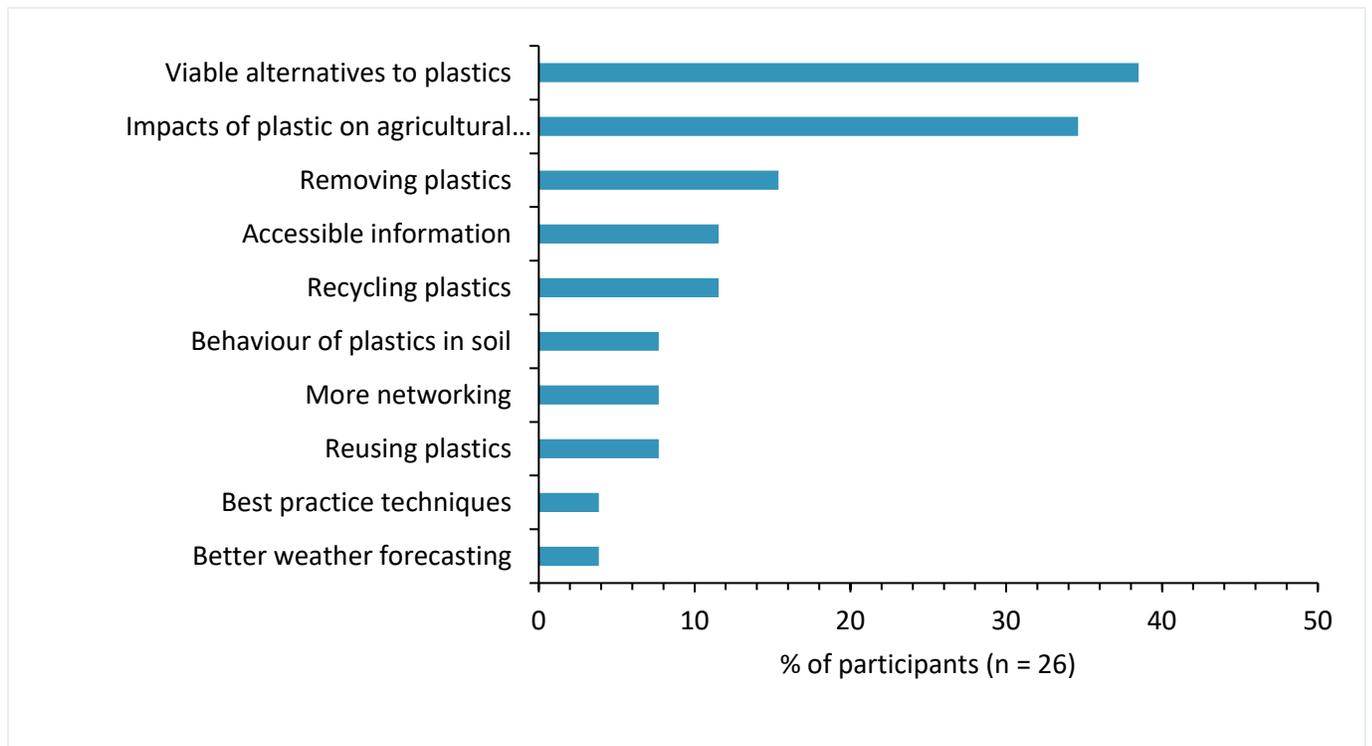


Fig 3.14 Key knowledge and information gaps identified by interviewees surrounding agricultural plastics

Table 3.7 provides an overview of the knowledge gaps by country, indicating that further research may be needed in certain countries across Europe, with most countries mentioning viable alternatives to plastics and impacts of plastics.

Table 3.7 Knowledge gaps by case study country identified by stakeholders

Knowledge gap/information need	Country(s)
Viable alternatives to plastics	UK, France, Austria, Greece, France, Switzerland, The Netherlands
Impacts of plastics	Slovenia, UK, Austria, Switzerland, Spain, Estonia, The Netherlands
Removing plastics	Slovenia, UK, Italy, Greece
Accessible information (general)	Slovenia, UK, Spain
Recycling plastics	UK, Greece, France
Behaviour of plastics in soil	UK, Spain
More networking opportunities	Slovenia
Reusing plastics	Slovenia
Best practice techniques	Austria
Better weather forecasting	UK

3.2.10 Summary

Over half of interviewed stakeholders are associated with organisations that provide information on agricultural plastic in general and their audience is mainly farmers. Although the majority of farmers said they would like to receive technical information about the impact of the different plastic products on the soil and on how to avoid the negative impact of the products in order to avoid negative impacts on the soil, only three CSS stakeholders stated that they provide some information specifically relating to the impacts of agricultural plastics on soils, thereby exposing a knowledge gap.

Conversely most of the farmers interviewed said they had no access to advice or information regarding best practice techniques related to the use of plastic products in agriculture, while a third of stakeholders said their organisations provide information on this subject, suggesting that farmers are unaware of this information.

As with farmers, stakeholder organisations use a range of information sources and mechanisms but these do not always match with the mechanisms preferred by farmers, revealing an important area for future investigation.

3.3 Stakeholder forum workshop

The comments and responses to the four questions set during the workshop session are set out in Table 3.8. These comments reveal that variable nature and extent of information and advice across Europe. There are also examples of sources of information on a range of issues including best practice, alternatives to plastic, recycling, biodegradable plastics, additives and regulation. This information formed the basis of the follow up interviews with EU level experts to ascertain the sources and mechanisms for information and advice across the supply chain and life cycle.

Table 3.8 Stakeholder responses to questions at the stakeholder forum workshop

<p>1. What current advice and information surrounding agricultural plastics are you aware of?</p> <p>1a. Delivered by your organisation</p> <ul style="list-style-type: none"> Articles of different types of mulches from FiBL-CH Durability class of greenhouse film determining end of life On additives from a general standpoint Post consumption greenhouse film recovery and recycling project PlasticsEurope contribute to fine tune type of plastics use and market data No information (Norway) <p>1b. Delivered by others</p> <ul style="list-style-type: none"> A.D.I.VALOR Use of wool mulches 	<p>2a. What information or advice does your organization deliver surrounding agricultural plastics?</p> <ul style="list-style-type: none"> Research on transfer mulch to farmers and advisors (FiBL-CH) The different kinds of plastic mulches (FiBL-CH) European Bioplastics has published a position on microplastics also in the context of soil-biodegradable mulch films https://docs.european-bioplastics.org/publications/pp/EUBP_PP_Biodegradable_plastics_do_not_cause_persistent_microplastics.p Information on different plastic for greenhouse film and mulch. <p>2b. How have you seen others organisations provide information/advice surrounding agricultural plastics</p> <ul style="list-style-type: none"> The green tractor web site provides all collectors part of the uk collection service for farmers to find a collection service near them.
<p>2. Have you seen any advice and information surrounding best practices for using agricultural plastics, in particular relating to soil health (recycling, re-using, sustainable sources)?</p> <ul style="list-style-type: none"> France: plastics to be recycled once used for 3-5 years (handed to a specific plastic recycling organisation: https://www.adivalor.fr/collectes/) Use EN 17033 certified biodegradable mulch film NL: refrain from using oxo-degradable plastics Trying to re-use and if not possible recycle using certified company Not much (CH) 	<p>3. If you have seen any advice on alternatives, please share where/how this information was presented</p> <ul style="list-style-type: none"> Novamont Mater-Bi (biodegradable) for mulch film https://materbi.com/en/solutions/agriculture/mulching-film/ CGIAR PATI Biodegradable EN17033 certified mulch film https://pati.it/en/agriculture/mulch Soil Association Rodale institute Inspirational ideas: Biodegradable mulch films to reduce plastic footprint https://ec.europa.eu/eip/agriculture/en/news/inspirational-ideas-biodegradable-mulch-films

3.4 EU level main actors and their role in the AKIS for agri-plastics

This section draws largely on document analysis drawing on some details from the interview analysis.

3.4.1 Main actors and their roles in the AKIS

To understand the AKIS at the EU level it is important to identify the organisations and stakeholders involved. The stakeholders described in section 2 are all represented at the EU level. These were mapped out using document analysis and expert stakeholder forum interviews in Fig 3.15 which captures the broad knowledge landscape showing the main organisations and the links between them. Each link suggests potential knowledge flow (dissemination, exchange and sharing of knowledge). This analysis focuses on the interviews which were largely with value chain actors, but also draws on some document analysis.

Some of the main actors and their roles are described below, referring to the interviews and the documents reviewed. This review is not comprehensive, it provides a snapshot of the actors and their knowledge activities.

3.4.2 EU level policy makers

At the EU policy level there are numerous associated DGs, directives and instruments, but most relevant is the EU Action Plan for the Circular Economy and the EU Strategy for Plastics which indicate the need for reduction in the use of conventional plastic and encourage environmentally friendly alternatives⁷. They produce high level strategy documents disseminated to industry, members states, media and citizens. The European Commission also launched the Circular Plastics Alliance (CPA) in 2018 with 200 signatory organisations, this aims to help plastic value chains boost the EU market for recycled plastics, and has identified research and innovation priorities. This high-level role in setting research agendas and communicating outputs, as well as initiating alliances, collaboration and knowledge exchange is key in the AKIS. The EEA also produce relevant reports for a range of audiences, for example, the European Bioplastics factsheet (EEA, 2020), which sets out the different standards to assess the degradability of plastics in industrial conditions and in soil⁸.

3.4.1 Research community

A number of bodies are building a knowledge and evidence base, setting research agendas and making recommendations to policy. The EU H2020 research programmes (Societal Challenges - Food Security, Sustainable Agriculture And Forestry, Marine, Maritime And Inland Water Research, and The Bioeconomy; Sustainable Food Security – Resilient And Resource- Efficient Value Chains) which have been active in the agri-plastics area. Projects address different aspects and draw on a range of scientific and technological expertise, partnering with industry (e.g. BIO-PLASTICS EUROPE, RECOVER, START, Organic-PLUS, BIOMAC, EUROqCHARM). The EU also commissions other research such as the project ‘Conventional and Biodegradable Plastics in Agriculture’ (EU 2021) which helps to identify policy actions. A number of EU project networks and clusters operate to link research projects contributing to the EU Plastics Strategy (e.g. European Bioplastics Research Network launched in 2020) to ensure that knowledge is exchanged

⁷ E.g Directive (EU) 2019/904 on single-use plastics in 2019 restricts putting certain single-use plastic items on the market.

⁸ Biodegradability in soil : The certification scheme “Bio products – degradation in soil” developed by Vinçotte, the Belgian certifier.; EN 17033 “Biodegradable mulch films for use in agriculture and horticulture – Requirements and test methods” ; IN CERTCO awards DIN-Geprüft biodegradable in soil in accordance with CEN/TR 15822.

across projects. Manufacturers have in house expertise and capacity to undertake research and their trade bodies can collate and disseminate research outputs.

At the international level the FAO and Basel Convention Secretariat review and collate research, disseminate reports and fact sheets for a wide audience and produce recommendations for policymakers. For example, *Assessment of agricultural plastics and their sustainability. A call for action* FAO (2021) was based on data derived from peer-reviewed scientific papers, governmental and non-governmental organization’s research reports, as well as from industry experts, including relevant trade bodies. NGO and advocacy bodies like the Ellen MacArthur Foundation and WWF also collate scientific evidence and disseminate information to the public and policy makers.

3.4.2 Value chain actors

European trade associations represent the interests of their industry members in the value chain. These organisations provide knowledge platforms to allow them to access and share knowledge, as well as to educate and to inform media, public and policy audiences. They also enable networking of their members to collaborate strategically, host events and conferences, and collate and facilitate research. These trade associations (and their members) and other membership organisations will have different goals and priorities and therefore generate, share and use different knowledge (content, mechanisms, audiences and needs), a broad distinction can be made between those that promote and develop: pre-consumption improvements in materials often coupled with post-consumption management and waste management, and interventions that prioritize the reduction of plastic use through replacement with alternative products and reuse

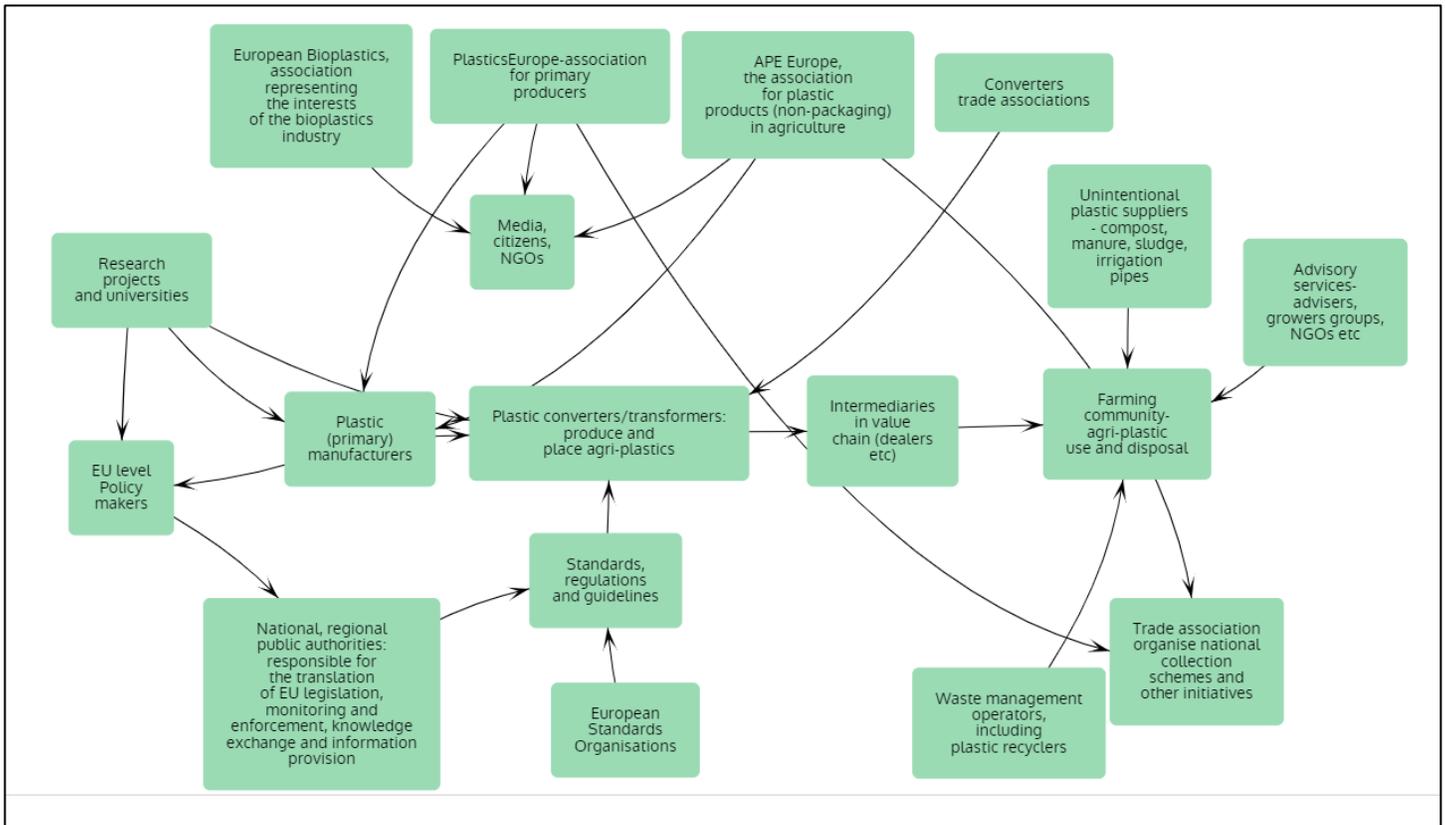


Fig 3.15 Organisations active in the EU level AKIS for agri-plastics

PlasticsEurope is the trade association for primary material producers. They aim to reduce plastics waste, promote the reuse and collection and recycling of plastics waste. They support, educate and help build the evidence base. They also produce position papers and fact sheets for their trade members, policy makers and NGOs and aim to 'drive industry in the directions required by the environment'. According to an interviewee, they provide generic information such as type of additives that may be used in the raw materials in the polyolefins, however they cannot provide information on specialist products. PlasticsEurope have a particular interest in looking at human health aspects of plastic ingestion.

There are two trade associations for transformers/converters, the downstream users who manufacturer agri-plastics- Flexible Packaging Europe (FPE), and (EUPC). These bodies exchange knowledge and collaborate, for example, they collaborated in the European Technology Platform for Sustainable Chemistry (SUSCHEM) to create the SUSCHEM's Sustainable Plastics Strategy (the European Composites, Plastics and Polymer Processing Platform – ECP4 , European Plastics Converters – EuPC, and PlasticsEurope).

Agriculture Plastics Environment Europe (APE Europe) provides a forum and network specifically for agricultural plastic, bringing together a partnership and a network of organisations. APE Europe is the non-packaging plastics products' association for agriculture. It is 'acting for a sustainable, profitable production, and a reliable agri-plastics' end of life management'. Their priority is to provide farmers and growers with sustainable solutions for their production and the end of life management of agri-plastics. APE Europe members concentrate on two key connected missions, which is where their knowledge activities are focused:

- Promotion of plastic products usage in European agriculture
- Development of National Collection Schemes (NCS) for the recovery and recycling of used agricultural plastics in all European countries

Linked to these missions, APE Europe has a dedicated knowledge role, aiming to:

- Inform farmers and the public on the various advantages of agri-plastics
- Share and disseminate technical, scientific experience and good practices
- Support R&D projects for a sustainable agriculture in Europe through agri-plastics

They published the The European Plasticulture Strategy in 2020 (supported by COPA-COGECA, the European association of farmers and cooperatives, as well as by the plastics industry), as a contribution to the Circular Plastic Alliance, and distributed to almost 2,000 decision-makers in the plasticulture community or public authorities in Europe.

European Bioplastics is an association that represents the interests of the bioplastics industry. Their mission is to 'advance the economic and regulatory framework in Europe to allow for the bioplastics market to grow'. As part of this they aim to bring together all relevant partners and stakeholders and act as both, a knowledge platform for all audiences and a business platform. According to an interviewee the knowledge platform was set up to collect the interests of members and also give input to standardisation as well as information to the outside world, like the media, and policy makers on possible applications and the properties of bioplastics. They rely on the input from their members, because these are the companies who produce the materials and sell the agricultural applications and receive feedback from farmers. The website hosts an Info Centre (Position papers, Factsheets, Background papers). European Bioplastics also developed the Environmental Communication Guide (ECG) to help safeguard good communication along the entire bioplastics value chain. Bioplastics Europe have an internal group working group on agricultural

plastics. There are national associations as well for the bioplastics industry however it was suggested by an interviewee that that not many countries are active in bioplastic agricultural products, apart from Italy.

Manufacturing companies operate at the European and international level as well as being members of trade associations. Manufacturers can supply plastic converters who produce agricultural applications. These are the companies that have capabilities in producing the films/mulches, and these companies liaise with the distributors who deal directly with farmers. They tend to have a large portfolio, producing additives and biopolymers for agricultural plastics (e.g. light stabilizers, UV absorbers and antioxidants for agricultural plastic applications such as mulches). They aim to enhance the durability of plastics, improve crop productivity and quality, while meeting environmental requirements.

3.5 Stakeholder forum interview analysis

This section focuses in the main themes that emerged in the interview analysis.

3.5.1 Standardisation and guidelines

European Standards Organisations have agreed European Standards for Plastics Biodegradable mulch films for use in agriculture and horticulture (EN 17033) which are communicated to an industry audience. These are applicable to films intended to biodegrade in soil without creating any adverse impact on the environment. These set out requirements for biodegradable films, manufactured from thermoplastic materials, to be used for mulch applications in agriculture and horticulture, the test methods to assess these requirements as well as requirements for the packaging, identification and marking of films.

Interviewees considered that there is increasing interest in these Standards (which are voluntary). Standardisation for biodegradability (EN 17033) is seen as important as claims have been made by manufacturers over the years about biodegradable material which have been wrong, leading to a lack of trust and credibility on the industry. A recent report supports this saying “It is clear that standardisation is critical in creating a level playing field and preventing false claims” (EU, 2021). An international manufacturer stakeholder explained:

“Our products are certified according to the certification scheme for soil biodegradable emulsions. And in this range, only specific additives are allowed with properties... For us, it's very important to have a framework in which we can actually work and diversify from other producers that claim things, demonstrate them with scientific facts...we conduct a lot of work in terms of research, with universities and so on and scientific publications to actually demonstrate that these products are biodegradable”. International manufacturer interviewee

Another interviewee remarked that big agricultural producers are extremely careful about using bioplastics because of these false claims that have been made.

Meeting the Standards required some specialist knowledge. Regarding the extent of awareness about these standards across agricultural sectors, according to one trade association interviewee, the plastic producing companies will comply with them, but it is not clear if farmers know about or understand the labels properly. However, the international manufacturer interviewee suggested that users of these products would research and understand these products well, especially as they are more expensive:

“There is a diverse know how on this on this topic. So there are some that are very well informed about the products, the certification, how it works and how to apply it and a lot of producers that use it several years and others that are less informed. So somebody who is who is a conventional user of a polyethylene mulching might not know so much. But those that have been in contact with this type of applications, they, they usually know quite well, how they how they work and how to differentiate between these different products... I cannot judge about the distributors and the growers... we know that there is a very good level of information. And from the distributors, I mean, as usual, it's going to depend from the Association and the different people in the field”
International manufacturer interviewee

Regarding guidelines for best practice for bioplastics, one trade association interviewee felt that communication of best practice, outside of the standardisation or certification of biodegradability is limited. Although best practice guidelines are added to the Standards, the Standards are voluntary and have to be purchased, so this questions whether the farmers in the case of agricultural products or even the public would buy them (and read the best practice guidelines).

With respect to guidelines and supporting documents for agri-plastic use in general, according to one interviewee, trade associations like PlasticsEurope do not themselves necessarily know about guidelines or manuals about plastic use in agriculture that might be circulating in the agricultural community, although their constituent members, who are polyolefin manufacturers, would know. This is evidenced by the comment from the international manufacturer stakeholder who said that they cover the whole range of communication, from the very technical details for the converters to the more understandable documents that go to the distributors. They produce standard documents for their products and disseminate these, explaining how the product should be used. There are specific ranges of thickness for specific crops, and also specific environmental conditions that need to be communicated.

APE Europe promote good practice in agri-plastic collection, recycling and reuse through their national members and the national collection scheme and communicate with farming community through their national members.

Research projects also create guidelines, for example, the EU H2020 project Bio-Plastics Europe produced the handbook “On the impacts of bio-based and biodegradable plastics (and additives) on existing waste management frameworks”⁹ for a broad audience of decision-makers on national and regional level, business representatives, scientists and citizens. This aimed to ensure capacity building to the development of sustainable strategies and solutions for bio-based plastic products.

⁹ Handbook on the impacts of bio-based and biodegradable plastics on existing waste management frameworks file:///C:/Users/s2104665/Downloads/bpe-handbook_public.pdf

3.5.2 Linkages in the value chain and agri-plastic life cycle

The value chain for plastic which connects manufacturers to the agricultural plastic users can be simplified as: raw material producers (pellets), transformers/converters, dealers and retailers, users/growers. The raw (primary) material producers will be responsible for the composition and additives in the plastics while the transformer/converter industry will produce plastics for a range of agricultural applications such as agricultural films. So only further downstream in the value chain is the material specifically manufactured for agricultural use/products (mainly mulches). The extended value chain with many steps (and intermediaries) between manufacturers, transformers and farmers means that high level organisations are often removed from practice. As such the knowledge links between EU/ international level organisations concerned with plastic to agricultural plastic users can be tenuous. As one trade association representative said

“For us there are multiple steps because we will have transformers who will then have the dealers which is more taking care about the agriculture type of applications then it will go to the shop and then it will go to the farm”. Trade association interviewee

This means that these high-level organisations do not have a direct role in providing information to agricultural users but see a role in educating the people that are in “between us and the final farmers” (Trade association interviewee).

This long value chain can lead to disconnection and misunderstanding, as a trade association representative remarked:

“I saw and I heard even people tried to develop film that [...] is easily to just mix in all grounds at the end of the production of the vegetables [.....]. They were even asking us [...] or the members along the value chains to produce some things that were quite easily destroyed by all those operation despite it was not biodegradable [...]. So if people are not educated all along the value chain they will do, this which is clearly something that we absolutely need to avoid.” Trade association interviewee

They see this as a reason for education about what happens to plastic left in the soil, although for the grower it may ‘disappear’, the fact that it is still present needs to be communicated.

The international manufacturer stakeholder said that farmers would get information about plastic- from the distributors. They also work closely with farmers as the scientist working for the manufacturer explained:

“I've been working on the on the topic of soil biodegradable for six years. And so, we are regularly in contact also with producers... some requests because the monitoring degraded too fast..... so we have colleagues, agronomist that are active on the field, they are present in the discussions and also events. agronomists are they working on particular projects” Scientist International manufacturer interviewee

Considering knowledge linkages across trade associations and suppliers, there are regular discussions between parties with common interests as it is important to have a common framework for some aspects. However, there is limited exchange between the bioplastics and recycling communities since there are tensions due to different goals and priorities and perceived competition (biodegradable plastics are seen to be threatening the recycling industry).

3.5.3 Complexity hinders communication

Interviewees highlighted the complexity in the agri-plastics supply chain in terms of the many different plastic materials available. This can complicate communication and lead to misunderstanding. According to interviewees, microplastics are often grouped together but can be different things. Some polymers that are referred to as microplastics are not, for example, encapsulations of beads are more a coating type of application and they have a different type of structure and are not the same as the pellets produced by manufacturers. There are also many groups of material called bioplastics, which can mean both bio based and biodegradable plastics, and this can create issues for different people and their knowledge needs in the value chain.

In the case of farmers, they require simple information on agri-plastics: “how to use it, what it can do, how it performs”, according to one interviewee. The interviewees said that the industry carries out a lot of testing regarding the degradation, behaviour and ecotoxicity of plastics and that there are labels that should help to make communication easy. However, interviewees remarked that the biggest challenge is to “translate the whole complex issue to a simple level with descriptions for users... so plastic producers need to ask: what does the user needs to know and what do they actually want?” (Trade association interviewee). This echoes findings in the Bio Plastics project¹⁰ (no date) which, referring to environmentally friendly alternatives, states

“The complexity of the alternative materials, and the concomitant complexity of their recycling and waste management.... extends not only to the producers or entities responsible for waste management, but also to consumers.... who have lost track of the variety of alternative plastics on the market, lack knowledge of the meaning of how materials are marked, and are often confused when it comes to sorting of waste” (here consumers would include farmers).

3.5.4 Linking the value chain and research

EU funded projects such as those in H2020 bring together industry and academic partners which is invaluable for the exchange of knowledge and for pilot and test cases, according to interviewees, and each project has outputs and dissemination strategies for targeted audiences. Trade bodies and their members have their own scientific expertise and capacity to both generate their own research as well as follow other research outputs. They ensure they are up to date with any research project outputs by attending conferences, meetings and workshops organised by projects as well as scientific publications.

However, trade associations and commercial manufacturers have a particular interest in connecting to research projects from an early stage to support all the elements related to the characterisations and the measurements of microplastics. This is to ensure standardisation in techniques and that standard reference materials are used that correspond to the actual microplastics used in the field. There is some frustration that, when academic researchers use different material/techniques without consultation with the industry, their results are not transferable nor valid for the industry, as one explained:

“For us what it's very important, it's actually continuous exchange, because a lot of work has been done in the past. And what we see that quite often, scientists working on the environmental sites, they are not so familiar with the polymer. ... which are not really representative for the final products ...and the results can actually lead us in different directions. And we spent a lot of work in the optimization of these products so that they really perform on the fields and the biodegrade and

¹⁰ Handbook on the impacts of bio-based and biodegradable plastics on existing waste management frameworks file:///C:/Users/s2104665/Downloads/bpe-handbook_public.pdf

afterwards and this is actually one of the most important points so far, to have a continuous exchange also during the experiments, because sometimes studies are designed without the connection” International manufacturer interviewee

The need to collaborate and exchange knowledge is captured in this comment in SUSCHEM’s Sustainable Plastic Strategy¹¹ (SUSCHEM, 2020):

“The complexity of this value chain (made up of producers of plastics and chemical raw materials, converters, brand-owners, retailers, actors of waste management...) makes the creation of innovation ecosystems necessary to tackle the sustainability challenge. To achieve this, we need to continue to harness the power of research and innovation to significantly increase reuse and recycling”.

For bioplastics, some of the material producing companies are ‘very much’ in contact with researchers to get some basic information on how the materials work, and how they can perform. But there was a suggestion that it is not always a formalised process, as one interviewee remarked *“someone has heard that something was going on there and tries to find out if it was true. It’s quite anecdotal”.*

3.5.5 Common themes

Whilst mechanisms are in place at EU level to enable knowledge exchange, networking and alliances between organisations, there are some barriers to knowledge exchange, communication and understanding that emerged in the analysis. These are shown in Fig 3.16 on the left, with proposed enablers on the right of the diagram.

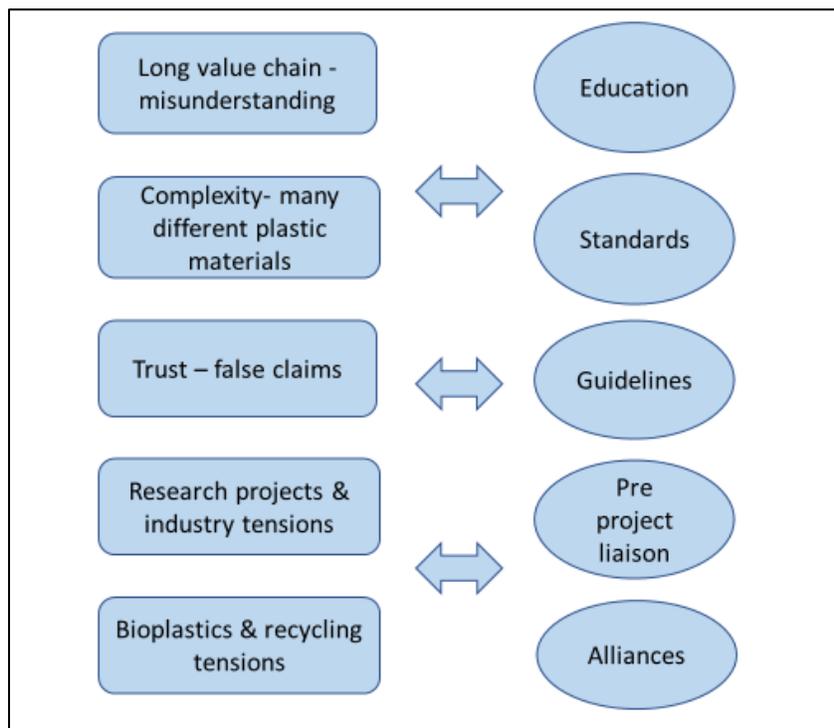


Fig 3.16 Barriers and potential enablers to knowledge exchange, communication and understanding

¹¹ <https://plasticseurope.org/knowledge-hub/sustainable-plastics-strategy/>

4. CONCLUSIONS

Looking across the analysis of data from the four sources and levels, some key points emerge:

- The AKIS for agri-plastic is multi layered and complex, and only just merging for soil.
- Looking for alignment in farmer and stakeholder interview responses exposed some knowledge gaps. With respect to farmer and stakeholder responses about receiving and providing information about agricultural plastic use and its impact on soil, approx. half of stakeholders' organisation providing information but only 25% of farmers said they were well informed on the topic, **revealing limitations in knowledge exchange**.
- Furthermore, although the majority of farmers said they would like to receive technical information about the impact of the different plastic products on the soil and on how to avoid the negative impact of the products in order to avoid negative impacts on the soil, only three CSS stakeholders stated that they provide some information specifically relating to the impacts of agricultural plastics on soils, thereby **exposing a knowledge gap**.
- Conversely most of the farmers interviewed said had no access to advice or information regarding **best practice techniques** related to the use of plastic products in agriculture, while a third of stakeholders said their organisations provide information on this subject, suggesting that farmers are **unaware of this information**.
- At the EU level, whilst mechanisms are in place to enable knowledge exchange, networking and alliances between EU level organisations and their constituent members at national level, there are some **barriers to knowledge exchange, communication and understanding that emerged in the analysis**. These include: a long supply chain separating manufacturers and users, a complex agri-plastics landscape, issues of trust and accountability, and some tensions between different actors, which have implications for knowledge exchange.

This analysis will inform the preparation of the Dissemination and Communication Strategy.