

COST Action Final Achievement Report (19/09/2022 to 18/09/2026)

CA21134: Towards zero Pesticide AGRIculture : European Network for sustainability

The Action was approved by the Committee of Senior Officials (CSO) on 27-5-2022 and has the MoU reference COST 048/22.

This report shows the data entered into e-COST to enable the Action Chair to verify the completeness and accuracy of the report with the MC prior to submitting the report via e-COST in fulfilment of the rules for COST Action Management, Monitoring and Final Assessment.

Action leadership and participants

Leadership positions

Position	Name	Contact details	Country*
Chair	Dr Christian Huyghe	christian.huyghe@inrae.fr +33142759477	France

Position	Name	Contact details	Country*
Action Vice-Chair	Prof Renata Bazok	rbazok@agr.hr +38512393969	Croatia

Working groups

#	WG Title	# of participants	WG Leader	Country*
1	Setting the scene: identifying research gaps and needs	164	Dr Jitea Ionel Mugurel mjitea@usamvcluj.ro	European Commission and EU Agencies
2	Transformation and transition steps towards zero pesticide based value chains	151	Dr Danilo CHRISTEN danilo.christen@agroscope.admin.ch	Switzerland
3	Breakthroughs in biological research offering new prospects in zero pesticide agriculture	257	Prof Dimitrios Tsitsigiannis dimtsi@aia.gr	Greece
4	Redesigning cropping systems for zero chemical pesticide use	224	Prof Riccardo Bommarco Riccardo.Bommarco@slu.se	Sweden
5	Community building, dissemination and communication	164	Ms Silke Dachbrodt-Saaydeh silke.dachbrodt-saaydeh@julius-kuehn.de	Germany

Other key leadership positions

Position	Name	Contact details	Country*
Science Communication Coordinator	Ms Silke Dachbrodt-Saaydeh	silke.dachbrodt-saaydeh@julius-kuehn.de	Germany
GH Scientific Representative	Christian Huyghe	christian.huyghe@inrae.fr	France

* The country displayed is:

- for the Action Chair, the country that nominated that person to the Management Committee before they were elected Action Chair;
- for the Action Vice-Chair the country that nominated the person as a Management Committee Member,
- for all other leadership positions, if the person is a MC Member the country displayed is the country of nomination, otherwise it is the country of the person's primary work affiliation.

Participants

COST members having accepted the MoU

AL	22/06/2022	AM	09/01/2023	AT	22/06/2022	BE	22/06/2022	BA	22/06/2022
BG	22/06/2022	HR	22/06/2022	CY	22/06/2022	CZ	22/06/2022	DK	22/06/2022
EE	22/06/2022	FI	22/06/2022	FR	22/06/2022	GE	22/06/2022	DE	22/06/2022
EL	22/06/2022	HU	22/06/2022	IS	22/06/2022	IE	22/06/2022	IL	22/06/2022
IT	22/06/2022	LV	22/06/2022	LT	22/06/2022	LU	22/06/2022	MT	22/06/2022
MD	22/06/2022	ME	22/06/2022	NL	22/06/2022	MK	22/06/2022	NO	22/06/2022
PL	22/06/2022	PT	22/06/2022	RO	22/06/2022	RS	22/06/2022	SK	22/06/2022
SI	22/06/2022	ZA	22/06/2022	ES	22/06/2022	SE	22/06/2022	CH	22/06/2022
TR	22/06/2022	UA	22/06/2022	UK	22/06/2022				

Other participants

Institution Name	Country
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Summary

Main aim/ objective

to pave the way for new crop protection strategies and practices without chemical pesticides and to co-build a new research paradigm among research communities by no longer adopting a progressive pesticide reduction approach, but rather encouraging a breakthrough in redesigning crop protection.

The Action addressed this as described below

The COST Action CA21134 entitled 'T0P-Agri-Network' was devoted to the transition towards sustainable agroecology-based crop protection, paving the way for reduced pesticide use and impact, mobilizing emerging technical levers and redesigning cropping systems with strong emphasis on prophylaxis.

The COST Action, run by a close knit core group and supported by a large management committee (56 members), helped to build a very large scientific community (more than 400 participants from over 40 countries, including many ITC countries). Analysis of the research and innovation activities of all participants showed the richness of the research currently on the way in the COST and related countries. Many young scientists attended and contributed to all the events and activities organised by the COST Action.

A wide range of activities was offered. This included i) STSM, ii) four training schools held in Greece, France, Spain and Bosnia-Herzegovina, iii) two international C-K workshops in Romania and Germany complemented by more than 30 national C-K workshops, iv) numerous webinars held every two weeks with priority given to young researchers, v) two writing retreats, vi) Virtual Mobility Grants to conduct country surveys of crop protection and of the barriers and levers for the transition towards sustainable crop protection and to write scientific syntheses on all topics relevant to agroecology-based crop protection, and vii) an international scientific conference held in Berlin in June 2026 presenting all the achievements of the COST Action.

The website of the COST Action (<https://wissen.julius-kuehn.de/t0p-agri/topics/project>) provided access to all resources related to the activities of the COST Action.

The main achievements are

- The identification of barriers and drivers for the adoption of crop protection with little or no pesticides, in which the crop health status required for food safety and security is ensured through the implementation of agroecology. It was demonstrated that crop protection centred on the pesticide use is a typical lock-in situation. The shift towards agroecology and low-pesticide use may be achieved through i) major technical innovations, ii) a thorough redesign of cropping systems, which is easier in annual crops than in vineyards or orchards and iii) profound changes in the socio-technical landscape, i.e. public policies, regulations, commitment from downstream industries.
- A thorough analysis of all recent advances in technologies for better control of weeds, diseases and pests, including i) developments in machinery, robots and digital technologies, ii) breakthroughs in understanding microbial communities and their use in controlling fungal diseases, iii) options for further improving the genetic resistance of crops, considering a holobiont approach, and iv) chemical ecology to control insects through the management of volatile organic compounds.
- An exploration of the redesign of cropping systems, with particular attention to prophylaxis. Possibilities were identified in many countries and the impacts on production and economic performance were documented. In doing so, the COST Action provided participants with tools to support future redesign, especially in view of the challenges for crop protection under climate change.

Action website

<https://wissen.julius-kuehn.de/t0p-agri/>

Achievement of MoU objectives, deliverables and additional outputs/ achievements

MoU objectives

Please self-assess and describe the level of achievement of each MoU objective. For any MoU objectives that were less than 76% achieved please provide justification.

Please provide proof to enable the Action Rapporteur to confirm the level of achievement.

Mou objective	To build our research activities on the concrete experience of end-users in two strategic agricultural sectors, together identifying barriers and levers for a zero pesticide agriculture and constructing a truly multi-actor Action.		
Type of objective	2.a Building a community around a topic of scientific and/or socio-economic relevance, allowing for knowledge exchange and the development of a joint research agenda 2.d Acting as a stakeholder platform or trans-national practice community, pertaining to a certain area of socio-economical or societal application, or to a certain market sector		
Level of achievement of MoU objective	76 - 100%	Dependence of achievement on the action networking	High
Proof of achievement of MoU objective	The community building has been real and very fruitful, on the side of academic research. This is evidenced through the following issues: - The size of the community, with more that 400 participants at the end of the project. The number of WG participants to our COST action was very high, with many countries actively participating. Participants originated from 44 countries belonging to the very types of countries, according to the COST structure. The motivations expressed by the applicants to join the project clearly showed that it was important for them to belong and contribute to this scientific community. the presentation of research results during the numerous webinars implemented from the end of Y1. It showed a diversity of results, but it evidenced that research domains were similar among countries. People set connections during and after the webinars. - Many events took place such as C-K workshops, nationally and at the European level. A large attendance contributed to the community building. This was also evidenced during the final scientific conference, held in Berlin in June 2026. The large attendance and above all the large share of young researchers, including some who had STSM grants beforehand showed that the COST action was very efficient in building the research community. - The structure of the STSM grants, which shows the connections that were built during this project. See the relevant objective and deliverable. - Many research projects are quoting partnerships with companies and/or collaboration with farmers for either determining objectives, testing new pest control options or redesigning cropping systems. This is obvious from the CV of the participants, from the results of the WG1 where the national workshops were very active with a large diversity of stakeholders. It was also the case for the national workshops for C-K design of future workshops. However, the stakeholders, not belonging to the academic research, little applied to join the COST action. It is not possible from our experience to know whether this situation is common with COST actions covering other topics. From individual discussions, not based on a broad and systematic survey, it appears that these stakeholders, especially companies and farmers organisations, did not perceive the immediate added value for them of being part of such a COST action		

Mou objective	To assess how to achieve an agroecology-based transition of farming and food systems, in which pesticide use is marginal and only when all other options for securing crop health have been implemented		
Type of objective	1.a Development of a common understanding/definition of the subject matter		
Level of achievement of MoU	76 - 100%	Dependence of achievement	Medium

objective	on the action networking
Proof of achievement of MoU objective	The transition is crop protection from a full pesticide-based situation to an environment and human health-friendly situation is difficult. Indeed, crop protection is a typical lock-in situation, where many elements must move at the same time and in synergy. Thanks to the COST action and to other connected research projects, it was evidenced that the levers of efficiency (E), substitution (S) to pesticides and of redesign (R) must be implemented (the ESR categories defined by Hill and McRae (1998)). This requires research efforts at various levels. But it also requires that the overall paradigm is well-understood and accepted by all participants. The present project contributed to a paradigm shift in crop protection. The pre-existing paradigm is set by the eight principles of Integrated Crop Management and illustrated by the ICM triangle, from the use of chemicals to landscape analysis. During this COST action, it was evidenced that the eight principles had to be analysed in a 2 dimension plot, with an axis corresponding the ESR scale and the other one related to the time between action and impact, the short time corresponding to tactical approach as it is the case when applying chemical pesticide to the long-term and strategic action which is compulsory, when preventative approaches are implemented through a significant redesign of the cropping systems. This was named as a Triangle in the Wind. This approach made it possible to avoid a severe and sterile opposition between the improvement of the existing systems, their small modifications, especially for perennial crops (vineyards) where less degrees of freedom exist and the situations where deep redesigns. The enrichment due to the paradigm shift reinforced the collaboration among the participants to all WGs and especially the collaboration between WGs. This was very much debated during all meetings and events organised by the COST action, either webinars, training schools, national and international workshops and the final scientific conferences. The participatory approaches, in WG1 and 2, the national and international workshops in WG4 for redesigning agroecology-based cropping systems as well as the connexion with other research projects (such as Acropics) made it possible to share these discussions and to contribute to the development of a common understanding of the future fully sustainable crop protection and the pathways to achieve it in all countries and for all crops.

Mou objective	To analyse the state of the art in the different scientific fields at the forefront of providing revolutionary innovations for zero pesticide agriculture.		
Type of objective	1.d Comparison and/or performance assessment of a theory, model, methodology, technology or technique		
Level of achievement of MoU objective	76 - 100%	Dependence of achievement on the action networking	High
Proof of achievement of MoU objective	Objective 3 was successfully addressed in WG3 "Breakthroughs in biological research offering new prospects in zero pesticide agriculture" through a comprehensive analysis, critical review, and comparative assessment of emerging scientific breakthroughs and innovative approaches supporting the transition towards zero-pesticide agriculture. The COST Action CA21134 integrated advances in pest prophylaxis, microbiota-based crop protection, novel biopesticides, chemical ecology, agroecological approaches, digital technologies, artificial intelligence (AI) and precision agriculture. This objective was fully achieved through a combination of scientific exchange, interdisciplinary collaboration, knowledge transfer, and targeted research activities, including: - Scientific discussions and knowledge exchange during the Action's meetings, bringing together experts from complementary scientific disciplines.- Thematic webinars, facilitating the dissemination and critical discussion of recent scientific advances, emerging technologies, and innovative crop protection strategies.- Training Schools: "Unmanned Aerial Systems (UAS) in Agricultural Applications in Vineyards" (19–22 June 2023, Nemea, Greece), addressing advanced remote sensing, precision		

	agriculture, and digital technologies for crop monitoring and management; Spring School “<i>Rethinking Plant Breeding for a Zero-Pesticide Agriculture</i>” (14–15 May 2024, Bordeaux, France), innovative plant breeding strategies and genetic resistance for sustainable crop protection through breeding plant holobionts; Biocontrol and Biostimulants (April 2025, Valencia, Spain). - Virtual Mobility Grants (VMGs), through targeted scientific reviews, expert consultations, synthesized recent breakthroughs across different fields relevant to zero-pesticide agriculture. These activities facilitated identification, evaluation, and integration of promising scientific advances, with their potential applications, limitations, and research gaps. A comparative assessment of conventional and emerging diagnostic methodologies highlighted complementary performance of molecular techniques (PCR, LAMP, CRISPR-based diagnostics), remote and proximal sensing, and AI-assisted detection. Molecular methods provide pathogen-specific identification; multispectral, hyperspectral, thermal, and UAV-based technologies enable spatially extensive monitoring. Their integration is a promising strategy for early detection and effective surveillance. Different AI approaches were evaluated regarding diagnostic accuracy, predictive capabilities, transferability, uncertainty, and decision-support potential. Emphasis was placed on moving beyond model accuracy towards validated field performance and actionable recommendations. For weed management, digital mapping and precision herbicide application were compared with emerging non-chemical technologies, including autonomous robotics, mechanical, electrical, thermal, and laser-based interventions. Their potential benefits and limitations were assessed in relation to selectivity, operational feasibility, environmental impacts, and long-term weed population dynamics. Biological innovations and solutions were examined through comparisons of single-strain microbial biocontrol agents, microbial consortia, synthetic microbial communities, antagonistic yeasts, entomopathogens, and microbiome-mediated plant resistance. Mechanisms, efficacy, environmental stability, formulation challenges, and regulatory constraints were critically assessed. Semiochemical approaches, including pheromones, and manipulation of insect–plant interactions, were evaluated as alternatives to conventional insecticides. We finally proposed an integrated Observe-Diagnose-Predict-Prevent-Intervene-Learn framework, combining biological and agroecological protection with digital intelligence and technologies. Achievement of Objective 3 is therefore demonstrated by the systematic comparison of scientific approaches, identification of technological strengths and limitations, formulation of innovative interdisciplinary concepts, and establishment of research priorities and performance indicators. Deliverable D7 provides a multidisciplinary scientific foundation for developing and validating integrated crop protection systems that reduce dependence on harmful chemical pesticides while maintaining agricultural productivity, environmental sustainability, and economic viability. It supports new paradigms for the transition towards zero-pesticide agriculture.
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Mou objective	To gather multidisciplinary knowledge in the field of agroecology to enable a paradigm shift from curative to preventive crop protection in farming.		
Type of objective	1.b Coordination of information seeking, identification, collection and/or data curation		
Level of achievement of MoU objective	76 - 100%	Dependence of achievement on the action networking	High
Proof of achievement of MoU objective	A large effort to create the conditions for this paradigm shift was undertaken across the entire action and in particular in WG4. The WG activities have been dedicated to the ongoing challenge of moving from a logic of substituting pesticides to a true cropping systems redesign approach. Transitioning to pesticide-free cropping systems requires more than replacing chemical pesticides with alternative inputs. It requires fundamental changes and redesign in crop and landscape management. However, options for redesign might differ depending on cropping system and region. We used a		

transdisciplinary and geographically inclusive approach to explore how stakeholders envision such systems. We identified promising practices and implementation challenges, and defined research needs. In 2024, we conducted in the COST-action 21 regional workshops in 14 countries in Europe and beyond engaging at total 400 participants. Using the Concept-Knowledge framework we engaged farmers, advisors, and representatives from agribusiness, non-governmental organisations, governmental organisations, and researchers to identify practices and research needs for pesticide-free crop production in two contrasting cropping systems: annual cereal-based crop production systems and viticulture. The identified practices were subsequently harmonised and evaluated during an international synthesis workshop in February 2025, where 30 experts, with close to 50-50 in gender representation, representing 13 countries that had organised the regional workshops, synthesised and compared results and assessed their expected contribution to pesticide-free crop protection. The rich output from the regional and international workshops is collected in deliverable 8, which is the pre-print of a scientific paper to be submitted rich after the end of the COST action.

A keynote has been delivered during the final conference of the COST action on 10th of June as part of Session 2, Future cropping systems based upon active prophylaxis by Kathrin Grahmann about "Diversified cropping systems for pesticide reduction: experimental challenges and analytical solutions". The key note highlighted that reducing pesticide use through diversified cropping systems requires a shift from reactive pest control towards preventive crop protection based on ecological regulation. However, diversification increases the spatial, temporal and biological complexity of agroecosystems, challenging conventional experimental approaches that typically rely on small plots, short observation periods and controlled conditions. Therefore, this talk explored how experimental design and data analysis can be adapted to investigate system-level prophylaxis under real-world conditions. Using the landscape-scale patchCROP experiment in Brandenburg as an example, it discussed co-designed diversification strategies, situation-specific management and the trade-offs between experimental control and practical relevance. Particular attention was given to analytical approaches that can address complex, non-replicated and spatially structured datasets, including mixed models, multivariate methods, propensity-score approaches, spatial analysis and process-based modeling. Examples across plot, field and landscape scales illustrated how these methods can help disentangle interacting effects of crop diversity, management, soil heterogeneity and landscape structure. The talk concludes by highlighting the need for new forms of experimentation, analysis and knowledge transfer to support the redesign of cropping systems for preventive crop protection.

Mou objective	To connect researchers with EIP Agri Operational Groups aimed at pesticide reduction.		
Type of objective	1.j Dissemination of research results to stakeholders (excluding specific input in view of knowledge application)		
Level of achievement of MoU objective	76 - 100%	Dependence of achievement on the action networking	Medium
Proof of achievement of MoU objective	Connecting with the stakeholders and the farmers and farming communities has been a permanent objective of the COST action. This was achieved through many actions, which were very fruitful. It is important to quote here - the motivation expressed by the WG participants in their applications. It is interesting to note that many of them explain the motivation of their research by the need expressed by the farming communities. Some of them implement their research with farmers or on farms, i.e. in real conditions. However, it is difficult out of the analysis of the applications to know whether the farmers are belonging or not to EIP groups. It is not clear whether the farms are always aware or mentioned that they belong to a EIP operational group.- the national and international workshops in WG1, where the stakeholders were invited and massively contributed (see Deliverables 1 and 2) in order to identify the barriers and levers in the transition towards a sustainable crop protection-the works implemented in WG2 in order to understand the situation of strong lock-in that is in place in crop protection making it difficult to move away from a pesticide-		

	centered approach. The understanding of this lock-in situation was based upon theoretical and academic analysis and was supported by many interactions with practitioners, especially farmers groups, in order to understand their motivations to act, to change and how it would be possible to de-risk a transition towards more sustainability. Some country surveys also included farmers groups in order to properly identify the trajectories in the countries and all the on-going projects. A close connection with the Acropics project was established with common joint meetings which took place at the same time as the MC meetings in Year 2 (Zagreb) and Year 3 (Bucharest) and during the scientific conference in Berlin in June 2026. The Acropics project, where many COST participants are also contributors, is based upon the participatory approaches including many farmers and farmers organisations in 4 continents. The ACROPICS project brings together 12 case studies across the globe, three of them being in Europe and including COST participants. These promote the sustainability of agroecological crop protection strategies creating value from production to consumption. Within the scope of the ACROPICS project, these case studies are named "SAS" (Sustainable Agroecological Systems), referring to place-based co-innovation initiatives involving local and farmers actors with agroecological crop protection strategies. A Virtual Mobility Grant was awarded to analyse the benefits of the participatory approaches https://wissen.julius-kuehn.de/mediaPublic/T0P-agri/Reports/Thematic_contributions/Co-designing_territorial_strategies.pdf. - A virtual Mobility Grant was dedicated to document a case study on tomato production in Spain, where farmers belonging to EIP operational groups were highly committed into the transition towards protection systems with low-pesticide use https://wissen.julius-kuehn.de/mediaPublic/T0P-agri/Reports/Thematic_contributions/Crop_protection_in_EIP_Operational_group.pdf. During the four years of the COST action, the activities of the EIP operational groups progressively declined in many countries, when the national animations slowed down. They happened independently of the activities of the COST action.
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Mou objective	To raise awareness of the importance of the issue and the need for a strong research and innovation paradigm shift.		
Type of objective	1.g Input to stakeholders (e.g. standardization body, policy-makers, regulators, users), excluding commercial applications 2.e Building capacity in the demographic inclusiveness of networks in science and technology, including representation of newly established research groups, Early-Career Investigators, the under-represented gender and teams from countries/regions with less capacity in the field of the Action		
Level of achievement of MoU objective	76 - 100%	Dependence of achievement on the action networking	High
Proof of achievement of MoU objective	The COST-action has been highly successful in meeting Objective 6 via numerous complementary approaches. Importantly, there has been an exceptionally high level of participation in the COST action, with 405 approved members representing 41 countries. The participants include a large proportion of junior scientists (31%) covering a broad range of competence related to crop protection, e.g., linked to different crops and cropping systems, organisms and scale of inquiry from cell to landscape. Stakeholders have been actively engaged throughout the COST-action, for instance in numerous C-K workshops in WG1 and WG4 with hundreds of participants from the agricultural sector who were not participants to this COST action. The management committee meetings and the presentations and discussion at these meetings have considerably raised awareness about region-, organisms-, and crop-specific challenges and the need for a strong paradigm shift. Rich and challenging		

discussions on complementary technological and redesign approaches have been brought together. Well-attended and regular webinars and dissemination activities among the many COST members have further enriched the discussions and raised awareness among researchers and stakeholders. Training schools and STSMs have been effective tools to build competence and networks among junior researchers, preparing them to meet the formidable challenge of protecting crops without chemical pesticides. The final conference brought all the above elements together with the diversity of approaches in research and application that typically characterizes crop protection, presented mainly by young researchers with a substantial gender-balanced geographic inclusion across Europe and beyond. Finally, the COST Action has designed ways to link members with key research networks represented in the European Research Alliance (ERA) for Chemical Pesticide Free Agriculture which gathers 38 research organisations from 21 European countries, the international Agropics project (Agroecological Crop Protection towards international co-innovation dynamics and evidence of sustainability) gathering 15 organisations from 4 continents, and European research projects, notably the Life-PLP project Agrowise and the coordinated support action FORTUNA. A yearly synchronisation of venue and time for the management committee meetings, the annual meetings of Agropics and the ERA has catalysed interactions and networking. Another proof of achievement of this objective may also be found in many reports of the Virtual Mobilities which took place at the end of the COST action. Indeed, many reports are focussing on new fields of research such as microbiota, are considering all compartments of the agroecosystems such as soil, and are discussing the redesign of the cropping systems. They are clear proofs of the increasing awareness of the transition and how far this has been endorsed by the community of the Early-Career investigators.			
Mou objective	To bridge separate fields of science and technology to create a strong scientific community with a broad representation across Europe (including 10 Inclusiveness Target Countries) oriented to develop research solutions for a zero pesticide agriculture.		
Type of objective	1.e Development of knowledge needing international coordination, pertaining to a new or improved theory, model, methodology, technology or technique		
Level of achievement of MoU objective	76 - 100%	Dependence of achievement on the action networking	High
Proof of achievement of MoU objective	All along the COST action, discussions during all events (Management Committee meetings, training schools, workshops, webinars, virtual mobility meetings) contribute to create a strong community and to facilitate the collaboration among disciplines, everyone learning from the other disciplines for boosting his/her own research and innovation activity. This objective was achieved and identified some key elements for the future. It was also confirmed by the survey run over many countries through very valuable Virtual Mobility Grants in Year 4. The key elements shared among participants and among countries are The crop protection has changed over the last decade, with less chemical pesticides and more alternative options for a sustainable crop protection, some being based upon agroecology. However, the trajectories differ among countries, with three groups being identified: established EU member states, EU accessions and candidate countries and Southern Mediterranean partners There is a very strong role played by the regulations. Again, there are contrasting situations regarding governance and regulatory alignment, with the same three groups of countries The transition of supply chains to a more sustainable crop protection also depends on the downstream economics and market		

	valorisation which are primary bottlenecks. It is very visible when considering the two supply chains which were primarily covered by the COST action, ie annual grain crops and perennial crops (vineyards and orchards). Advisory capacity and technical support to farmers are essential. The role of education and extension services must be fully taken on board. This also meets the conclusions of the EU project Life-PLP Agrowise. Research plays a key role in order to provide knowledge, innovations and tools for implementing new cropping systems according to a wide range of modifications, i.e. from simple input substitution to systemic redesign and traceability, with attention paid to prophylaxis. The COST action was particularly intense in three domains: digital traceability & precision agriculture, microbiota analysis and development of new options as well as a better use of the emerging option (such as soil management), systemic de-risking & redesign Research was also active and is very important in order to ensure that the use and impact of pesticides are properly used. Indeed, progresses must be evaluated beyond crude sales volumes. Research is also invited to develop and feed the concept of hidden costs due to pesticide uses. To conclude, achieving a low-pesticide transition requires moving beyond simple input substitution. Sustainable success depends on combining digital supply-chain traceability, cooperative-led risk-sharing mechanisms, strengthened advisory networks, and market valorisation of low-residue agricultural produce
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Mou objective	To promote scientific development of Early Career Investigators and young researchers (by offering them Summer Schools and Short-Term Scientific Missions), helping establish a new generation of research leaders with innovative mind-set looking at the problems with a holistic approach.		
Type of objective	2.e Building capacity in the demographic inclusiveness of networks in science and technology, including representation of newly established research groups, Early-Career Investigators, the under-represented gender and teams from countries/regions with less capacity in the field of the Action		
Level of achievement of MoU objective	76 - 100%	Dependence of achievement on the action networking	High
Proof of achievement of MoU objective	STSMs, Training schools and VM contributed to this objective, fostering the scientific development of early-career and young researchers, contributing to the emergence of a new generation of research leaders with an innovative mindset and building a scientific community across Europe connecting diverse fields of science and technology, altogether developing research and innovations for pesticide-free agriculture. 29 STSMs were performed by 26 grantees, 81% of them young researchers and most were female (69%) and 62% from ITCs. Among the host countries there were also ITCs. The STSM covered topics of the WG1 to WG4, with a majority on WG3 and WG4. The grantees were committed with the overall objective towards less use of pesticide in agriculture, and active in the WG and the transition to agroecology in their own countries. Some were /are also in other COST actions with related objectives. Considering the main topics, and bearing in mind that some STSMs covered more than one of the topics considered (Pesticides and biopesticide alternatives, Breeding for resistance, Insect control in cops and stored products, Disease control, Weed Control, Microbiome, Pollination, Biodiversity for crop protection and System Approach), a majority of STSMs were related to insect control, disease control and the systems approach. The least represented topics were microbiome and weed control. VM reported on the outcomes and on the perceptions of trainees and their supervisors (https://wissen.julius-kuehn.de/mediaPublic/TOP-agri/Reports/Thematic_contributions/STSMs_Research_Networks.pdf) Four training schools focused on the design of future crop cultivation systems and their components, and explored pathways toward agriculture with reduced or no		

	pesticide use, with integrated approaches based on systems thinking. Programs combined Earth observation tools, soil health management, genetics and agroecological practices to support resilient and sustainable crop production, with a key role played by preventive actions. Through practical sessions and case studies, participants gained hands-on skills in monitoring crop conditions, enhancing natural system functions, and implementing efficient interventions. Training schools were interactive, with engagement between professors and students and two-way communications. Interactive sessions stimulated the creative approaches, whatever the topics of the training schools. They also encouraged multidisciplinary approaches as participants were from various disciplinary fields, even if there was always a predominant one, according to the themes of the training schools. Organizers paid attention to facilitate the life of the trainees and to show new working and cultural environments. All surveys run right after the events were positive. Virtual Mobilities, implemented for the preparation of the final report were fruitful and young researchers represented 40% of the grants. VMs were based upon virtual meetings and interaction with either national or international communities. VMs contributed country surveys (https://wissen.julius-kuehn.de/t0p-agri/reports/topics/virtual-mobility-country-surveys) mapping the current status of plant protection, national pesticide sales trajectories, regulatory frameworks, technological innovations and the structural drivers and barriers governing the transition towards preventive and agroecological crop protection. Most other VMs were related to breakthroughs in scientific domains and to participatory approaches (https://wissen.julius-kuehn.de/t0p-agri/reports/topics/thematic-contributions). The VM grants allocated to young researchers contributed to the quality of their network.
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Mou objective	To reinforce links between the production of knowledge actors and the agri-food sector actors in order to share a common understanding and willingness to co-design an environment-friendly, sustainable, fair, just and competitive agri-food sector.		
Type of objective	1.j Dissemination of research results to stakeholders (excluding specific input in view of knowledge application) 2.d Acting as a stakeholder platform or trans-national practice community, pertaining to a certain area of socio-economical or societal application, or to a certain market sector		
Level of achievement of MoU objective	76 - 100%	Dependence of achievement on the action networking	High
Proof of achievement of MoU objective	The reinforcement of the links between researchers and practitioners and the engagement of the stakeholders in order to achieve more co-design were ensured through the C-K workshops implemented in WG1 and WG4 WG1 identified barriers and needs in the significant reduction of pesticide use, a multi-actor approach was used. The contribution of the actors involved in the value chain is necessary to guide towards impactful research. Concept – Knowledge workshops brought together farmers, suppliers of agricultural inputs, advisors, specialists from agro-food industries, researchers, non-academic partners in the consortium, and various other interested parties, especially NGOs. Those groups shared experiences in pesticide reduction and their expectations. For a uniform data collection, a common guide was created for conducting the workshops, describing organization, structure of the group, topics to be debated and agenda of the event. In addition, an individual digitalised report was created to present results in a common template. Guidelines for the national C-K workshops were sent by email to all members of the Cost Action Working Group 1 (104 members) in early 2023. The national K-C workshops were implemented in 3 agricultural sectors: small grains		

	(8), viticulture (9) and horticulture (4). Afterwards, a Pan European workshop was held to identify the most stringent barriers towards zero pesticides agriculture. It took place in Cluj-Napoca, Romania on September the 14th, 2023 with a hybrid format (on site (8 participants) and online (16 participants)). Similarly, WG4 developed a common approach for stakeholder engagement in the national C-K workshops. Stakeholder participation was recommended, allowing organisers to adapt engagement to their local context. The engagement of six stakeholder groups ensured a broad range of perspectives across 21 national workshops conducted between April and December 2024 in 14 countries, involving approximately 400 participants. Academia and research represented the largest stakeholder group (142 participants; 35.5%), followed by farmers (98; 24.5%) and advisors (80; 20%). Agribusiness and suppliers contributed 37 participants (9.3%), policy and governmental organisations 28 (7%), and NGOs and interest organisations 15 (3.8%). Academia and research were present in 20 of the 21 workshops, while farmers and advisors participated in 17 and 15 workshops, respectively. To ensure comparability and methodological consistency across countries and production systems, WG4 provided all regional workshop organisers with common guidelines and a standardised data-collection template. The protocol included clear instructions and explanations to conduct the regional C-K workshops. An Excel-based results matrix was provided to document the outcomes of each workshop. This standardised approach was essential for consolidating and comparing results across different countries and production contexts, including arable cropping and viticulture. Results were further analyzed in the international workshop held in Mainz in February 2025 with facilitators representing the regional workshops. This activity created a structured process through which researchers and diverse agri-food sector actors could exchange perspectives and develop a common understanding of sustainable production challenges and possible solutions.		
Mou objective	To develop dissemination tools and learning materials to empower farmers, consumers, media, and public policy makers by providing them with a source of reliable information and a trusted reference point on zero pesticide agriculture issues.		
Type of objective	1.i Dissemination of research results to the general public 1.j Dissemination of research results to stakeholders (excluding specific input in view of knowledge application)		
Level of achievement of MoU objective	76 - 100%	Dependence of achievement on the action networking	High
Proof of achievement of MoU objective	The activities focused on maintaining communication within the network, informing external audiences and making the knowledge generated during the Action accessible beyond the network. A dedicated website (https://wissen.julius-kuehn.de/t0p-agri/) was established and maintained throughout the Action. It served as the main communication and information platform for the network. It was regularly updated with news and materials generated by the network. The website also served as a repository for selected materials produced during the Action. In particular, presentations from webinars were made available online following the events, ensuring continued access to the material after the live sessions (https://wissen.julius-kuehn.de/t0p-agri/news, e.g. https://wissen.julius-kuehn.de/t0p-agri/topics/working-groups/working-group-3). Social media, LinkedIn (https://www.linkedin.com/company/ca21134/posts/?feedView=all) was used as an additional channel for promoting the Action and communicating its activities. Annual meetings, webinars and other events were announced through the Action's communication channels, and information on completed activities was shared afterwards. This helped to maintain visibility of the Action throughout its lifetime and to reach audiences beyond the Action participants.		

The activity supported knowledge exchange within and beyond the network through a combination of face-to-face and online activities. The Training Schools and Short-Term Scientific Missions provided opportunities for researchers from different countries and at different career stages to exchange knowledge and experience. The results were shared with a broad audience.

Annual meetings of the Action were organized (Uppsala 2023, Zagreb 2024, Bucharest 2025). The annual meetings were accompanied by dissemination activities. Information about upcoming meetings was communicated through the Action's website and social media, while information on the meetings and their activities was shared afterwards. This ensured that the work carried out during the meetings was also communicated to members of the wider network.

A 2,5 day final conference was organized as the concluding event of the Action from 9.-11.June 2026 in Berlin. It brought together about 80 scientists, members of the network and external participants. Across three thematic sessions, a total of 18 scientific presentations and 40 poster contributions were presented. The contributions were largely delivered by early-career researchers, who presented the results of their respective projects.

A visit to the JKI long-term crop protection experiment was also included in the programme. The visit provided a direct link between the scientific activities of the Action and regional agricultural practice and enabled participants to gain insight into long-term crop protection research under practical field conditions. It also supported exchange with the regional agricultural sector and farmers, thereby strengthening the connection between the Action's scientific activities and the needs and perspectives of agricultural practice.

A Book of Abstracts was produced for the final conference (<https://doi.org/10.5073/20261014-092648-0>). It documents the scientific contributions presented at the event and provides a consolidated dissemination output of the Action.

Deliverables

This section covers only deliverables that were foreseen for the Action, not additional outputs that were generated during the Action (these additional outputs will be added in the following section). Please select and comment on the level of achievement of each deliverable as well as the extent to which the achievement was dependant on the Action networking.

For deliverables that are:

- Delivered, please provide proof to enable the Action Rapporteur to confirm the delivery
- Not delivered but delivery is foreseen within 2 years please explain how the delivery will be achieved
- Not foreseen to be delivered please explain why not

Deliverable	D1.1.1 Synthesis report summing up the results of the Concept-knowledge (C-K) workshops		
Level of achievement of deliverable	Delivered	Dependence of achievement on the action networking	High
Proof of achievement of deliverable	https://wissen.julius-kuehn.de/mediaPublic/T0P-agri/WG1/WG1_2026-D1.1.1_Synthesis_report-CK_workshop_12_2023.pdf		

Deliverable	D1.1.2 testimonies of some Concept-knowledge (C-K) workshops participants will be disseminated on the web platform.		
Level of achievement of deliverable	Delivered	Dependence of achievement on the action networking	High
Proof of achievement of deliverable	https://wissen.julius-kuehn.de/mediaPublic/T0P-agri/Reports/Final_Report-supporting_documents/Deliverable2-Testimonials.pdf		

Deliverable	D1.2 A scientific review paper analyzing obstacles and levers faced by end-users, strategies of actors, impacts of private initiatives and public policies aiming at reducing pesticide uses and developing pesticide free chains		
Level of achievement of deliverable	Delivered	Dependence of achievement on the action networking	High
Proof of achievement of deliverable	https://wissen.julius-kuehn.de/mediaPublic/T0P-agri/WG1/WG1_2026-Report_T_1_2.pdf		

Deliverable	D2.1 Scientific opinion paper on agroecological transition and transformation concepts sto align transformation viewpoints with agroecology as science, practice and social driver for change.		
Level of achievement of deliverable	Delivered	Dependence of achievement on the action networking	High
Proof of achievement of deliverable	https://wissen.julius-kuehn.de/mediaPublic/T0P-agri/Reports/Final_Report-supporting_documents/Deliverable_4.pdf		

Deliverable	D2.2.1 A scientific synthesis paper will be published to evaluate the effectiveness of the participatory approaches for agricultural transformation and to propose measures for all stakeholders in European agriculture		
Level of achievement of deliverable	Delivered	Dependence of achievement on the action networking	High

Proof of achievement of deliverable	https://wissen.julius-kuehn.de/mediaPublic/T0P-agri/Reports/Final_Report-supporting_documents/Deliverable5-Participatory_Approaches.pdf		
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Deliverable	D2.2.2 Publication of a Commentary and information brochure to propose measures for all stakeholders in European agriculture.		
Level of achievement of deliverable	Delivered	Dependence of achievement on the action networking	Medium
Proof of achievement of deliverable	https://eng-agrowise.hub.inrae.fr/content/download/273/2910		

Deliverable	3.1 A perspective paper will sum up and formulate new paradigms based on the most prominent scientific breakthroughs and a webinar dedicated to researchers will be held.		
Level of achievement of deliverable	Delivered	Dependence of achievement on the action networking	High
Proof of achievement of deliverable	https://wissen.julius-kuehn.de/mediaPublic/T0P-agri/Reports/Final_Report-supporting_documents/Deliverable7.pdf		

Deliverable	D4.1 A concept-knowledge (C-K) workshop with non-academic partners and end-users will be organized to discuss the three topics on task 4.1, and a synthesis paper will be written based on these exchanges and literature review.		
Level of achievement of deliverable	Delivered	Dependence of achievement on the action networking	High
Proof of achievement of deliverable	https://doi.org/10.5281/zenodo.23416116		

Deliverable	D5.1.1 Action's website will be set-up to host the scientific materials created through other tasks		
Level of achievement of deliverable	Delivered	Dependence of achievement on the action networking	High
Proof of achievement of deliverable	https://wissen.julius-kuehn.de/t0p-agri/		

Deliverable	D 5.1.2 General promotional and informational materials will be created and feed the web platform (newsletter, articles, links to other networks and resources, etc.) as well as a Twitter account. Month : every semester		
Level of achievement of deliverable	Delivered	Dependence of achievement on the action networking	High
Proof of achievement of deliverable	https://wissen.julius-kuehn.de/mediaPublic/T0P-agri/Reports/Final_Report-supporting_documents/Deliverable10-Dissemination.pdf		

Deliverable	D5.1.3 A position paper on the research gaps that should be explored under Horizon Europe (5.1.3), specifically aimed at policy-makers, will be drafted and disseminated.		
Level of achievement of deliverable	Delivered	Dependence of achievement on the action networking	Medium
Proof of achievement of deliverable	https://zenodo.org/records/22643576		

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Additional outputs / achievements

Co-authored Action publications

Please enter below ONLY publications (including publications that are submitted but not yet accepted):

- that are on the topic of the Action, and
- that are co-authored by at least two Action participants from two countries participating in the Action, and
- for which the Action networking was necessary.

Please pay special attention to the COST Excellence and Inclusiveness policy and ensure the inclusion of publications with authors from COST Inclusiveness Target Countries (ITCs), from the underrepresented gender in the Action and from Early Career Investigators/Young researchers.

	Bibliographic data	Countries participating in the Action among authors	Open Access	COST cited?	COST funds?	Relevance to H2020 Societal challenge	Peer Reviewed?
1	doi:10.1007/s13593-021-00742-8 Title Pesticide-free agriculture as a new paradigm for research Authors Florence Jacquet; Marie-Hélène Jeuffroy; Julia Jouan; Edith Le Cadre; Isabelle Litrico; Thibaut Malausa; Xavier Reboud; Christian Huyghe DOI doi:10.1007/s13593-021-00742-8 Type Journal article Published in Agronomy for Sustainable Development Published by Springer Science and Business Media LLC ISSNs 1774-0746; 1773-0155 Links https://link.springer.com/content/pdf/10.1007/s13593-021-00742-8.pdf; https://link.springer.com/article/10.1007/s13593-021-00742-8/fulltext.html		Other	Y	Y		Y
2	doi:10.1038/s43016-021-00424-4 Title On-Farm Experimentation to transform global agriculture Authors Myrtille Lacoste; Simon Cook; Matthew McNee; Danielle Gale; Julie Ingram;		Other	Y	Y		Y

	DOI Type Published in Published by ISSN Links	Véronique Bellon-Maurel; Tom MacMillan; Roger Sylvester-Bradley; Daniel Kindred; Rob Bramley; Nicolas Tremblay; Louis Longchamps; Laura Thompson; Julie Ruiz ; Fernando Oscar García; Bruce Maxwell; Terry Griffin; Thomas Oberthür; Christian Huyghe; Weifeng Zhang; John McNamara; Andrew Hall doi:10.1038/s43016-021-00424-4 Journal article Nature Food Springer Science and Business Media LLC 2662-1355 https://www.nature.com/articles/s43016-021-00424-4.pdf; https://www.nature.com/articles/s43016-021-00424-4						
3	doi:10.1093/erae/jbaf049 Title Authors DOI Type Published in Published by ISSNs Link	Intercropping can enhance long-term farm economic performance: Evidence from Swedish agriculture 2001–2018 Shaibu Mellon Bedi; Riccardo Bommarco; Martin Weih; Helena Hansson doi:10.1093/erae/jbaf049 Journal article European Review of Agricultural Economics Oxford University Press (OUP) 0165-1587; 1464-3618 https://academic.oup.com/erae/advance-a rticle-pdf/doi/10.1093/erae/jbaf049/652455 78/jbaf049.pdf		Other	Y	Y		Y
4	doi:10.1016/j.agee.2025.109822 Title Authors	Within-field overwintering contributes to arthropod predator assemblages in arable fields irrespective of tillage intensity Janina Heinen; Monique E. Smith; Sara E. Emery; Ola Lundin; Riccardo Bommarco		Other	Y	Y		Y

	DOI Type Published in Published by ISSN Links	doi:10.1016/j.agee.2025.109822 Journal article Agriculture, Ecosystems & Environment Elsevier BV 0167-8809 https://api.elsevier.com/content/article/PII:S0167880925003548?httpAccept=text/xml ; https://api.elsevier.com/content/article/PII:S0167880925003548?httpAccept=text/plain						
5	doi:10.1016/j.gfs.2025.100857 Title Authors DOI Type Published in Published by ISSN Links	doi:10.1016/j.gfs.2025.100857 Narrowing the ecological yield gap to sustain crop yields with less inputs Martin K. van Ittersum ; João Vasco Silva; Riccardo Bommarco; Renske Hijbeek; Ola Lundin; Romain Nandillon; Göran Bergkvist; Alexander Menegat; Ingrid Öborn; Annika Söderholm-Emas; Frederick L. Stoddard; Giulia Vico; Wytse J. Vonk; Christine A. Watson; Chloe MacLaren doi:10.1016/j.gfs.2025.100857 Journal article Global Food Security Elsevier BV 2211-9124 https://api.elsevier.com/content/article/PII:S221191242500032X?httpAccept=text/xml ; https://api.elsevier.com/content/article/PII:S221191242500032X?httpAccept=text/plain		Other	Y	Y		Y
6	Pinto, M., Soares, C., Figueiredo, A.C., Neto, J., Sousa, P., Aguiar, A. Narduzzi, M., Antonelli, C., Vettraino, A.M., Andreani, T., Tavares, F., Fidalgo, F. 2026. How does leaf age affect performance? A comparative study of essential oils from young and mature Eucalyptus globulus leaves in crop protection. Pest Management Science 82:		PT, ES	Y	Y	N	Food security, sustainable agriculture and forestry, marine and maritime and inland water reasearch, and the Bioeconomy	Y

	7510-7525. Doi: 10.1002/ps.70815						
7	doi:10.1016/j.cropro.2025.107332 Title Authors DOI Type Published in Published by ISSN Links	Courtship and mating traits of <i>Tenebrio molitor</i> and <i>Sitophilus zeamais</i> are impacted by sublethal concentrations of carlina oxide Maria C. Boukouvala ; Nickolas G. Kavallieratos ; Filippo Maggi; Marta Ferrati ; Eleonora Spinozzi doi:10.1016/j.cropro.2025.107332 Journal article Crop Protection Elsevier BV 0261-2194 https://api.elsevier.com/content/article/PII:S0261219425002248?httpAccept=text/xml ; https://api.elsevier.com/content/article/PII:S0261219425002248?httpAccept=text/plain		Other	Y	Y	Y
8	doi:10.4067/s0718-58392026000400628 Title Authors DOI Type Published in Published by ISSN	Pest-specific chemical strategies for the management of <i>Aleurocanthus spiniferus</i> (Quaintance, 1903) in mandarin orchard supported by on-site chlorophyll assessment Mitar Đukanović; Tatjana Perović; Vojislava Bursić; Snežana Tanasković; Nenad Magazin; Biserka Milić; Milica Baloš; Dušan Marinković; Antonije Žunić doi:10.4067/s0718-58392026000400628 Journal article Chilean journal of agricultural research SciELO Agencia Nacional de Investigacion y Desarrollo (ANID) 0718-5839		Other	Y	Y	Y

9	doi:10.1111/wre.70004		Other	Y	Y		Y
	Title	Burial depth and temperature effects on the germination and viability of Giant ragweed (<i>Ambrosia trifida</i> L.) seeds					
	Authors	Aleksandra Savić ; Björn Ringselle ; Didac Barroso-Bergadà ; David A. Bohan ; Göran Bergkvist					
	DOI	doi:10.1111/wre.70004					
	Type	Journal article					
	Published in	Weed Research					
	Published by	Wiley					
	ISSNs	0043-1737; 1365-3180					
	Link	https://onlinelibrary.wiley.com/doi/pdf/10.1111/wre.70004					

Projects resulting from Action activities

Please enter below all the projects on the topic of the Action resulting from Action activities, involving at least one Action participant, and for which the Action networking was necessary.

The Action reported 1 project(s) and 0 proposal(s) resulting from the Action networking.

Key details of the projects are shown below.

#	Title	Countries participating in the Action among proposers	Main proposer name	Funder	Amount	Call identifier	Relevance to H2020 Soc challenge
1	Agrowise: Guidelines for farm-specific or crop-specific rules for mitigating pesticides impacts while ensuring sustainable agriculture	HR, FR, DE, IE, IT, PL, SE	Maud Blanck, Inrae	Other EU	2000000 €	Life-PLP	Food security, sustainable agriculture and forestry, marine and maritime and inland water reasearch, and the Bioeconomy

Other outputs / achievements

Please enter below any additional outputs/ achievements on the topic of the Action that contribute to the COST mission: "COST enables break-through scientific developments leading to new concepts and products and thereby contributes to strengthen Europe's research and innovation capacities", and for which the Action networking was necessary (e.g. a patent, standards, white paper).

Output / achievement description	Dependence of achievement on the Action networking
A part of the activities of the scientific community, a survey of the pesticide use, regulatory issues and on-going changes in COST countries was undertaken. 13 countries contributed. The individual country surveys are available on the TOP-Agri Website (https://wissen.julius-kuehn.de/t0https://wissen.julius-kuehn.de/t0p-agri/reports/topics/virtual-mobility-country-surveys) as well as a detailed synthesis. This synthesis compiles findings from country surveys across European, Mediterranean, and Near East nations . Across all surveyed countries, a central consensus emerges: achieving a sustainable, low-input agricultural transition cannot be accomplished through simple "input substitution" (replacing synthetic chemicals with biological inputs). Instead, success requires systemic redesign of cropping systems, digital supply-chain traceability, expanded independent advisory services, and value-chain de-risking mechanisms to compensate farmers for economic transition risks. Trajectories and Differences Among Country Typologies National trajectories vary significantly based on regulatory status, climate, and cropping profiles: Established EU Member States (e.g., France, Czechia, Croatia, Portugal, Sweden, Finland): These nations enforce the EU Sustainable Use Directive (SUD). France demonstrates a qualitative shift, reducing Category 1 CMR hazardous active substances to 0.1% of sales while biocontrol and organic inputs reached 36%. Czechia reduced active substance application by 38% between 2011 and 2025. Portugal's sales are heavily dominated by fungicides (52.7%) due to severe disease pressure in perennial crops. EU Accession & Candidate Countries (e.g., Türkiye, Albania, Serbia, BiH): These countries are actively aligning national laws with the EU acquis. Türkiye leads in centralized digital tracking through its Plant Protection Products Tracking System (BKÜTS) and B-Prescription system. Albania combines a 0% VAT on imported biocontrol organisms with 50%–70% direct subsidies. BiH faces delays due to a fragmented four-tier administrative structure. Non-EU Partners & UK (e.g., Egypt, Morocco, UK): Egypt operates under tight land and water constraints, implementing a 6-layer decision hierarchy to meet strict export MRLs. Morocco enforces Law 34-18, deploying native entomopathogenic nematodes and biofumigation. The UK leverages precision technologies (UAV weed mapping, electrical weeding) supported by Sustainable Farming Incentive (SFI) payments. Key Lessons and Strategic Priorities A critical need for research and innovation: academic research and innovations in private companies are active in all countries. They need continuous support for ensuring delivery of efficient and viable practices and cropping systems to farmers. Downstream Economics & Advisory Gaps: Adoption of non-chemical solutions is blocked primarily by high transition risks, lack of price	High

premiums for low-residue produce, and shortages of independent field advisors.

Systemic Redesign & Digital Traceability: Effective transitions combine digital monitoring with preventive practices like crop rotation, resistant varieties, and habitat diversification.

Toxicity-Based Metrics: Progress must be evaluated by toxicological risk reduction—such as France's proposed Aggregated Total Applied Toxicity (ATAT) metric—rather than crude sales volume, which can be distorted by heavy mineral inputs like sulfur and copper.

Priority Policy Actions: CA21134 highlights four priorities: territorial multi-actor risk-sharing (e.g., France's PRAAM), institutionalizing digital tracking and advisory networks, modernizing biopesticide registration and fiscal incentives, and adopting toxicity-based governance metrics.

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Impacts

Please describe the impacts (the short- to long-term scientific, technological, and / or socioeconomic changes produced by a COST Action, directly or indirectly, intended or unintended) that have resulted, or might result, from the Action in the following table (one impact per line).

Description of the impact, i.e. what will change, and for whom, as a result of what the Action achieved	Type of impact	Timing of impact
To ensure impact, a priority was given to STSM, as the improvements of skills was considered by the Core Group as a critical issue for increasing the long term impact. https://wissen.julius-kuehn.de/t0p-agri/topics/project/calls	Scientific / Technological	Achieved

Please describe how the Action has advanced careers, skills and network of researchers, including Early Career Investigators (for example: joint supervision of graduate and PhD students, research exchanges not funded by the action, collaborations, Training Schools with ECTS accreditation, joint projects, internship and job prospects).

The Action contributed to careers of the researchers and especially young ones. Indeed, the COST action put an emphasis on the young researchers, who were numerous among our participants. The validation of the applications to contribute to the WGs was an important element for the career of the Turkish Post-Doc and junior scientists. The training schools and the C-K (Concept-Knowledge) workshops offered possibilities for connexions among groups who did not know each other before. They led to initiatives leading to projects, with in most cases an intermediate step which was a STSM. This was clear from the STSM. Indeed, several collaborative projects started from these STSM or where boosted after the STSM. The joint organisation of events between the COST action and international collaborative projects, such as the CSA FORTUNA and the international ACROPICS project offered possibilities for international collaboration. International awards were given to students during the scientific conference held in Berlin in June 2026, leading to a national and recognition of the quality of their research. The oral contributions to the international scientific conference was acknowledged and used by some contributors as an element in their application for their national habilitation

The career benefits were mainly to researchers with the following amount of experience after their PhD: ≤ 8 years.

Which of the stakeholders described in the “Plan for involving the most relevant stakeholders” in the Action’s MoU have been engaged and how? What additional stakeholders have been, or will be, engaged and how? This information will not be included in the Action Report that is made publicly available (on the website).

Several groups of stakeholders were involved in the activities of the COST action. Among the participants, it is interesting to note that many are already involved into collaborations and interactions with stakeholders. The COST action has offered them the possibility to reinforce these partnerships. The groups of stakeholders were - groups of farmers. It was an objective of the COST action. Beyond the links existing at the level of the various participants, farmers were directly involved in the activities of WG1 (barriers and levers) and WG2. - chambers of agriculture, extension services and technical institutes: they were strongly involved in the activities of the C-K national and international workshops of the WG4, debating on the agronomic and economic feasibility of the redesigned cropping systems - companies: contacts existed with companies interested into the advances toward a sustainable crop protection (biocontrol companies). Several companies (breeding, biostimulation, digital) actively contributed to the training schools. However, very few of their staff applied to become participants of the COST action. This diversity may be illustrated by the attendance to the WG4 C-K workshops: Academia and research: 35.5%, farmers: 24.5%,

advisors: 20%, agribusiness and suppliers: 9.3%, policy and governmental organisations: 7%, NGOs: 3.8%.

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Dissemination and exploitation of Action results (other than co-authored Action publications listed previously)

Please describe the Action's dissemination and exploitation approach as well as all activities undertaken to ensure dissemination and exploitation of the Action results and the effectiveness of these activities.

Dissemination and exploitation approach of the Action

Dissemination was undertaken through classical approaches, i.e. websites, social networks, conferences, webinars. Field days were organised after all Management Committee meetings and during the final international scientific conferences. During the preparation of these field days and during their implementation, this offered the possibility to inform the visited sites and visited partners about the COST action and the main achievements.

Dissemination

Dissemination meetings funded by the Action (possible only until 31st October 2021)

Title of Dissemination meeting	Meeting date	Meeting country	Action participant	Event name and hyperlink to the website	Title of presentation	Description of added value to the Action
N/A						

Other dissemination activities

E.g. participation to non-Action meetings, e.g. EU Parliament, meetings with policy makers, experts in the field, regional authorities.

Item/activity	Target audience	Outcome	Hyperlink
Webinars. Every two weeks since Y2, T0P Agri Network action is organizing a webinar for dissemination. Up to May 2025, a total of 35 webinars were organized. During every webinar, 2 presentations are given.	The target audience is - the participants to all WG (today, there are more than 400 WG participants and it is a challenge to offer possibilities of discussion to such a large group) - everybody interested in crop protection	A total of 35 webinars have been organized for a total of 62 presentations. These presentations are distributed as follows - Weed control: 9 presentations - Insect control: 11 presentations - Disease control: 5 presentations - Systemic approached: 19 presentations - Plant breeding and microbial: 7 presentations - Pesticides - biopesticides and alternatives:	https://wissen.julius-kuehn.de/t0p-agri/topics/working-groups/working-group-1

		11 presentations A synthesis of all Webinars is available All presentations are available on the website. Below, I only inserted the link to presentations related to WG1	
Short-term scientific missions (STSM). They are open every year. Applications are received and sometimes improved in a constructive discussion with the applicants. A selection is done to fit with the budget This could appear to be redundant with the Impact section. We believe that STSM both contribute to Impact and to Dissemination	The priority target is the young researchers. However, in Y3, we accepted a STSM whose the objective was to stabilize a partnership between two institutions	In Y1, out of 8 applications, 6 were approved and carried out In Y2, 11 applications were received and approved and 10 were actually carried out in Y3, 13 applications were approved A synthesis is available (VMG from Elisabete)	https://wissen.julius-kuehn.de/t0p-agri/topics/project/calls
An International Scientific Conference dedicated to Crop protection was organized by the COST action and was held at the JKI facilities in Berlin in June 2026	European and international Scientific Community with a priority given to young researchers	A 2,5 day final conference was organised as the concluding event of the Action from 9.-11.June 2026 in Berlin. It brought together about 80 scientists, members of the network and external participants. Across three thematic sessions, a total of 18 scientific presentations and 40 poster contributions were presented. The contributions were largely delivered by early-career researchers, who presented the results of their respective projects. A visit to the JKI long-term crop protection experiment was also included in the programme. The visit provided a direct link between the scientific activities of the Action and regional agricultural practice and enabled participants to gain insight into long-term crop protection research under practical field conditions. It also supported exchange with the regional agricultural sector and farmers, thereby strengthening the connection between the Action's scientific activities and the needs and perspectives of agricultural practice. A Book of Abstracts was produced for the final conference and is available with a dedicated DOI (https://doi.org/10.5073/20261014-092648-0). It documents the	https://wissen.julius-kuehn.de/mediaPublic/T0P-agri/Reports/Final_Report-supporting_documents/Final_Conference_-_Summary.pdf

		scientific contributions presented at the event and provides a consolidated dissemination output of the Action. A summary of the conference was prepared. It is available in the hyperlink, with all the details regarding the conference agenda.	
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Exploitation activities

Please describe below any activities undertaken to ensure exploitation (use, in particular in a commercial context) of the Action's achievements.

Item/activity	Target audience	Outcome
N/A		

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Action Success(es)

Taking into account the achievements, impacts and policy implementation of the Action described in the preceding sections, please describe below the two most significant successes of the Action.

Description of the success	Contributing to a paradigm shift in crop protection: Crop protection is compulsory for ensuring productive and economic performance of cropping. Today, in Europe and neighbouring countries, it is mainly achieved with pesticides, with negative impacts on the environment and human health. The COST action activities provided room for intense discussions on the necessary and on-going transitioning and transformation of crop protection, from a more efficient use of pesticides (precision farming), to substitution of pesticides (biologicals, genetic resistance) and to prophylactic approaches implying redesign of cropping systems and landscapes. The COST focused particularly on redesign which relies on strategic choices, needing a new dedicated toolbox. The efficiency approach uses more tactical tools and can be implemented rapidly in all cropping systems. The possibilities differ among crops, with more possibilities for redesign in annual cropping systems than in perennial (vineyards), i.e. the two priority situations considered in the COST action. The discussions, as well as the experiences from the many countries contributing to the COST action, emphasized the dependency to local conditions, which increases when using less pesticides and more agroecology-based solutions. This paradigm shift calls for revising education in agriculture and support to farmers, as well as the regulations.
Dimensions of the success	• Scientific breakthrough • Contribution to regulatory policy • Building capacity in a new or emerging field of science and technology
Description of the success	Emergence of a large, active and very creative research and innovation community. A large scientific community contributes to the research and creation of innovations for future crop protection approaches. This was obvious from the very large number of applications received to become participants in the various WGs. 405 applications from 41 countries were approved, mainly from academia and public research organisations. 52% of participants were female, 56% from ITC countries and 4% from NNC countries. 31% were young researchers, this group being very active in STSM, training schools, final conference, Virtual Mobilities. The Core Group awarded them a clear priority. This community was a resource for fostering the transition of participants' mindset when considering crop protection issues. Indeed, cross-fertilisation among disciplines occurred. It also evidenced that it was essential to pay attention to site-specificities and context dependency of crop protection, identifying many scalable agroecological practices and principles. This large community was strongly committed to the participatory approaches and the C-K workshops implemented in the WG1, 2 and 4. Participants gained expertise in research practices that are essential for highly-targeted research and for maximizing impact and also bridged the COST action with other EU projects, such as LIFE-PLP-AGROWISE and CSA-FORTUNA
Dimensions of the success	• Building capacity in an existing field of science and technology • Building capacity in bridging separate fields of science and technology • Building capacity in the demographic inclusiveness of networks in science and technology, including representation of newly established research groups, Early-Career Investigators, the under-represented gender and teams from countries/regions with less capacity in the field of the Action

Other matters

This section is confidential to the Management Committee, the Action Rapporteur and the COST Association, and is not included in the version of the report that is published on the COST website.

Difficulties in implementing the Action

If any difficulties were experienced in the implementation of the Action (e.g. imbalances of participation across the Working Groups, inactive country representatives) please describe these below. Please also describe the efforts made by the MC to address these.

The Action chair and vice-chair and the administrative officer met two major difficulties which are shared by other coordinators of COST action.

- 1) The e-Cost platform includes everything, but is neither user-friendly nor logic from a user point of view. Despite a massive userguide, it is difficult to find the right items. This induces massive loss of time for the coordinator, and delays documents submission
- 2) The management of the budget is complex, with the two levels (COST and coordinator) leading to a complex management and the need for frequent validation by the MC after any budget modification (even if the MC allowed the Core Group to decide). In addition, the fact that the budgets are annual is inducing a very boring management. Why such a difference with the EU projects, where a budget over the whole period is providing flexibility

However, to balance these difficulties, I want to stress

- very high efficacy: a lot is achieved with little money. This low-cost activity is possible thanks to the commitment of the Core Group, working for free.
- quality of the Core Group I had the chance to work with, with highly skilled WG leaders and talented vice-chair and grant awarding coordinator.

Suggestions for improvements to COST framework/ procedures

The mandate of the Scientific Committee includes providing advice to the COST Committee of Senior Officials on possible improvements to the COST framework. Please describe below any improvements that you believe should be made to the COST framework.

Sustaining the network beyond the Action

Are there any plans to sustain the network beyond the end of the Action?

YES

Please describe how the network will be sustained beyond the end of the Action.

The topics of the reduction in pesticide load in agriculture is an important topics for many European research organisations. Today, a European Research Alliance has been created. Its name is 'Towards a chemical pesticide-free agriculture'. It gathers 37 public research organisations from 21 European countries. It is the cradle for exploring new topics and coordinates actions of its members in order to propose new topics and to create consortia that are able to address such topics

Emerging topics/ developments in the field of the Action

Please describe any emerging topics or potentially important future developments identified during the Action and that could potentially be addressed by future COST activities such as Actions S&T Conferences or Exploratory Workshops.

- In the cropping systems, there are plenty of individual measures for individual components, but little considering the system level. There are few systems analyses, on the long run, documenting all issues related to all dimensions
- Regulations must be based upon the most recent scientific knowledge. How to make the best use of it, to facilitate transition to production systems which are safe for environment and human health?
- Less active substances (withdrawal and few new approvals), more use of a limited number of pesticides, leads to an increasing rate of pesticide resistance. How to deal with this situation in order to avoid dead-ends for most supply chains? In case of dead-ends, the farmers will stop the considered crops. This leads to loss of crop diversity and loss of ecosystemic services provided by diversity.
- How to document and reduce the large context-dependency of the 'alternative' methods for crop protection ? Or, how can we learn from one situation and disseminate lessons to other contexts?
- How to deal with climate change? It will generate a situation with a different mean and higher variance of extreme events
Climate change will also increase the rate of introduction of new invasive species and modify the equilibrium between pests and predators. Climate change must become a component of the Pest management.

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Annex 1: Types of objectives

1 - Coordination of scientific and technological activities at a European level

- 1.a - Development of a common understanding/definition of the subject matter
- 1.b - Coordination of information seeking, identification, collection and/or data curation
- 1.c - Coordination of experimentation or testing
- 1.d - Comparison and/or performance assessment of a theory, model, methodology, technology or technique
- 1.e - Development of knowledge needing international coordination, pertaining to a new or improved theory, model, methodology, technology or technique
- 1.f - Achievement of a specific tangible output that cannot be achieved without international coordination (e.g. due to practical issues such as database availability, language barriers, availability of infrastructure or know-how, etc.)
- 1.g - Input to stakeholders (e.g. standardization body, policy-makers, regulators, users), excluding commercial applications
- 1.h - Input for future market applications (including cooperation with private enterprises)
- 1.i - Dissemination of research results to the general public
- 1.j - Dissemination of research results to stakeholders (excluding specific input in view of knowledge application)

2 - Community building

- 2.a - Building a community around a topic of scientific and/or socio-economic relevance, allowing for knowledge exchange and the development of a joint research agenda
- 2.b - Building a community around a new or emerging field of research
- 2.c - Bridging separate fields of science/disciplines to achieve breakthroughs that require an interdisciplinary approach
- 2.d - Acting as a stakeholder platform or trans-national practice community, pertaining to a certain area of socio-economical or societal application, or to a certain market sector
- 2.e - Building capacity in the demographic inclusiveness of networks in science and technology, including representation of newly established research groups, Early-Career Investigators, the under-represented gender and teams from countries/regions with less capacity in the field of the Action

Annex 2: Dimensions of successes

1 - Breakthroughs

- 1.a - Scientific breakthrough
- 1.b - Technological breakthrough
- 1.c - Breakthrough in socio-economic or societal applications

2 - Policy contribution

- 2.a - Contribution to regulatory policy
- 2.b - Contribution to environmental, infrastructural or agricultural policy
- 2.c - Contribution to economic or socio-economic policy
- 2.d - Contribution to social, cultural or legal policy

3 - Capacity building

- 3.a - Building capacity in an existing field of science and technology
- 3.b - Building capacity in bridging separate fields of science and technology
- 3.c - Building capacity in a new or emerging field of science and technology
- 3.d - Building capacity in valorising and implementing advances and applications in science and technology
- 3.e - Building capacity in the demographic inclusiveness of networks in science and technology, including representation of newly established research groups, Early-Career Investigators, the under-represented gender and teams from countries/regions with less capacity in the field of the Action

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