



DIVERSify: Designing InnoVative plant teams for Ecosystem Resilience and agricultural Sustainability

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Executive Summary

Plant teams offer promising opportunities to improve yield stability, reduce pest and disease burden and enhance the resilience of agricultural systems to stresses such as climate change and market pressures. However, several barriers have been identified which may affect the ease of implementation and use of plant teams. Barriers have been broadly categorised as either unsolved, solved or perceived.

The most commonly identified unsolved barrier was a lack of available advice or knowledge for farmers/advisors to use. This barrier was identified in all workshop countries except Italy and Kenya, who both identified it as perceived. Austria and Sweden found lack of advice/knowledge to be both unsolved and perceived, reflecting that some plant teams may have more information and guidance attached to them than others. The second most common unsolved barrier was harvest complexity, largely as a result of variable maturation of species in plant teams, uneven grain size and the required adjustments to combine harvesters. The complexities around harvest varied between countries. This suggests that differing climates affecting crop maturity timings, the guidance provided, the machinery or equipment used for cropping and end use of plant teams, which affect how complex plant team harvesting is viewed by growers. Other unsolved barriers included the cost of implementing plant teams, crop management and processing and drilling complexity.

DIVERSify Participatory Farmer trials all noted higher overall yield in plant teams compared to monocrop controls in Denmark and Italy as well as reduced weed and pest burden. In the UK trials, while the overall yield for the plant teams was lower than expected, due to extreme weather conditions, they were, not on average, lower than the monocrop controls. Difficulties were noted from one UK participatory farmer who observed issues related to varieties chosen and incorrect drilling densities.

Modern machinery and precision agriculture technology could help overcome a number of these barriers and improve uptake of plant teams. However, this will depend on the type of barrier identified. Barriers to drilling, harvesting and processing complexity can be directly overcome with machinery. Other barriers to pest and disease control can be overcome using a combination of precision agriculture, machinery and improved advice and guidance to growers. DIVERSify will produce a number of guidance documents, recommendations and host demonstration days to help overcome practical barriers identified, and will also engage in discussion with machinery and PAT providers in order to create a barrier 'Trouble-Shooting Matrix' for farmers and advisors to use when implementing plant teams.





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1. Introduction

Plant teams offer promising opportunities to improve yield stability, reduce pest, weed and disease burden, minimise inputs such as fertilisers and enhance the resilience of agricultural systems to stresses such as climate change and market volatility. However, a number of barriers exist which may affect their uptake and implementation across Europe and worldwide. It is therefore imperative that these barriers are identified, and solutions sought and communicated to farmers and advisors. Barriers to the uptake of plant teams and wider crop diversification approaches have been investigated by DIVERSify and a wider group of sister Horizon 2020 projects in the 'Crop Diversification Cluster'.

In this deliverable report, we describe the practical barriers to plant teams identified during DIVERSify Stakeholder Workshops (in WP1) and through the experiences of Participatory Farmers (PFs; in WP4), as well as drawing from the findings of H2020 sister projects such as TRUE and DiverIMPACTS. Barriers have been classed as unsolved (barriers which do not currently have readily available solutions), solved (barriers with readily available solutions and which are no longer an issue in plant team implementation), or perceived (seen to be a barrier by stakeholders, but which is not actualised) based on stakeholder workshop outcomes where stakeholders were asked to categorise barriers into these three classifications. The frequency with which a barrier was identified as unsolved at the stakeholder workshops and the experiences from PFs and sister projects was also used to help inform whether a barrier is unsolved, perceived or solved. Unsolved practical barriers and the potential solutions for these will help to inform future discussion with machinery and PAT providers, allowing for the production of a barrier 'Trouble-Shooting Matrix' in a future deliverable output.

2. Methodology

As part of WP1 activities within the DIVERSify project, fourteen Stakeholder Workshops were held across 11 partner countries and reported on as part of DIVERSify project outputs¹. The workshops were hosted in 2017 and early 2018 by consortium partners and identified stakeholder barriers to plant team implementation. Unsolved, solved and perceived practical barriers were discussed, as well as relevant solutions to solved and perceived barriers and the potential ways to overcome unsolved practical barriers. Outcomes from these workshops were presented in Deliverable Report 1.1 (Pearce et al., 2018).

Following the stakeholder workshops, a number of PFs were recruited to the project to conduct commercial-scale field validation trials of plant teams as part of WP4 validation activities. A number of such trials were undertaken in the 2018 growing season, in which the PFs were able to trial plant teams of interest on their farm. The trials helped identify and highlight challenges and barriers to the





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implementation of plant teams on commercial farms, and these initial observations have been incorporated into this report.

Furthermore, H2020 sister projects to DIVERSify, such as TRUE and DiverIMPACTS, are also researching the barriers to wider crop diversification approaches, including plant teams. DIVERSify is therefore continuing to seek collaboration between the projects to share outcomes and provide solutions to barriers.

This report follows on from the initial outcomes from the stakeholder workshops by analysing how barriers are viewed differently between countries and the how other factors (such as farming system and type) can affect whether barriers are unsolved, perceived or solved. The experiences of PFs and the outcomes from other H2020 projects were also integrated in the report to draw comparisons with the barriers identified during the stakeholder workshops.

3. Unsolved practical barriers to plant teams

A number of unsolved practical barriers to plant teams were identified as part of the stakeholder workshops, farmer trials and other H2020 projects. Potential solutions to these barriers were also identified. Both barriers and solutions will be investigated further within DIVERSify WP4 activities over the course of the project. Within the unsolved barriers some geographical differences have been identified. There are examples where farmers in one country consider a barrier unsolved, whereas those in another either do not have that barrier or consider it to be solved or perceived within the farming community.

3.1. Lack of available advice or knowledge

The most commonly identified unsolved practical barrier was a lack of available advice or knowledge for farmers and advisors to utilise when attempting to implement plant teams on-farm. This was identified as an unsolved barrier in 9 of the 11 countries that hosted a stakeholder workshop. The exceptions to this were Italy and Kenya, where it was felt that this was a perceived barrier. Farmers in Austria and Sweden felt this barrier was both unsolved and perceived, while those in Switzerland felt it was an unsolved and solved barrier.

This suggests that confidence is lacking in plant team implementation, and that there is a lack of freely and readily available advice to facilitate plant team use by providing explanations of what to do, what to use and when to do something when using plant teams on farm. Variability between and within countries as to whether this is an unsolved practical barrier or solved/perceived suggests that some sectors or plant teams are better supported by available information, whether this be through better-informed advisory services or peer-to-peer support.

To solve this practical barrier, guidelines are required which provide practical information on the implementation of plant teams; for example, providing guidance on the best varieties and combinations to use and optimum drilling rates and depths. Guidance needs to be readily available in a suitable format to support farmers in implementing plant teams. The resources will also help





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share best practice to advisors and agronomists on how to use plant teams on-farm. This knowledge can then be shared further with clients looking to implement plant teams. It was felt that advice and recommendations need to be created by impartial non-commercial organisations or advisory services, to ensure there is no bias behind them (for example, a company using it to try to sell their seed mix), as any perceived commercial leverage would risk inherently reducing the level of trust placed in any guidelines provided.

Lack of knowledge was also highlighted as a barrier in the TRUE project. The TRUE project hosted a range of legume innovation and networking (LIN) workshops. During these workshops, knowledge gaps in cultivating, harvesting and processing legumes were highlighted². This is particularly relevant as legumes are often a preferred component within plant teams. Increased knowledge exchange between farmers, scientist and advisors is required to break down some of these barriers. Better communication between farmers, consumers, researchers, processors, politicians and advisors would also be beneficial.

3.2. Harvest complexity

Harvest complexity was the second-most commonly identified practical barrier. This is largely as a result of variable maturation of species in plant teams, uneven grain size and required adjustments to combine harvesters. This again was identified as a barrier by most stakeholder workshop countries with exception of Austria, Italy and Palestine. Austria and Palestine identified it as a solved barrier and Italy identified it as perceived. As well as identifying harvest complexity as unsolved, Sweden also identified it as solved, Germany identified it as both unsolved and perceived and the United Kingdom (UK) identified it as unsolved, perceived and solved. Variability between and within countries may reflect differences in end use of plant teams, with plant teams used for animal feed or silage having less complex harvesting requirements than other grain crops.

Possible solutions to this barrier include ensuring the correct machinery is available, combined with further advice on plant team maturity and harvest requirements. It was noted at one of the UK stakeholder workshops that while this is a major concern and reservation from farmers, it is often overcome through trials and experience. This suggests that demonstration events and sharing experiences between groups of farmers and advisors may also help to remove this barrier in the future.

The harvest complexity varied amongst the 2018 PF trials, depending on the plant team used. Whilst the majority of PFs did not come across any barriers at harvest when using, for example, plant teams including beans and wheat or Carlin peas and triticale, one UK PF trialing beans and oilseed rape found their beans in the plant team plots had higher moisture contents than those within the monocultured bean crop due to them being slightly less matured at time of harvest. The farmer noted that this occurred due to the oilseed rape also maturing later. From their experience, plant teams tend to ripen at the same time due to ethylene ripening hormone released by the crops which will have caused the beans in the plant team to ripen later than the monocrop beans.





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3.3. Crop management complexity

Crop management complexity, including strategies for management of weed, pest and disease burdens, was also identified in workshops as a practical barrier to the implementation of plant teams. There was no common consensus between farmers in France, Germany, Austria, the UK and Sweden on whether this was a solved, perceived or unsolved barrier.

Crop management presented a barrier to plant teams due to lack of knowledge on management options within a plant team approach. Questions around rotation were also discussed at workshops, for example on the practicalities of how plant teams fit into a rotation, and what crops should be used or avoided following cropping of a plant team. Uncertainty on the varieties and mixtures to use were also identified as a problem to managing plant teams. Scepticism around plant team efficacy in pest and disease control also limited uptake but experiences from the Italian PFs (and trials within WP2 activities) noted that the presence of weeds in cereal-grain legume plant teams were always lower compared to the monocrop faba bean crop. Among the UK PFs, one farmer struggled with selecting the correct varieties of wheat and beans (spring varieties *vs.* winter varieties), which resulted in a low-yielding crop. Similar to the harvest complexity, it was noted that while these uncertainties can put farmers off implementing plant teams, they are overcome quickly through trial and experience.

3.4. Processing complexity

Complexity of processing plant team harvested products was identified as an unsolved barrier in 7 out of the 11 workshop countries. Stakeholders in the UK, Germany and Sweden also identified processing complexity as a perceived barrier, while those in Austria, Palestine and Italy identified this barrier as either perceived or solved.

Processing complexity included issues such as the expense of drying, storing and separating plant team species, with specialised equipment noted to be needed to separate certain plant team mixtures. Grain size will also impact how readily harvested matter from plant teams can be separated. If grain size is different between members of a plant team, separation is generally more straightforward than if both varieties have grain with similar sizes. It was noted that, while generally easier to separate grain of different sizes, damage of seeds/grains can be common, where fragments of one species contaminates the separated seed of the other species thus affecting the marketability of the end product. The degree to which this barrier would affect a farmer depends on the end market specifications. If used for animal feed, for example, separation may not be necessary and therefore processing would be less complex.

The end user and supply chain will also impact the extent to which this is a barrier. There are some cooperatives, such as Hodmedods³ in the UK and multi-stakeholder initiatives³ in the Styria county in Austria where plant team (pulses in the UK, and beans and corn in Austria) harvest is delivered to a single point and then separated, meaning farmers growing under these contracts do not need to separate their plant team products before sale, therefore reducing the overall processing complexity on farm.





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3.5. Crop-crop competition and yield suppression

The potential for competition between plant team species and an overall suppression in yield was another barrier identified in the stakeholder workshops. This barrier ranged from unsolved (in Austria, UK, Denmark, Sweden and Kenya), perceived (in Italy, Sweden and France) and solved (in the UK, Sweden and Switzerland).

Issues with competition and yield suppression were largely attributed to having the wrong sowing densities, using incorrect management practices and using inappropriate plant team mixtures. Advice and guidance are required to inform farmers and advisors on the optimum seed rates, inputs and management practice and species which complement each other.

Environmental factors such as temperature and rainfall will also influence yield and competition of the plant teams. For example, some crops will be more sensitive to rainfall than others and so influence their overall yield. Available nutrients (such as nitrogen (N), phosphorus (P) and potassium (K)) as well as soil health will also influence overall yield and competition of plant teams. These environmental factors that influence yield and competition may be harder to overcome than management practices and are likely to become less predictable in the future under climate change.

From workshops, it was noted that whilst overall yield of a plant team might be lower than the monoculture of individual components, plant teams can reduce variable costs such as fertiliser and pesticide input rates, such that overall gross margin remains stable. In addition, the TRUE continental LIN workshop concluded whole crop rotations also need to be evaluated when looking at the benefits of crop diversification approaches, namely around legume or pulse integration, to acknowledge any benefits to following crops in the rotation², such as increased available N or P in the soil following a legume or pulse production cycle. Furthermore, the Danish PFs in 2018 found yield was higher in the plant team compared to the monocrops, and in the UK PFs found that although legume yield was low in the plant teams, particularly due to the atypical weather conditions experienced, they were not, on average, lower than the yields recorded in monoculture controls.

3.6. Expense/cost of implementing plant teams

Increased cost for specialist machinery, additional tools and materials, seed costs and increased labour was identified as a barrier in 6 of the 11 stakeholder workshop countries. Austria identified this as both unsolved and perceived, Sweden identified it as solved and unsolved. Italy identified it as perceived and Portugal and Switzerland identified this as a solved barrier.

There were several reasons suggested for why this is seen as an unsolved barrier in many countries. Where additional machinery is required, this can require high-risk investment in terms of acquisition cost. With the benefits of plant teams still relatively variable, this required investment can be a large barrier. Other additional materials or tools needed for plant team implementation, such as storage equipment, were also identified as a financial barrier, but less so than machinery. It has been suggested that subcontracting or rental options for the machinery needed for plant team implementation might provide a potential solution to overcome financial barriers to uptake. Farmer





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cooperatives could also help relieve the financial burden of buying new equipment by spreading cost across a group of farmers. The prevalence of farming cooperatives and predominant farming types (machinery-dependent *vs.* hand harvest) varies, influencing whether machinery costs will be seen as a barrier or not to farmers within a particular country or sector.

Seed costs for plant teams was also identified as a barrier. Plant team seed mixtures do cost more than monocrop seed, however implementation of a plant team approach often leads to cost savings in other input areas, such as fertiliser and pesticide inputs. Increased labour demand and a need for skilled personnel who are knowledgeable on plant teams were also identified as barriers to plant teams.

4. Perceived and solved practical barriers

4.1. Evidence to support the effectiveness of plant teams

During the stakeholder workshops, the barrier ‘not enough evidence supporting the effectiveness of plant teams’ was largely identified as either perceived or solved in most countries. Italy, Kenya and Portugal all identified it as a perceived barrier, the UK identified it as both perceived and solved. Switzerland and France also identified it as a solved barrier. Only Palestine, Austria and Sweden identified it as an unsolved barrier, although Sweden also identified it as solved and Austria as perceived.

This suggests that stakeholders largely feel there is enough past experience and independent research demonstrating the benefits of using plant teams, but that the outcomes and outputs of this tacit knowledge and research is not easily accessible and needs to be tailored to fit their own specific farming system. It is therefore suggested that research and past experiences need to be better disseminated to stakeholders through guides, videos or demonstration events. Ensuring any research is relevant at a farm and commercial scale is also important. Some workshops identified this barrier as both unsolved and perceived/solved suggesting evidence for plant teams may vary depending on the type of mixture used. Therefore, additional evidence or research or knowledge transfer may be required for some plant team mixtures.

4.2. Market requirements

Barriers related to market and supply chain requirements and availability were largely identified as perceived although Austria and Kenya identified this as unsolved. The UK highlighted this barrier as both perceived and unsolved.

While there is a perception between farmers that there is a lack of available markets or strict market requirements for plant teams, a miller present at one of the stakeholder workshops countered this by mentioning they are willing to take plant teams as long as they are aware of the species used. There are also potential practical restrictions to plant team implementation largely based around characteristics demanded of end products. An example of this is grain N concentration in barley, which will determine whether it is high quality (for alcohol production) or lower quality (animal feed)





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and which will therefore affect overall price given for the crop. This barrier is not restricted to just plant teams, but is, rather, a broader barrier related around market requirements. Issues with processing and separation may also lead to contamination of one plant team species with another, which may result in a reduced end price or rejection of the product.

4.3. Policy restrictions

There was also a feeling that there is not enough policy support for plant teams to encourage their uptake. Whether this is an unsolved or perceived barrier, it was felt that policy has a role to play in facilitating changes to a more diverse cropping system. TRUE also identified this as a barrier to legume production and noted that policy needs to support environmentally sustainable approaches and move towards a results-based agri-environmental payment system^{2,4}. There was also a feeling within the Italian PFs that there was a lack of available information on how using plant teams may affect what CAP subsidies they are entitled to and if it would affect their claims. While many national-level greening options and agri-environment schemes could be used to encourage plant teams they often do not (for example, the three-crop rule in the UK), and there is currently no scheme that specifically values the environmental benefits associated with diversified crops. Legislation may also deter the selling of crop seed mixtures creating practical barriers to plant team implementation.

Therefore, reforms to national and EU policy need to be made in order to recognise the benefits of intercropping and reward those implementing them. Incentives for implementing plant teams and other diversified systems would also help to lessen the practical barrier around the cost of implementation.

5. Other factors influencing practical barriers

The range of barriers identified varied greatly between countries. In addition, stakeholder views on the same barrier varied (i.e. the same barrier might be viewed as a major unsolved barrier to plant team uptake through to being solved, perceived or not seen as a barrier at all). This suggests that other factors, such as climate, policy or farming system may be influencing how a barrier is perceived. It could also suggest some countries may have solutions to barriers which are unknown or not utilised by another.

Of the responses from the stakeholder workshops, many identified barriers were both unsolved and solved or perceived. This suggests that the range of barriers change and are dependent on what plant team mixture is used. From the Italian workshops, it was noted that plant teams containing Durum wheat have more concerns or barriers due to the durum wheat being such an economically important crop in the region. In the Austrian workshops it was noted that their identified barriers were largely around plant teams using legumes but not *Phaseolus* and maize mixtures due to this plant team having a well-established value chain and guidance available. Differences in barriers





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between plant teams can largely be attributed to varying advice or guidance availability, where plant teams with more guidance available have fewer barriers attributed to them.

Barriers related to harvest complexity appeared to be specific to geographic region. This could be the result of differing climates which could affect crop maturity of the plant teams, as well as differences in cropping system and available guidance. The range of machinery or equipment available in each country could also play a role in how harvest, drilling and processing complexity is viewed by stakeholders. In countries where cooperatives or options to lease machinery are available, barriers due to machinery and complex harvesting/processing will be reduced. Furthermore, in some regions and cropping systems, stakeholders are less dependent on machinery and other equipment, opting to hand harvest instead, for example, and so are also less likely to find that barriers relating to available machinery are a problem.

Farmer perceptions of plant teams will also affect their uptake and implementation, and was identified at the TRUE LIN workshops where it was highlighted farmer perceptions and policy are also barriers to legume and pulse production⁵. From the DIVERSify stakeholder workshops, farmer perceptions of plant teams include a perceived link between plant teams and organic farming, which can dissuade conventional or integrated farmers from implementing them. Differences in farmer perception of plant teams may also be influenced by generation and business size. The TRUE Atlantic LIN workshop also reported grower reluctance in legume and pulse production because they perceive them as unattractive due to market constraints and lack of demand⁵. Furthermore, there seems to be a cultural perception in Palestine where farmers are ashamed to use the same land or field to produce two or more crops.

The cropping system used by stakeholders will affect what is viewed as a barrier. It was noted in the UK that a lack of pesticides and termination approaches were a barrier to using plant teams, but this was not identified as a barrier in any other stakeholder workshop country. Concerns on decreased availability of crop protection products were also identified in the TRUE Atlantic LIN workshop⁵. Differences in the perception of available pesticides could be attributed to the relative proportions of conventional and organic growers present at the workshops and within the country. For example, in the UK many of the stakeholders present at the workshops were from conventional and integrated systems who viewed the reduction of available pesticides and the potential ban on glyphosate within the EU as a barrier, whereas in Switzerland, Denmark and Italy, where there have higher levels of organic production, this was not noted as a particular issue for stakeholders. Growers from organic or integrated systems may have more prior experience with plant teams and therefore have fewer unsolved or perceived barriers compared with farmers under conventional systems.

Market availability will also be affected by end use as well as the species present in the plant team. Plant teams used for animal feed largely have fewer barriers than harvested products aimed for human consumption, as they have fewer processing requirements. Species present and end use of plant teams dictated the available market. Some plant teams had a more established or niche market available to them. These markets can either be national, such as the Hodmedods cooperative





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in the UK, or local, supplying local bakers or millers, for example. The TRUE Mediterranean LIN workshop also identified market and supply chain as a barrier to increased production of legumes and pulses; the project felt more efforts are required to work with the supply chain to produce domestic products that can compete with imports⁴.

While there is a perception between farmers that there is a lack of available markets for plant teams, a miller present at one of the stakeholder workshops countered this by mentioning they are willing to take plant teams as long as they are aware of the species used.

While public perception of environmental mitigation and sustainability in agricultural production is increasing, there is a perceived view from farmers that this is not reflected by supermarket standards of farmed products. It is thought that these standards are incompatible with plant team produce, therefore limiting market pull. TRUE also highlighted this barrier in their LIN workshops and stated that awareness of the sustainability and environmental benefits of legumes needs to increase in the general public to help drive markets and consumer demand^{2,4,5}.

There is also large seasonal and yearly variation in the barriers identified for plant teams. During the 2018 UK PF trials, there were extreme weather events which influenced the success of the plant teams trialed, and also the barriers identified. An example of this is weed burden; in one of the UK PF trials (Beans and Oilseed rape), weed burden was higher in the plant team plot due the oilseed rape not establishing as a consequence of particularly wet weather during crop establishment. This, combined with a lower seed rate of the other plant team species compared to the monocrop, allowed weeds to successfully compete against the plant team. No other PF trial experienced higher weed burden in the plant teams. In the Danish PF trials hot weather conditions did not negatively affect weed burden; plant teams all suppressed weeds better than the monocrop and had an overall higher yield than the monocrops.

6. Role of machinery in solving practical plant team barriers

The role of machinery and precision agriculture technology in overcoming plant team barriers will be further investigated in future DIVERSify outputs. The DiverIMPACTS project will also investigate the use of machinery in wider crop diversification. From the barriers identified, machinery and precision agriculture may be able to solve and overcome practical barriers relating to:

- Soil preparation (tillage).
- Sowing/ drilling: by providing machinery adapted for drilling of multiple species at the same time which will help to ensure seed rate is consistent across the field, helping to reduce competition due to patchy drilling and establishment of the crop. Machinery and precision agriculture can help to implement more direct drilling, under-sowing and strip cropping approaches. Machinery needs to be affordable, or financial support or renting/lease options need to be available to farmers.





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- Nutrient management: by helping to target applications to only where it is needed. Improved monitoring of soil nutrient availability and monitoring of plant stress to enable farmers to respond to plant stressors before they reduce the overall quality of the crop.
- Other management operations: such as approaches to help detect any pest or disease and allow for treatment targeted to problem areas. Sensors to ensure soil moisture is optimal and technology to allow for efficient and targeted application of water.
- Harvesting: by providing equipment to harvest different grain sizes effectively and minimise the number of adjustments to harvesters, as well as minimise breakage of grains during harvest.
- Processing: by providing equipment to facilitate effective separation of grains or seed while minimising damage to the grain/seed. Improved technologies for better processing are needed to ensure high quality end products². Approaches for improved drying and storage are also needed.

7. Role of other solutions to solving plant team barriers

Other solutions to solving plant team barriers also need to be identified in addition to machinery and precision agriculture solutions. These solutions could include:

- Effective communication between researchers, advisors, policy and farmers to help share experiences and advice when implementing plant teams. Methods to increase this can include hosting discussion groups, demonstration events, Facebook groups and Twitter. DIVERSify has an active Twitter and Instagram presence to help share key updates, events and results to stakeholders. An online Speak Out Toolkit will be created, which will help to provide communication training to researchers, advisors and farmers and which will further help to encourage and increase communication between stakeholders.
- Increase the advice and guidance available to farmers and advisors, including hosting demonstration events, producing help guides and recommendations. This will help to provide farmers with knowledge on what plant teams work well together, what varieties have similar maturation and growing stages and are easy to separate/ process. A number of 'how to' guidance notes and EIP-AGRI practice abstracts will be produced which will be freely available and accessible. Furthermore, PF and project partners will be hosting demonstration days to share experiences and demonstrate how plant teams have been implemented in their farming systems. DIVERSify will also produce a decision aid to further help farmers to implement plant teams.
- Training and education of researchers and farmers to provide them with the skills, knowledge and confidence needed to implement plant teams.
- Initiatives to help with processing and marketing of end products, such as establishment of cooperatives to relieve processing and marketing pressures from individual farmers. Other





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H2020 projects such as TRUE and DIVER-IMPACTS will be looking at ways to increase market availability for diversified cropping products across Europe.

- Cost effective methods to manage plant teams, including case studies, that highlight the cost breakdowns of previous plant team implementation. Socioeconomic analysis of plant team implementation and the benefits will be undertaken in DIVERSify to highlight cost breakdowns of plant teams.
- Breeding programs to ensure the best varieties and seed are available. Greater resilience to environmental pressures would also be beneficial. Improved knowledge and guidance on the interactions between varieties in different crops and which varieties work or do not work with other varieties is also needed.
- Policy changes to encourage the uptake of plant teams and acknowledge the environmental benefits of plant teams to soil health.

8. Conclusions

Plant teams offer a host of potential benefits to farmers, and in some sectors, particularly within organic systems, are well established. However, there are a number of practical barriers which need to be overcome in order for them to be implemented more widely, in particular within conventional systems. Lack of available advice and knowledge was widely identified as a barrier to implementation, suggesting there is a lack of confidence using plant teams as well as a lack of freely available advice explaining how to use plant teams. Complexities with harvest, processing and crop management were also broadly identified as barriers to the implementation of plant teams, as was crop-crop competition and yield suppression. This suggests further development and research needs to be undertaken in order to provide approaches and machinery that can be used to help remove complexities in the management of plant teams. Increased dissemination of results and experiences will also help remove management pressures by providing guidance or advice and highlight the costs, challenges and solutions that farmers have come across when previously implementing plant teams.

A number of perceived or solved barriers were also identified and included evidence to support the effectiveness of plant teams, market availability, and the perception of plant teams by farmers, the public, and policy. These again suggest further work needs to be undertaken to share experiences of plant teams, promote available guidance and ensure farmers and advisors have the skills and knowledge to successfully implement plant teams.

The role of machinery and precision agriculture in overcoming practical barriers to plant teams will be further investigated as part of DIVERSify WP4 activities, and will form the basis of a future WP4 deliverable output. Machinery solutions are also being investigated within other European projects such as DiverIMPACTS, who are working on various technological solutions to see how they can help make agri-ecological approaches manageable in practice.





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