EUROPEAN WEED RESEARCH SOCIETY

Proceedings

1st Joint meeting of the EWRS Working Groups

Weed Vegetation and Biodiversity **&** **Biological Control**



Dijon, France | 26-29 October 2026

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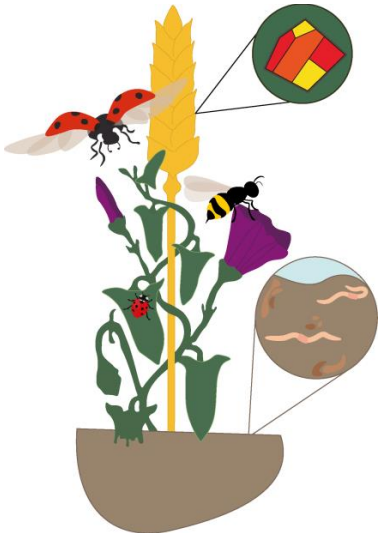
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Session 1: Biodiversity

Tuesday 27 October 2026

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An Ecologist's Perspective on Arable Weed Communities

Guillaume Fried[1]

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Weeds are perceived differently by botanists, ecologists, and weed scientists. For a botanist, a cultivated field is generally a species-poor habitat dominated by common species. Yet arable habitats can also provide opportunities to observe rare plants, either declining archaeophyte segetal species or emerging neophytes. For an ecologist, the presence of these alien species raises questions about the assembly rules governing weed communities and their specialization to arable habitats.

Functional approaches can help us understand how the weed species pool was assembled. By comparing herbaceous species occurring in open habitats across France (n=998) with the French arable weed species pool (n=1383), we showed that weeds differ from non-weeds in their functional strategies: they are mostly therophytes, have higher specific leaf area, flower earlier and for longer, and are more strongly associated with nutrient-rich, sunny and dry environments. Based on these traits, on the related Grime's CSR strategies and on the current distribution of weeds outside cultivated fields, we can identify potential primary habitats from which weeds may have colonized arable fields since the Neolithic, including dry grasslands, screes and rocky habitats, riverbanks, and woodland edges and fringes.

Another group arrived directly in agricultural fields, already pre-adapted to arable conditions: archaeophytes, including many segetal species, and some neophytes. These species had already been filtered by arable habitats in their regions of origin, but they also had to pass a second filter during translocation, for example by surviving as contaminants of crop seeds. As a result, we showed that archaeophyte and neophyte weeds tend to be more specialized to arable habitats than native weeds and have an even higher proportion of therophytes. These three groups also occupy partly distinct ecological and functional niches, reflecting different ecological and evolutionary histories.

Ecologists have also proposed frameworks to understand how weeds affect agroecosystem functioning, not only through crop yield but also through interactions with other trophic levels, including pollinators, birds, and natural enemies. The perspective of weed scientists has therefore shifted from simply asking how weeds can be controlled to asking whether, and how, weed communities can be managed towards neutral or beneficial communities.

According to coexistence theory, weeds that are functionally similar to the crop are expected to compete most strongly with it. Moreover, intensive and repetitive management may select for crop-mimicking weeds, as predicted by Vavilovian mimicry. We indeed found evidence for this pattern, with weed communities becoming increasingly specialized towards maize, oilseed rape, and sunflower under intensive management, although the pattern was less clear for wheat. Conversely, the Resource Pool Diversity Hypothesis proposes that diversified practices, such as crop rotation, organic amendments, and diverse cover crops, increase the diversity and heterogeneity of resource pools, thereby promoting resource partitioning and reducing competitive overlap. Together, these mechanisms suggest that management diversification could favour weed communities with greater taxonomic and functional richness while limiting the abundance of highly competitive species.

A good example of this process is provided by the effects of different cropping systems and management practices on the floral traits of weeds and, consequently, their potential contribution to pollinators. Agricultural practices can trigger a cascade of effects, from changes in management intensity to changes in weed community composition and ultimately in the functional resources available to pollinators. Our results, based on large-scale spatial and temporal surveys, show that this cascade differs strongly between cropping systems: vineyards supported weed communities with more favourable floral traits for pollinators than annual crops. In annual crops, a higher frequency of herbicide use was associated with reduced floral resources, whereas in vineyards, practices such as tillage and mowing were associated with the maintenance of greater floral diversity. These contrasting effects illustrate how management practices can filter weed communities differently depending on the cropping system and management intensity, with consequences for the quantity and diversity of floral resources available to pollinators in agricultural landscapes. Over the long term, this was reflected in contrasting trajectories, with a decline in floral functional diversity in annual crops since the 1970s, but an improvement in vineyards since the 1980s.

Ultimately, the perspectives of botanists, ecologists, and weed scientists can come together around the concept of "neutral" or potentially "beneficial" weed communities. What botanists may value as diverse and rare flora, ecologists may interpret as functionally complementary communities with low impacts on crops and high value for other trophic levels, while weed scientists may see an opportunity to reconcile weed management for biodiversity with crop production.

Acknowledgements: I would like to thank EWRS and INRAE for covering my travel expenses, as well as the organizing team, Bruno Chauvel and Delphine Moreau. I would also like to thank Professor Elena Kazakou and the many students we have co-supervised together over the past decade. This work is a product of the FELLOW research project funded by OFB and the French Foundation for Research on Biodiversity (FRB) through its Centre for Synthesis and Analysis of Biodiversity data (CESAB). ChatGPT was used for linguistic correction.

Weed species composition in seed-producing annual clover *(Trifolium)* and vetch *(Vicia)* fields in north-west Hungary

Gyula Pinke[1], Richárd Réder[1], Zsolt Giczi[1], Bálint Czúcz[2], Zoltán Botta-Dukát[3], Ákos Bede-Fazekas[3]

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There is an increasing demand for legumes in European cropping systems as they provide versatile ecosystem services. One of the main reasons for the popularity of annual small-seeded legumes as cover crops is their excellent weed-suppression ability; however, the weed vegetation of their seed-producing fields has not been studied to date. In this study, we compared the influence of various factors on the weed species composition in seed-producing annual clover (*Trifolium incarnatum*, *T. alexandrinum*, *T. resupinatum*) and vetch (*Vicia pannonica*, *V. sativa*, *V. villosa*, *V. benghalensis*) fields, in north-west Hungary, in one of the focal regions of clover and vetch seed production in Europe. We surveyed weed vegetation in 290 fields and collected 29 background variables, between 2023 and 2025, during the seasonal peak of annual legume crops, from the end of April to the end of June each year. We applied redundancy analysis (RDA) to estimate multivariate species responses and variation partitioning to compare the relative importance of different groups of variables. Variation partitioning demonstrated the huge dominance of management, particularly cultural practices, on weed vegetation. Among the individual variables, the effect of crop species, correlated with sowing season (autumn/spring), was by far the most influential. The net effects of five further cultural practices (preceding crop, farming type [organic/conventional], tillage system & depth and organic manure), the imazamox herbicide (applied in autumn or spring), and nine environmental factors, including two climatic (temperature, precipitation) and five soil variables (pH, texture, K, Mg, and Na content), were also significant. Our research highlighted that crop-related factors, especially the sowing season, are key drivers of weed community organization in clover and vetch fields. In the surveyed, extensively and organically managed legume fields, we found seven red-listed (*Agrostemma githago*, *Anthemis cotula*, *Bifora radians*, *Herniaria hirsuta*, *Neslia paniculata*, *Papaver argemone*, *Medicago polymorpha*) and three further rare (*Caucalis platycarpos*, *Chrysanthemum segetum*, *Sherardia arvensis*) weed species. Low-input seed-producing annual legume fields can be potential sites for conserving arable biodiversity.

Session 1: Biodiversity | Tuesday 27 October, 10h30-10h55 **ORAL P2**

Weed diversity in two contrasting regions of Germany

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Up to now, there is no systematic monitoring focusing on biodiversity in arable landscapes in Germany. Within the German MonViA project (https://www.agrarmonitoring-monvia.de/en/), a broad set of monitoring schemes covering different taxa were therefore developed. As part of MonViA, we developed a concept for a nationwide, long-term monitoring programme for arable weed diversity. As a proof of concept and to further refine the monitoring scheme, we conducted a pilot study in two contrasting regions in Germany. The eastern part of Lower Saxony is shaped by favourable conditions: high-quality soils and sufficient precipitation allow for intensive arable production. In contrast, the western part of Brandenburg is dominated by sandy soils and low precipitation level. In these two regions, we collected weed diversity data from 70 fields in 2022 and 2023 using two transects walks (100m * 1m) in each field, one at the field edge and one in the centre. Plant taxa were identified to species level whenever possible, and their abundance was estimated using the extended Londo-scale. Our results show a higher arable weed diversity in Brandenburg in comparison to Lower-Saxony. In both regions, the diversity did not change between both years. The higher diversity in Brandenburg might be a result of less intense management under less favourable cropping conditions. However, the crop diversity was higher in Brandenburg, potentially explaining the observed difference in weed diversity, as specific crops favour specific weed species. Our pilot study shows that the developed weed monitoring approach is capable of describing the weed diversity in different regions. We could only test parts of the monitoring approach, as the nationwide field selection and its implementation over several years could not yet be implemented. If a permanent monitoring scheme is to be established, a pilot phase is needed to test the developed approach for the nation-wide field selection.

Arable plant diversity and functional trait richness in field edges respond to farming system but the functional composition of the dominant community remains unchanged

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Functional diversity captures the ecological roles plants fulfill in both service provision, such as pollination, and disservices, such as crop competition, and is considered a better predictor of ecosystem functioning than species richness alone. Yet, how management shapes the functional composition of field edge communities remains poorly understood. In this study, we combine citizen science survey data with crop rotation history and soil information from national databases to examine how agronomic management influences the functional profile of arable plant communities in field edges using Hierarchical Modelling of Species Communities (HMSC).

Community data were drawn from a citizen science survey in which volunteer botanists recorded vascular plant taxa and their abundance along standardised 100 × 1 m transects in the outermost cultivated meter of field edges. These were linked to crop rotation data from the Swedish Board of Agriculture's Arable Field Database and soil characteristics from the National Soil Type Mapping. Functional trait data were sourced primarily from Tyler et al. (Ecological Indicators, 120:2021), supplemented with specific leaf area values from the TRY database (Kattge et al., Global Change Biology 26:1, 2020, p.119-188). Taxonomic and functional diversity were quantified using Hill numbers at orders q = 0, 1 and 2, and an HMSC hurdle model was fitted to 254 sites and 69 species.

Organic management significantly increased species and functional richness (q = 0), but this gain did not extend to common or dominant species diversity (q = 1 and q = 2). Beta parameters showed that most species were more likely to be present under organic management but did not grow more abundant. Soil characteristics were the strongest predictor of species presence, while unexplained site-level variation dominated the abundance model. Gamma parameters revealed that organic management promoted nectar-producing species but reduced mycorrhizal associations in both presence and abundance. These results indicate that organic management increases the presence of species with service-associated traits, but the dominant functional composition remains unchanged, suggesting that strong environmental filters constrain functional community assembly regardless of farming system.

Session 1: Biodiversity | Tuesday 27 October, 11h55-12h20 **ORAL P4**

Weed community responses to diversified, pesticide-free cropping systems contrasting in tillage and fertilisation

Guillaume Adeux[1], Emeline Felten[1], Anna Busset[1], Hugues Busset[1], Elodie Vouaux[1], Brice Mosa[2], Violaine Deytieux[2], Pascal Marget[2], Samuel Pouget[1], Stéphane Cordeau[1]

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Pesticide-free agroecological cropping systems rely on diversified crop rotations and non-chemical practices to regulate weeds, yet the long-term consequences of banning herbicides on weed communities remain poorly documented, especially across contrasted tillage strategies. We characterised weed communities in the four experimental pesticide-free cropping systems of the CA-SYS platform (INRAE, Dijon, France; 125 ha, 42 fields, established in 2018), which combine a diversified rotation with contrasted soil tillage intensities and levels of exogenous nitrogen fertilisation: two tillage-based systems with (TS1) or without (TS2) mineral nitrogen, a permanent no-till system (SD1), and a minimum-tillage system (SD2). Weeds were assessed annually through visual density estimates, weed and crop aboveground biomass at flowering, and the germinable soil seedbank. The seedbank was sampled each year at the end of winter (20 auger cores per field) and quantified by a manual washing (wet-sieving) method, followed by seedling emergence in a greenhouse over about six months and identification.

The seedbank increased roughly ten-fold between 2018 and 2024, reaching about 10,000 seeds m^{-2}, with only limited differences among systems (slightly higher densities in SD2). Species richness rose markedly over the same period (+200–300%), and Hill diversity likewise increased in every system, more strongly under direct sowing (+3–5 species-equivalents) than under tillage (+1–2).

Community composition diverged among systems, mainly separating SD1 from the others, with grasses and Asteraceae associated with direct sowing and creeping thistle (*Cirsium arvense*) associated with SD2 and TS2. Weed biomass at flowering increased in the reduced- and no-till systems until an occasional ploughing in 2023, and was negatively related to crop biomass, particularly under direct sowing. Withholding nitrogen (TS2) did not consistently reduce weed pressure relative to TS1.

Overall, removing herbicides while diversifying rotations allowed weed diversity to recover but drove a substantial build-up of the seedbank and rising weed pressure, most acutely under reduced tillage. These findings expose a central trade-off between restoring weed-mediated biodiversity and containing yield-limiting infestations, and motivate ongoing work quantifying the yield losses attributable to specific weed species or functional groups.

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Harnessing hemiparasitic plants for grass biocontrol and biodiversity-oriented cover crop management

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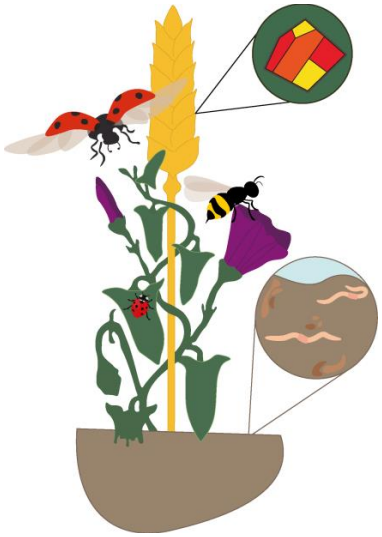
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Perennial cover crops in vineyards and fruit orchards can provide soil protection, erosion control and biodiversity benefits. However, when dominated by vigorous grasses, they may increase competition for water and nutrients, create humid microclimates requiring frequent mowing, and provide limited floral resources for pollinators and natural enemies. The BIOPAR project explores a novel agroecological concept: using the native annual hemiparasite hairy yellow-rattle (*Rhinanthus alectorolophus*) for hemiparasite-mediated biocontrol of grass dominance while promoting more diverse and functional vegetation in perennial crops.

The project combines three complementary approaches. First, a 1,500 m^2 field experiment in Lullier, Geneva, tests eight sowing compositions combining yellow-rattle, service plants and spontaneous vegetation, with repeated floristic, functional and agronomic assessments. Second, controlled-environment experiments quantify germination and host-parasite interactions across three seed origins, five grass hosts (*Arrhenatherum elatius, Bromus tectorum, Elymus repens, Lolium perenne* and *Poa pratensis*) and two fertilisation regimes. Third, field prospecting in Switzerland documents and collects local ecotypes of *Rhinanthus alectorolophus, R. minor* and other native hemiparasites for future applications. Controlled-environment experiments showed a strong suppressive effect of yellow-rattle on all five grass hosts, with significantly reduced final host biomass (parasite effect: $p < 0.0001$). Despite the strong effect of fertilisation on host productivity, yellow-rattle reduced host biomass across all species under both fertilisation regimes. Establishment emerged as a major practical constraint: germination differed markedly among seed origins, ranging from complete failure in one commercial seed lot to 45.6% in seeds collected from a local population. Consequently, low yellow-rattle establishment prevented a robust test of the ecological-engineering hypothesis in the 2026 field experiment. In contrast, observations of a naturally established population at Lullier revealed negative relationships between yellow-rattle abundance and both grass cover and total above-ground biomass, consistent with the experimentally demonstrated suppression of grasses.

Together, these results support the potential of native hemiparasitic plants as low-input tools for regulating grass dominance in perennial crop covers, while highlighting seed quality, provenance and establishment as critical determinants of success. The project provides a biological proof of concept and a framework for developing more diverse, functional and manageable vegetation in vineyards and fruit orchards.

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Session 2: Agroecology

Tuesday 27 October 2026

Chairs: Philip Weyl & Guillaume Adeux

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Can strip cropping diversify the arable flora and arthropod predator communities and promote arthropod-mediated ecosystem services?

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Intensive agriculture is characterised by large fields of few crops grown in monocultures that are susceptible to pest outbreaks and rely on synthetic pesticides to maximise crop production. While such systems have been successful in achieving high crop yields, increasing environmental and health concerns and developing herbicide and insecticide resistance force us to transition to alternative cropping systems that foster biodiversity and associated ecosystem services. Strip cropping is a form of intercropping where two or more crops are grown side-by-side in alternating, wide strips. Through increasing crop diversity, and heterogeneity of resources, microclimates and crop management on a single field, strip cropping increases insect and weed biodiversity and may so counteract the negative effects of industrialised agriculture without decreasing crop productivity. The project StripES in Sweden is investigating how strip cropping winter oilseed rape, winter wheat and spring faba bean affects arable flora and arthropod predator communities and associated ecosystem services such as weed seed and dummy larvae predation rates, and crop yield compared to larger sole crop reference fields. Measurements were taken during three sampling rounds, differing in crop and arable flora phenology, alternative prey abundance, and compared between strip edges, strip centres and larger sole crop plots. Preliminary results indicate that weed species and carabid beetle species communities, and predation rates differ among crops leading to higher species richness in strips compared to sole crop fields.

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First results of spontaneous and planted soil cover in nectarines for thrips control

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Injuries caused by thrips in nectarines in north-eastern Spain are increasing because of the replacement of *Frankliniella occidentalis* by the secondary species *Thrips fuscipennis,* whose habits are not yet well-known. With the aim of studying the presence of thrips in weed flowers and planted flowers, field trials have been initiated maintaining the spontaneous vegetation in the interrows as untouched as possible and planting flowers under the tree rows to facilitate thrips living on the soil cover. Two commercial nectarine plantations, 1 and 3 years old (plot 1 and plot 2), were selected for the trials and interrows disturbed as seldom as possible. Soil cover by spontaneous vegetation was assessed in spring and summer 2025 and 2026 in three interrows of 200 meters each by recording the cover of each single plant species as well as the total cover. Additionally, in spring 2026 three flower species (*Calendula officinalis, Tagetes patula* and *Borago officinalis*) were planted in the tree lines in 8-meter blocks, inserting 20 meters between one flower block and the next one. Four replicates of each species were established. Thrips were counted in May and June 2026 in the flower blocks and in the tree branches. Both years and in both plantations spontaneous plant soil cover in the interrow decreased from spring to summer, in plot 1 from 9 to 6% and from 78 to 47% in spring and summer 2025 and spring and summer 2026, respectively, and in plot 2 from 94 to 40% and from 95 to 50%. Main flowering weed species were *Anacyclus clavatus* and *Malva neglecta* in plots 1 and 2, respectively, but the flower cover decreased in summer, when the nectarine fruits are susceptible to thrips, and when the cover should serve as insect habitat. The lack of synchronisation of the flowering of the weeds and the presence of the thrips confirms the interest to artificially increase flower supply in the tree line to extend the flowering period. *C. officinalis* and *T. patula* were able to flower during the summer period until nectarine harvest while *B. officinalis* remained in vegetative stage. *F. occidentalis* was abundantly found in *C. officinalis* and less in *T. patula* and *B. officinalis*, while *T. fuscipennis* preferred living on the trees. The biological habits of this new species need to be confirmed with other trials to establish the appropriate control strategy.

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Advances in the reduction of herbicide use in Conservation Agriculture: French case studies

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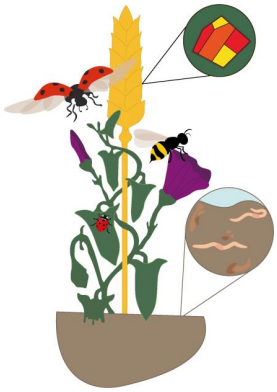
Reducing herbicide reliance is a key challenge for Conservation Agriculture (CA), since excluding tillage removes one of the main levers traditionally used for integrated weed management (IWM). This work synthesises 17 years of French experimental data gathered by INRAE across long-term cropping-system trials, strategic tillage experiments, a multicriteria farm-network assessment, and a pesticide-free CA platform, aiming to quantify CA performance in terms of weed management, crop performance, and economic outcomes. A long-term cropping-system experiment (2000–2017, Burgundy) compared a standard reference system (S1, herbicide-based), an IWM system transitioning towards CA (S2), and a tillage-based IWM system (S4). Over 17 years, S2 reduced total herbicide use by only 9% relative to S1, half of applications being glyphosate-based, mainly used to terminate cover crops and crop volunteers before sowing. In contrast, S4 achieved a 64% reduction through crop diversification, occasional ploughing, mechanical weeding, delayed sowing and false seedbed techniques. Weed pressure remained controllable and weed-induced yield losses negligible in all systems, although S2 profitability was lower than the reference.

A strategic tillage experiment conducted after 17 years of no-till within S2 showed that a single occasional ploughing or superficial tillage operation significantly increased weed density and species richness compared with continued no-till, mainly by disturbing the weed seedbank concentrated in the topsoil. Reduced tillage also improved wheat yield and gross margin relative to no-till, without a clear economic advantage from full ploughing.

At a wider scale, a multicriteria comparison of 36 CA and 19 pseudo-CA farms from the French DEPHY network, benchmarked against conventional and superficial-tillage systems, showed that CA reduced fuel consumption, traction time and mechanization costs, but relied more heavily on herbicides overall.

Finally, the CA-SYS platform, testing fully pesticide-free no-till and reduced-tillage pathways since 2018, revealed persistent agronomic deadlocks related to weeds, slugs and crop volunteers, prompting a step-by-step redesign incorporating strip-tillage to reconcile weed-free crop establishment with minimal soil disturbance.

Acknowledgements: the ANR SPECIFICS project (ANR-20-PCPA-0008), the ANR BeCreative project (ANR-20-PCPA-0001), the European Horizon 2020 Adopt-IPM and IWM PRAISE, the French ministries for agriculture and environment and the Agence Française de la Biodiversité (DEPHY Expe II project ABC “Agroécologie en Bourgogne et Région Centre”), the Casdar projects RAID (Biological control of weeds) and Vancouver (Weeds management with cover crop), the French “Investissements d’Avenir” program and the project ISITE-BFC (contract ANR-15-IDEX-03), the Ecophyto COSTRAA project funded by OFB (Office Français de la Biodiversité), the INRAE SumCrop ASPECT project, and the COPRAA project which was supported by OFB as part of the Ecophyto call on "Global approaches to limit the use of phytopharmaceuticals: Combining preventive and curative products in sectors, from farmers to consumers" launched by the French Ministries in charge of Ecology, Agriculture, Health and Research.



Posters

Flash poster presentations: Tuesday 27 October, 15h30-16h00
Poster session 1: Tuesday 27 October, 16h30-17h00 (Dommergues hall)
Poster session 2: Wednesday 28 October, 11h10-11h40 (Dommergues hall)

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From Deadlock to Redesign: Five Years of Pesticide-Free Conservation Agriculture on the CA-SYS Platform

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The CA-SYS platform, launched in 2018 near Dijon, France, tests biodiversity-based, pesticide-free agricultural systems across 125 ha divided into 42 fields surrounded by ecological infrastructure. The platform explores ecological intensification—integrating biodiversity's ecosystem services into crop production—as an alternative to conventional farming, aiming for profitable yields while minimizing environmental harm.

Two conservation agriculture (CA) pathways were tested: SD1, a no-till system relying on permanent soil cover, and SD2, allowing occasional superficial tillage. Both used six-year diversified rotations, targeted fertilization, and selective irrigation, entirely excluding pesticides, including organic-approved bio-products.

The 2018–2023 phase revealed major agronomic challenges. Weed management proved especially difficult without tillage or herbicides: weed communities shifted toward Asteraceae, grasses, and perennials, while pests like slugs and voles caused unpredictable damage. Crop volunteers were hard to control during fallow periods, and climate-driven dry summers limited cover crop establishment—counterintuitively, irrigation sometimes increased weed biomass rather than suppressing it. In SD2, superficial tillage failed to fully terminate cover crops and appeared to favor persistent weeds like *Cirsium arvense*, requiring alfalfa insertion in most fields to manage it.

These compounding difficulties led researchers to conclude both systems had reached an "agronomic deadlock." Rather than abandoning the initial de novo design approach (which implemented abrupt, expert-designed prototypes without gradual transition), the team adopted a step-by-step redesign process. New targets were set: SD1 to maximize biological pest regulation with minimal tillage and economic viability through ecosystem service payments; SD2 to combine biological and mechanical pest control with shallow, if more frequent, tillage, relying mainly on product sales for profitability. Strip-tillage and targeted biocontrol against slugs were introduced in SD1 to improve crop establishment.

The overarching lesson: transitioning to pesticide-free conservation agriculture requires iterative, flexible learning rather than a fixed, one-time design—prioritizing the ecosystem services CA delivers over rigid adherence to specific practices.

Acknowledgements: French "Priority Research Program Alternative Crop Production and Protection", the ANR SPECIFICS project (ANR-20-PCPA-0008), the ANR BeCreative project (ANR-20-PCPA-0001), the European Horizon 2020 Adopt-IPM and IWM PRAISE, the French ministries for agriculture and environment and the Agence Française de la Biodiversité (DEPHY Expe II project ABC "Agroécologie en Bourgogne et Région Centre"), the Casdar projects RAID (Biological control of weeds) and Vancouver (Weeds management with cover crop), the French "Investissements d'Avenir" program and the project ISITE-BFC (contract ANR-15-IDEX-03), the Ecophyto COSTRAA project funded by OFB (Office Français de la Biodiversité), the INRAE SumCrop ASPECT project, PARAD under the PARSADA program and the COPRAA project which was supported by OFB as part of the Ecophyto call on "Global approaches to limit the use of phytopharmaceuticals: Combining preventive and curative products in sectors, from farmers to consumers" launched by the French Ministries in charge of Ecology, Agriculture, Health and Research.

Fabaceae Weeds in Annual Crops of Bourgogne-Franche-Comté

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Fabaceae weeds play a dual role in agroecosystems. They can benefit crops through their ability to fix atmospheric nitrogen, fertilizing the soil, and by attracting and supporting pollinators. However, they also represent a challenge for farmers by increasing the time needed for harvesting and seed sorting, and by potentially being hosts for various bio-aggressors. The aim of this study was to answer three questions: i) What role do Fabaceae play in the weed flora of agro-ecosystems? ii) To what extent do weedy Fabaceae provide benefits or cause harm to crops? iii) What is the impact of cultivation practices on weeds, particularly those in the Fabaceae family?

Flora surveys were carried out in winter wheat crops in Bourgogne-Franche-Comté across a network of 58 plots belonging to different farmers at four different times during 2024, from February to August. The study of the total weed flora was conducted over an area of 2,000 m² (50 x 40 m). For each species observed, density was estimated using the Barralis scale, and the predominant growth stage for a given species was also recorded.

During the February survey, the number of weed species observed (90 in total) on the plots was low, with an average species richness of 8 species per plot. During the second survey in March, the community was more diverse, with 14 species per plot. During the May–June survey, a total of 137 species was observed.

Among the Fabaceae observed, the majority are regrowth of cultivated species. So-called ‘wild’ species are mainly found along the edges. Of the 26 Fabaceae species observed, 15 are annuals, but the most common species are perennials, such as *Lathyrus tuberosus*. A greater number of Fabaceae were found in the organically farmed plots, suggesting effective management of weedy Fabaceae using herbicides.

While integrating Fabaceae weeds into agroecological systems presents significant challenges, their capacity to reduce reliance on chemical inputs—such as herbicides and fertilizers—makes them a valuable opportunity. However, their long-term persistence requires careful considerations.

Acknowledgements: INRAE UMR Agroécologie, Farmers of the network

Ecologically informed filtering of weed communities through species-selective spot spraying: a simulation-based proof of concept

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Weed communities are multifunctional components of agroecosystems, simultaneously generating agronomic challenges but also influencing ecological processes. Importantly, weed species differ in both their agronomic impact and their potential ecological contribution, however, conventional weed control continues to treat detected weeds as equivalent targets. Precision spraying offers an opportunity to move beyond this uniform approach by using information on individual plants to determine not only where to spray, but also which weeds should be treated. Here, we explored whether species-selective spot spraying could act as a management filter on weed communities by suppressing species associated with greater agronomic risk while retaining selected components of in-field plant diversity. High-resolution RGB images were collected during the 2025 growing season in oat, sugar beet and wheat in Denmark. Crop and weed plants were identified using a hierarchical deep-learning model that generated taxonomic labels and bounding boxes at the highest achievable classification level. Plant detections were processed through a simulator calibrated to the geometry and actuation behaviour of a field-deployed spot sprayer. The simulator translated plant-level decisions into nozzle activations while accounting for spray footprint, plant overlap and conflicts between target and protected plants. Three spraying strategies were applied to the same image detections: non-selective spot spraying, a generic rule-based strategy based mainly on plant size and spatial context, and a crop-specific species-selective strategy in which competitive taxa were prioritised for treatment, while selected low-risk or potentially beneficial taxa could be retained depending on their identity, size and local density. The simulated residual community was defined as the weed detections not reached by the spray, including preserved plants, vetoed targets and targets missed because of actuation constraints. The species-selective strategy preserved 3.8% of weed detections, compared with 0% under non-selective spraying and 1.7% under the generic strategy. Of the detections preserved under the species-selective strategy, 87.7% belonged to the groups intentionally selected for retention, indicating that non-treatment was taxonomically structured rather than random. At the same time, 98.2% of competitive weed detections were assigned to treatment. This selectivity involved an operational trade-off: the veto rate increased to 5.4% because protection of selected plants prevented treatment of some neighbouring targets. Simulated post-treatment communities were further compared across strategies to assess changes in weed richness, diversity and composition. These findings show the potential of species-selective spraying to actively shape weed communities. The next challenge is to strengthen the ecological basis of these decisions by linking species-specific competitive ability and potential ecosystem-service provision to management rules, helping to identify which species, densities and spatial configurations can be tolerated without compromising crop production.

Acknowledgements: This work was supported by Innovation Fund Denmark [grant number 2105-00033B - AGRIVOLT - Integrating Green Energy and Food production in a dynamic AgriPhotoVoltaic system].

From wild populations to agroecological allies: seed source and establishment of *Rhinanthus alectorolophus* for grass biocontrol

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Wild plant populations may represent valuable sources of functional diversity for agroecological innovation. The BIOPAR project investigates whether the native annual hemiparasite *Rhinanthus alectorolophus* can be harnessed to suppress dominant grasses and promote more diverse cover crops in vineyards and fruit orchards. Turning this ecological function into an agronomic tool, however, requires reliable establishment and suitable plant material.

We compared three seed sources of *R. alectorolophus* in complementary germination and establishment experiments. After 13 weeks at 2 °C in darkness, germination in Petri dishes reached 91% for a locally collected population, 46% for one commercial seed lot and 0% for another. The same ranking occurred in a substrate experiment (45.6%, 30.4% and 0%, respectively), while poor establishment also constrained the first field experiment.

These results identify seed source and establishment as critical factors for developing reliable hemiparasite-mediated grass biocontrol. They motivated surveys and seed collection from wild populations of *R. alectorolophus, R. minor* and other native hemiparasites across western Switzerland, providing material for future comparative experiments. Although current results cannot distinguish genetic differences from seed production, storage or lot-quality effects, they support a broader perspective: wild plant populations may provide new functional allies for agroecological vegetation management.

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Sown and spontaneous perennial cover crops in French viticulture and orchard systems: which expected services and management?

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Perennial cropping systems are characterized by wide interrows, enabling sown or spontaneous cover crops to grow. Such systems therefore have high potential to integrate perennial cover crops, which can provide key ecosystem services related to soil quality and weed regulation. In orchard systems, spontaneous perennial cover cropping is widespread, but its management and expected services have not been studied in France. In viticulture, spontaneous cover crops are usually destroyed to avoid competition with vines. Yet, little is known about perennial cover cropping in viticulture and its management. To better understand the current use and management of perennial cover crops, we surveyed 60 winegrowers and 76 fruit growers currently implementing spontaneous or sown perennial cover crops. We explored management practices and farmers' perceptions of weed regulation across agricultural sectors. Weed control was not a major expected service: only 22% of winegrowers and 17% of fruit growers reported it. The three main expected services were similar in both sectors: reducing soil erosion, increasing biodiversity, and increasing soil fertility. Nevertheless, on a scale from −3 to +3, winegrowers and fruit growers scored weed control +0.8 and +0.9 on average, respectively. Around one third of winegrowers and fruit growers sowed their perennial cover crops, while two thirds were naturally occurring. Winegrowers mostly located perennial cover crops in the interrows (77%), whereas fruit growers implemented them both in rows and interrows (72%). Perennial living mulches were mainly managed through mowing, used by 92% of winegrowers and 90% of fruit growers. Roller crimping was used by 21% of winegrowers but was absent in orchard systems. Grazing was also used in both sectors to control living mulch, by 19% of fruit growers and 11% of winegrowers. Overall, 92% of winegrowers and 90% of fruit growers reported being willing to recommend perennial cover cropping to another farmer. Despite differences in crop systems, this study revealed quite similar management practices and expected ecosystem services in viticulture and orchard systems, suggesting that perennial cover crops may have a common role in supporting soil quality and biodiversity in perennial cropping systems.

Acknowledgements: PARAD

Perennial cover crops in French annual cropping systems: farmers' practices, perceptions and perspectives

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Integrated weed management relies on enhancing weed biological regulation in cropping systems. Perennial cover crops are pluriannual living mulches grown simultaneously with cash crops. Their longer presence within fields and their proximity to cash crops can enhance weed regulation over time through multiple mechanisms, including the inhibition of weed seed germination and emergence through shading, competition for light and belowground resources, and allelopathy. Yet, efficient management of these perennial structures is crucial to prevent them from competing with crops and reducing crop yields. In 2016, a first study explored how perennial living mulches were managed and introduced into annual cropping systems in France. Ten years later, we surveyed 49 French farmers who currently implement perennial cover crops in annual cropping systems and explored how management practices and farmers' perceptions of weed regulation have evolved since then. Weed suppression was among the top three services expected by farmers from perennial cover cropping, along with improved soil structure and fertility. Compared with the 2016 survey, farmers sowed more permanent cover crops as species mixtures (59% of farmers in 2026 compared with 15% in 2016), increased the duration of perennial cover crops within fields (3 to 5 years on average in 2026 compared with 1.5 to 2.5 years in 2016), and diversified the crops associated with these agroecological structures. Two main types of management strategies were employed by farmers, each accounting for approximately half of the sample. The first group had long-lasting perennial cover crops (3 to 5 years) and mainly used mechanical weeding to manage them (*e.g.* hoeing, roller crimping). The second group had short-lasting living mulches (1 to 2 years) and mainly used herbicides.

Interestingly, 70% of farmers using mechanical control of living mulch reported that living mulch reduced weed pressure, compared with only 23% of farmers relying mainly on herbicides. Overall, 88% of farmers reported being willing to recommend this practice to another farmer. Farmers also identified key research priorities for wider adoption of perennial cover crops, including cover crop breeding, improved crop–cover crop complementarity, and the forage potential of cover crops, highlighting promising avenues for future research.

Acknowledgements: PARAD

Elutriation as a tool for weed seed bank extraction: practical experience with an automated washing device

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In highly disturbed cropping systems, where most weeds are annual, characterising the seed bank helps anticipate weed pressure and investigate how weed communities respond to cropping systems over the long term, informing the design of more sustainable systems. Obtaining this estimate remains labour-intensive, which limits the deployment of large-scale seed bank studies.

Soil samples are too voluminous for direct germination: small weed seeds need a thin, even layer to emerge, so sample volume must first be reduced. Moreover, direct germination implies keeping the soil constantly wet to allow weed seed germination, which rapidly favours algae and mould. Samples are therefore washed to concentrate the seed fraction, then identified directly under a binocular microscope or after germination. Washing is tedious when done manually and can instead be performed with an elutriator. We report practical experience with such a device: samples are placed in fine-mesh cartridges, 36 of which load into a rotating drum, where nozzles spray high-pressure water onto the rotating samples, which also bathe in water pooling at the base. A full washing cycle takes about 20 minutes. While the elutriator removes much of the physical burden of manual washing, total processing time is not reduced proportionally, since loading and unloading numerous cartridges remains time-consuming. Cartridge mesh size must be chosen carefully, especially when different statistical units are washed together, to avoid cross-contamination or losing small seeds through overly coarse mesh. The equipment represents a substantial investment (around €30,000).

Elutriation improves the ergonomics of seed extraction, but does not eliminate the time cost of handling large sample batches; its benefits depend on batch size, cartridge mesh selection, and the range of seed sizes targeted. These trade-offs matter when weighing the investment against manual washing. More broadly, no certified (e.g. ISO) procedure exists for seed bank assessments, and the washing method used — elutriation or otherwise — is just one of several steps whose effect on the estimate remains poorly understood. Looking ahead, direct analysis methods — AI-based image analysis of washed samples, or soil tomography — could offer a more complete picture of the seed bank than current extraction techniques.

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Breaking the bank: weed seed decay in soil seed banks as a regulator of population and community dynamics

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Weed seed banks are the primary source of future infestations in arable systems, and their long-term regulation depends on the balance between seed inputs and losses. While seed predation by invertebrates and vertebrates is comparatively well studied as a biological control mechanism, microbial decay (the breakdown of buried seeds by soil pathogens) remains poorly characterised. This is largely because standard assessment methods (germination testing, tetrazolium staining, crush testing) cannot distinguish microbial decay from natural seed ageing. This PhD project positions microbial seed decay as an underexplored preventative ecosystem service and develops an epidemiological framework. The framework treats decay as the outcome of interactions between host (seed), agent (soil microbiome) and environment (soil and management). A survey of weed seed bank composition and abundance was performed across 96 fields on 48 farms in Denmark which provides a baseline for how seed banks vary under contrasting field management. A controlled greenhouse experiment then tests whether seed density during soil conditioning drives microbial decay pressure, pairing traditional tetrazolium/crush classification with metabolomics and shotgun metagenomics to develop a molecular assay capable of registering microbial decay directly. A planned extension asks whether the taxonomic diversity of seeds present in the soil shifts decay agents toward generalist or specialist strategies, linking seed bank biodiversity directly to decay dynamics. The validated assay is then applied across the management contrasts of Rothamsted's Large-Scale Rotation Experiment, tillage, nutrition and crop protection regime, to test whether cropping system design shapes a soil's capacity to suppress weed seeds through microbial decay.

Together, these studies aim to establish microbial decay as a measurable, management-responsive complement to existing biological control mechanisms in weed seed bank regulation, bridging the interests of both working groups, and to provide a transferable molecular toolkit for assessing it.

Nitrogen competition as ecological mechanisms for weed regulation in cereal-legume intercrops

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Weeds cause damage to crop production and weed control relies largely on herbicides.

Species mixtures can contribute to reducing herbicide use by increasing biological weed regulation. This study focuses on cereal-legume intercrops simulated with FlorSys, a multispecies 3D individual-based model useful to explore biological interactions in mixtures and to assess the many possible intercropping scenarios under nitrogen competition. The aim was to evaluate how nitrogen availability changed legume–cereal–weed interactions, long-term weed dynamics and their impact on crop production.

The simulated scenarios included four cereal–legume species mixtures: wheat (*Triticum aestivum* L.)–faba bean (*Vicia faba* L.), barley (*Hordeum vulgare* L.)–pea (*Pisum sativum* L.), triticale (*Triticosecale*)–faba bean, durum wheat (*Triticum durum* Desf.)–faba bean, with seven species proportions or nine spatial sowing patterns. The mixtures were compared to their corresponding sole crops (controls) with either non-limiting nitrogen availability, or without nitrogen fertilizer. The mixtures (or their controls) were included into rotations simulated with and without weeds, over 30 years and repeated with 10 climate scenarios using weather records from South-Western France.

The results showed that plant-plant interactions greatly changed with soil nitrogen availability. When nitrogen was non-limiting, plants competed only for light and then intercropping: (1) reduced yields more in legumes than in cereals compared to sole crops, and (2) reduced weed biomass and yield losses caused by weeds in legumes compared to sole crops. Without N-fertilizer, plants competed for both light and nitrogen and then: (1) legume yields increased and cereal yields decreased compared to non-limiting nitrogen conditions, (2) intercropping did not affect legume yields compared to sole crops, and (3) intercropping reduced yield losses caused by weeds even more than with non-limiting nitrogen availability.

Nitrogen competition emerges as a key mechanism influencing crop-weed interactions, in addition to spatial design.

Two decades of weed biodiversity monitoring on arable land in the Czech Republic

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Since the mid-20th century, agricultural intensification has driven a decline in weed species numbers within farmland. This trend is interpreted differently depending on perspective: as an erosion of biodiversity and ecological resilience, or as evidence of effective weed control. Rather than adjudicating between these positions, weed science should work toward reconciling biodiversity conservation with sustainable, effective management practices. Between 2006 and 2025, weed communities in winter cereals, spring cereals, and wide-row crops were surveyed phytocoenologically throughout the Czech Republic. Survey locations spanned a range of climatic and soil conditions, and farms were grouped into conventional and organic management categories. A total of 566 relevés (each 100 m²) were recorded to date using the nine-level Braun-Blanquet scale, allowing consistency with broader European datasets. Species were categorized by historical origin and conservation status, and multivariate methods were applied to assess how altitude, crop type, and farming system shaped weed diversity (α, β, and γ) and community composition. Results were incorporated into the AWME (Arable Weeds and Management in Europe) database to support cross-study analyses. The survey identified 189 weed species overall. Constancy was highest for *Chenopodium album* L., *Viola arvensis* Murray, *Fallopia convolvulus* (L.) Á. Löve, *Polygonum aviculare* L., *Cirsium arvense* (L.) Scop., and *Tripleurospermum inodorum* (L.) Sch. Bip. Among all recorded species, apophytes accounted for 43%, archaeophytes for 49%, and neophytes for 8%. Species richness in organic systems was more than twice that observed under conventional management, on average. Both farming systems showed a rise in average weed species counts with increasing altitude. Statistical analysis confirmed significant effects of farming system and altitude on α- and β-diversity, with conventional farms exhibiting greater β-diversity. Altitude was the strongest driver of compositional differences among weed communities, followed by crop type. Fourteen species recorded during the survey appear on the Red List of Vascular Plants of the Czech Republic. These findings underscore that weed community structure is shaped substantially by habitat conditions and farm management, positioning weeds as indicators relevant to both ecological assessment and agricultural production. Cross-European comparison of such datasets strengthens ties between vegetation ecology and weed science, offering practical value for shaping agri-environmental policy.

What is a weed worth?

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Introduction Perennial cereals may create novel patterns of disturbance in cropping systems that could be particularly valuable for organic weed management. Periods of reduced competition or strategic cutting may allow weeds to emerge, flower, and provide resources for biodiversity before being terminated prior to seed set. Such managed periods of "weed expression" could potentially reduce weed seed banks while maintaining ecosystem services from diverse weed communities. **Aims** We aimed to identify effective establishment methods for perennial cereal rye (PCrye) and explore how contrasting crop establishment systems influence plant community composition and provisioning services. **Methods** In 2026, a field experiment was established using a randomized complete block design with four replicates. Five spring establishment treatments were implemented that included PCrye monocultures, as well as annual and perennial companion crops. Green forage was harvested on 21 July and biomass separated by species. **Results** Biomass production and plant community composition differed among establishment systems. However, reviewing available literature revealed limited approaches for estimating the ecological value provided by plants in agroecosystems. **Discussion and Conclusion** As cropping-system research increasingly seeks to evaluate both agronomic harms and ecological benefits of weeds, there is a need for a simple, accessible framework. Based on published literature, we developed a proof-of-concept R Shiny application (WeedCheck) inspired by the Danish Pesticide Load framework, wherein complex and disparate weed species data are transformed into actionable values. While crude, we hope the tool can provide inspiration for developing a transparent and accessible method for estimating a weed's worth.

Changes in weed communities within a small agricultural area

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Weed flora in agroecosystems, through its composition and abundance, constitutes a major component of biodiversity in agricultural areas. This flora can be influenced by ecological and agronomic factors. Long-term monitoring of weed communities at a local scale on selected plots, therefore, enables a better understanding of their dynamics and helps to identify the factors that may affect plant diversity and the balance between different species. This study aims to characterise the evolution of weed flora across the 140-hectare agricultural area of Fénay, in Burgundy (France), and to analyse changes in community composition observed over a ten-year period. Between 2017 and 2026, 38 agricultural plots across 11 farms were subject to floristic monitoring across various winter and summer crops. Surveys were carried out on 2,000 m² areas using the Barralis method, enabling the presence and abundance of weed species within the plots to be characterised. The analysis focuses on changes in species richness, species frequency and community composition over the study period. Particular attention is paid to species whose frequency has increased over time (e.g. *Alopecurus myosuroides*), as well as to newly observed species (e.g. *Silybum marianum*) or, conversely, to those that have become less common (e.g. *Senecio vulgaris*). Initial results highlight changes in the composition of the weed flora over the monitoring period, with different dynamics depending on the species and crop types. Depending on the year, the number of weed species per plot varies from 0 to 35. The Shannon index indicates heterogeneity between plots, but also high intra-plot variability. On the majority of the plots observed, population densities are generally low (fewer than one plant per metre). Among the most common species are mainly annuals (e.g. *Viola arvensis*) but also a few perennials (e.g. *Cirsium arvense*). These trends reflect the temporal variability of weed communities within a small agricultural area. This monitoring study highlights the value of repeated observations at a local scale for detecting changes in weed flora and better understanding the trajectories of communities within agroecosystems. Ultimately, these results may contribute to greater consideration of weed biodiversity in the analysis of cropping systems.

Acknowledgements: Farmers of Fénay area, CA-SYS platform (INRAE)

Using allelopathy as an ecological mechanism for weed regulation

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Various mechanisms can influence crop-weed interactions. Competition for resources (light, water and minerals) is considered as the main mechanism and has been extensively studied. Conversely, the role of allelopathy (viewed here as a mechanism by which a plant can affect the growth of a neighboring plant through the release of allelochemical compounds into the rhizosphere during its life cycle) has been little investigated. Yet, the use of allelopathic species/varieties is regularly proposed as an agroecological lever to promote weed regulation. However, the simultaneous occurrence of allelopathy and competition makes it difficult to quantify the effects strictly attributable to allelopathy in the field.

Mechanistic models are valuable tools for quantifying variables/mechanisms that are difficult to measure in the field. The FLORSYS model is the only mechanistic model quantifying the effects of cropping systems, in interaction with soil and climate conditions, on the dynamics of multi-species weed flora and the impacts on arable crop production. This model takes into account plant competition, but not yet allelopathic interactions.

The aim of the presentation is to outline the work we are currently undertaking to develop an 'allelopathy submodel' to integrate into FLORSYS, in order to account for the ability of certain plants to affect the growth of neighboring plants by releasing allelochemicals into the rhizosphere during their life cycle. This work draws on experimental and literature-based data, as well as expert knowledge.

Feather meal as a pre-planting soil amendment for *Striga hermonthica* control in *Sorghum bicolor*

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Striga is a genus of parasitic plants that entails a major constraint to crop production across sub-Saharan Africa, causing severe yield losses in staple cereal crops like sorghum, rice and millet. Recent studies have shown that certain nitrogen (N)-containing compounds can negatively affect *Striga* seeds, either completely inhibiting their germination or rendering them non-viable. While N-rich organic amendments have mainly been studied for their fertilizer effect, their capacity to generate *Striga*-inhibiting N-containing compounds in the soil makes them a suitable candidate for depleting the *Striga* seed bank as a pre-planting strategy. In this study, feather meal (ground chicken feathers) was investigated as a suitable and locally available N-rich organic material. A greenhouse experiment was conducted with *Striga* (*S. hermonthica*) as the parasitic weed and sorghum (*Sorghum bicolor*) as the host crop to examine the effect of feather meal at four rates (0, 1, 2 and 3 g/kg soil). In each pot, *Striga* seeds were mixed through the upper 10 cm of soil. In addition, *Striga* seeds were introduced in the soil in seed burial bags made of nylon mesh. Sorghum was sown into *Striga*-infested soils 10 days after feather meal application with a final destructive harvest at 70 days after sowing. *Striga* infection was measured by regularly counting emerged *Striga* shoots above ground, and *Striga* seed germination rate was assessed after collecting seeds from the seed-burial bags and exposing them to germination stimulating strigolactone analog GR24. *Striga* seed germination was reduced by ~67% at the medium and high doses of feather meal relative to the control. *Striga* infection was reduced by 60-90% across all feather meal doses, and *Striga* biomass was reduced by 83-93%. Crop biomass approximately doubled in all feather meal doses relative to control. These results suggest that feather meal suppresses *Striga* by inhibiting seed germination, thereby reducing infection levels later in the season, supporting its potential as a pre-planting biocontrol strategy.

Acknowledgements: The authors acknowledge the support of Unifarm staff during the greenhouse experiments, NIOO-KNAW for the use of their laboratory facilities and De Ceuster Meststoffen NV for supplying the feather meal

Spatial configuration shapes the weed suppression in triticale–faba bean intercropping

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Intercropping has emerged as a promising strategy for sustainable weed management by enhancing weed suppression, thereby decreasing the reliance on herbicides. Recent studies suggest that this effective weed suppression is primarily driven by the selection effect, whereby the stronger weed-suppressive species contributes more than proportionally to the weed suppression of the intercrop. For example, in cereal-legume intercrops, the cereal is usually the most weed-suppressive species, making the weed suppression of this intercropping system closely resemble that of the cereal sole crop. However, the extent to which the expression of this mechanism is influenced by intercropping design and management, particularly spatial configuration and nitrogen availability, remains poorly understood. Furthermore, it is unclear how weed suppression is spatially distributed within strip intercropping systems. We therefore investigated the effects of spatial configuration and nitrogen fertilization on weed suppression and its spatial distribution within triticale–faba bean intercropping systems. Additionally, the productivity of the component crops was investigated. We conducted two field experiments in 2024 and 2025, varying spatial configuration (sole-crops, alternating-row intercropping and intercropping with different strip widths) and nitrogen application rate (0, 55, and 110 kg N/ha). Across experiments, pure stand triticale developed its canopy faster and suppressed weeds more strongly than faba bean. Canopy cover and weed suppression in intercrops more closely resembled those of triticale, but this resemblance weakened with increasing strip width.

Spatially, the weed-suppressive benefit of intercropping was mainly expressed in the faba bean growing zone, where weed biomass was lower than in the faba bean pure stand, while no clear difference was observed between the triticale growing zone and the triticale pure stand. Nitrogen application did not significantly alter the selection-effect pattern among spatial configurations, although higher nitrogen application increased overall weed biomass at the late growing stage. Intercropping had a positive net effect on triticale biomass but a negative net effect on faba bean biomass relative to their respective sole crops, indicating that triticale benefited at the expense of faba bean. However, weed presence reduced this trade-off by limiting the benefit to triticale while alleviating the negative effect on faba bean. Overall, our results demonstrate that in triticale–faba bean intercropping spatial configuration plays a key role in regulating the selection effect and its associated consequences for weed suppression and yield formation. These findings provide new insights into designing intercropping systems that improve weed suppression through crop interactions and suggest that weeds themselves can also play an important role in shaping competitive interactions between component crops.

Bioherbicidal activity and crop selectivity of olive mill wastewater against four grass weeds of cereal systems

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Weed resistance to synthetic herbicides is increasing in Mediterranean cereal systems, creating an urgent need for eco-friendly alternatives. Olive oil mill wastewater (OMW), a major pollutant of Mediterranean agro-ecosystems, is rich in phenolic compounds, long-chain fatty acids and dissolved salts conferring marked phytotoxicity, and its valorisation as a bioherbicide would serve circular-economy objectives. However, because OMW composition and phytotoxicity vary with olive cultivar, extraction process and geographic origin, and because its activity against several problematic weeds has not been assessed, region-specific evaluation is required. This study aimed to evaluate the phytotoxic and selective potential of Moroccan three-phase OMW against four grass weeds of major importance in cereal systems (*Avena sterilis*, *Phalaris minor*, *Bromus rigidus* and *Lolium rigidum*), using soft wheat (*Triticum aestivum*) as a reference crop. Three sequential bioassays of increasing ecological realism were conducted: a germination test on dry seeds, a bioassay on pre-germinated seedlings, and a pot bioassay under soil conditions, with OMW applied at five doses (0 to 100 m^3 ha^{-1}). OMW caused significant, dose-dependent inhibition of germination, emergence and seedling growth, with a clear selectivity gradient between the crop and the weeds. *Phalaris minor* and *Lolium rigidum* were the most sensitive species; germination of *P. minor* collapsed from 96 to 5% at the lowest dose applied, and both species reached complete suppression at intermediate to high doses, while wheat germination remained above 53% at the highest concentration, demonstrating a marked selectivity window, even if seedling growth was significantly affected at the highest concentration. *Avena sterilis* was the most tolerant weed, consistently tracking the crop response. Inhibitory effects were strongest on dry seeds and progressively attenuated under soil conditions, consistent with buffering of phytotoxic compounds by the soil matrix. These findings demonstrate that a three-phase OMW could exert genuine bioherbicidal activity against problematic grass weeds while preserving a selectivity window favourable to wheat, supporting its reuse as a locally available, low-input pre-emergence weed management tool, particularly suited to no-till contexts where mechanical control is limited.

Under what conditions does defoliation exceed the compensatory capacity of *Datura stramonium*?

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Datura stramonium L. is an expanding weed in France and a major management concern in agricultural systems because of its high reproductive capacity, prolonged emergence period and persistent seed bank. In the context of biological control, the effectiveness of a defoliating agent depends not only on the amount of leaf area removed but also on the plant's ability to compensate for damage. This study aimed to determine how defoliation intensity, timing and soil resource availability influence the compensatory response of *D. stramonium*. A greenhouse experiment was conducted on 260 plants grown under two soil fertility levels. Plants were subjected to artificial defoliation removing 30, 60 or 90% of leaf area, applied either early, late or repeatedly, together with untreated controls. Vegetative growth, leaf traits and several reproductive components were monitored throughout the experiment. Severe defoliation caused an immediate reduction in vegetative growth, followed by increased relative growth rates that allowed plants to progressively recover. Recovery was particularly marked after early defoliation, and even 90% early defoliation was largely compensated at the vegetative level. In contrast, late and repeated high-intensity defoliation had stronger consequences for reproduction. Compared with control plants, 90% late and repeated defoliation reduced the number of mature fruits by approximately 41% and 47%, respectively, and also decreased the production of presumed viable seeds. Higher soil fertility increased some vegetative performance traits but did not consistently improve compensation after defoliation, indicating that greater resource availability did not necessarily translate into greater tolerance to damage. Overall, these results show that defoliation intensity alone does not explain the response of *D. stramonium*. The timing and repetition of damage are major determinants of whether plants can compensate. Strong early damage may be largely overcome through vegetative recovery, whereas severe damage occurring later in development or repeatedly can reduce reproductive output and therefore plant fitness. From a biological control perspective, these findings highlight the importance of considering the complete damage profile of candidate agents, including not only the amount of tissue consumed but also when and how frequently damage occurs.

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The impact of novel perennial cereal rye on fall weed communities

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In the fall following grain harvest, a novel perennial cereal rye crop (PCrye) can regrow and potentially act as a cover crop. It is unclear how this regrowth impacts fall weed communities. The aim of this study was to assess the biomass production and community composition during the first year of PCrye and annual winter rye (Arye) based systems.

A field trial was set up in a complete randomized block design with four replicates, established in both the 24/25 and 25/26 seasons. Treatments consisted of PCrye ± cover crop mix seeded after harvest (CCmix) and Arye ± CCmix, all repeated with or without chemical weed control (CWC) used in early spring for a total of eight treatments. In the 24/25 season rye crops were seeded in November 2024, harvested in late July, and CCmix was seeded after grain harvest. Here we report results from aboveground vegetation sampling in early November when aboveground biomass had reached its peak (prior to the first frost).

Preliminary data analysis shows that CWC did not significantly impact total fall aboveground biomass, with an average of 526 kg ha-1 (SE: 40) and 608 kg ha-1 (SE: 40) in +CWC and -CWC treatments respectively. Arye +CCmix had the highest biomass while biomass did not differ significantly between PCrye ±CCmix and Arye -CCmix. While total fall biomass did not differ significantly between the treatments, the community composition appears to vary. Analysis of communities is ongoing with the aims of quantifying ecosystem services of each community. Data collection from the 25/26 season is ongoing.

Acknowledgements: This work was possible through the Novo Nordisk Foundation grant number NNF24OC0091092



Session 3: Biological control

Wednesday 28 October 2026

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Could Classical Biological Control Help Manage Invasive Plants in France?

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In France and Europe, the management of invasive alien plant species (IAPs) still relies largely on mechanical and chemical control. These approaches can be costly, difficult to sustain over the long term, and increasingly challenged by concerns about the use of chemical products. In contrast, classical biological control (CBC) has been successfully used worldwide to manage a wide range of IAPs. CBC aims to restore, at least partly, the ecological interactions disrupted by invasion by reintroducing specialist natural enemies from the plant's native range. This involves identifying and assessing suitable biological control agents, evaluating the risks associated with their introduction, and obtaining the necessary regulatory approvals before their release.

In this presentation, I will discuss the opportunities and challenges associated with developing CBC programs against IAPs in France. I will first highlight invasive plant species that appear to have high potential for CBC, based on a framework integrating the impacts of the target species, the resources required to develop and implement a CBC program, and the feasibility and likelihood of success.

I will then present two initiatives targeting problematic IAPs in agriculture, which are at contrasting stages of development: (i) an ongoing program against common ragweed (*Ambrosia artemisiifolia*) using the leaf beetle *Ophraella communa*, and (ii) the initial steps towards assessing the feasibility of developing a CBC program against Jimsonweed (*Datura stramonium*).

Stripping away the drivers of weed seed predation in strip cropping systems

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Strip cropping is a form of intercropping that maintains crop diversity while allowing the use of conventional farm machinery. In this system, crop species are grown in adjacent strips, allowing crop-specific management and mechanisation with machines used in monocropping systems. Greater within-field crop diversity may support a wider range of organisms, increasing the chance of weed seed predation. We hypothesized that in relay strip cropping systems, due to extended vegetation cover, weed seed predation in harvested strips would be higher than in harvested pure stands of the same crop. In this study, seed predation was evaluated in two consecutive years using strip cropping systems composed of crops differing in their planting and harvest dates. Seed exposure traps in such relay systems were placed in experiments at Wageningen and Lelystad in the Netherlands, using two crop pairs: oats-cabbage and faba bean-pumpkin. Weed seed predation in strip cropping was compared with that in monostands of the constituent crops, which served as reference. Fifty *Chenopodium quinoa* seeds were placed on seed cards in uncaged and caged setups to quantify post-dispersal seed predation. Four sampling rounds of 48 hours were conducted: two with both crops present and two when one of the crops (oats or faba bean) was harvested. Predation varied among crop species and sampling time, whereby seed predation was high when a crop had developed sufficient soil cover and decreased when the crop was harvested. This suggests that vegetation cover is the primary driver of weed seed predation. Unlike our expectation, strip cropping did not support higher weed seed predation levels in harvested strips compared with monostands of that same crop. This implies that neighboring vegetated strips did not enhance seed predation in harvested strips. Comparison of the uncaged and caged seed cards revealed differences in seed predator groups between the two locations.

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The contribution of seed predation to crop productivity in arable fields

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Weed seed predation is a widespread process that can contribute to the biological control of weeds but we still lack empirical quantification of the effects of weed seed predators on weed dynamics. Besides, if weed dynamics is affected by seed predation, one can expect that seed predators will indirectly positively affect crop productivity, but such assessment has to our knowledge never been conducted. Here, we report on a highly replicated predator exclosure experiment that aimed to assess the impact of seed predators on the demography of nine weed species and on crop productivity. We demonstrate that across the 28 experimental fields, seed predation significantly reduced total weed biomass, compared to the reference where predators were excluded. Moreover, we show that in the absence of seed predators, the potential wheat crop yield is reduced by 80% by weeds. The presence of seed predators strongly limits this drastic reduction, to 48% with invertebrate seed predators and to 56% with both invertebrate and vertebrate seed predators.

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Classical biological control of weeds in agricultural systems: a framework for identifying targets in Europe

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Invasive non-native plant species pose a significant threat to agriculture. While classical biological control (biocontrol), defined as the intentional introduction of co-evolved specialist natural enemies from a weed's native range into the invaded range, has been successfully employed worldwide for more than a century, its application in agricultural systems, especially in Europe remains limited. One major constraint is that classical biocontrol agents are typically highly host-specific, whereas agricultural stakeholders are often confronted with several problematic weed species rather than a single target weed. Careful target selection is essential for making biocontrol in European agriculture more mainstream. We propose a framework for identifying candidate weeds based on a combination of ecological and agronomic criteria. Ideal targets should be invasive non-native species that cause substantial impacts on agricultural productivity, are difficult or costly to manage using conventional approaches, and increasingly exhibit herbicide resistance.

Perennial cropping systems may offer particularly suitable environments for biocontrol because of their greater ecological stability and reduced disturbance; however, annual cropping systems will not be completely excluded. This presentation will discuss key selection criteria and highlight some invasive weeds that may warrant further investigation as potential candidates for future biocontrol programmes in European agricultural landscapes. By focusing efforts on carefully chosen targets, classical biocontrol could become an increasingly valuable component of sustainable integrated weed management in Europe.

Do weed diversity and weed seed predation act synergistically to regulate weed populations?

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Weed diversity has emerged as a promising strategy for sustainable weed management. However, managing weed diversity is not straightforward, and current theory largely attributes its potential to reduce weed pressure to intraspecific competition, while overlooking other ecological processes such as weed seed predation. The effectiveness of weed seed predation depends on complementary feeding among predator communities, which is influenced by ecological processes operating beyond the field scale, including landscape complexity. Consequently, it remains unknown whether weed diversity and weed seed predation interact to regulate weed populations and reduce weed-related crop losses. This study tests whether the synergy between weed diversity and weed seed predation reduces weed species population growth rates and whether these effects are mediated by landscape complexity. We conducted a field experiment in ten cereal fields in the Uppland region of Sweden which were selected along a gradient of landscape complexity. Within each field, fifteen permanent sampling plots representing low, intermediate, and high weed diversity were established. Weed community development was monitored throughout the growing season, together with key demographic processes, including seed germination, plant survival, seed production, and seed mortality due to vertebrate and invertebrate seed predation. These data will be used to parameterise stage-structured stochastic population models to estimate weed species population growth rates and quantify the contribution of weed seed predation across the weed diversity gradient. In this talk, preliminary results of the first year of the experimentation will be presented. We hypothesise that weed seed predation will more effectively suppress weed population growth in species-rich weed communities than in species-poor communities, and that these effects will be strengthened in more heterogeneous landscapes.

Acknowledgements: This work is supported by the Swedish Research Council for Sustainable Development (FORMAS; Grant No. 2023-01507) and the Centre of Biological Control (CBC). We thank the participating farmers for providing access to their fields and all field assistants for their support during data collection.

Seed predation by carabids helps to regulate weeds in arable crops. A simulation study

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Herbicide use must be reduced because of environmental and health issues, and weed management must thus rely more on biological regulation. Carabid beetles potentially predate a large proportion of weed seeds but to date, no field studies have demonstrated that this predation actually influences long-term weed dynamics and reports on its impact on crop production are rare. The objective of the present paper was to determine (1) which weed species are the most predated and which traits drive this predation, and (2) the management practices that favour weed-seed predation and its contribution to weed management. A database of 1376 contrasting arable cropping systems was built, from 434 cropping systems recorded from farming practices. These were simulated twice over 30 years (and repeated with 10 weather series) with the mechanistic crop-weed model FlorSys, once including weed seed predation by carabids and once again without. Annual seed predation rates per species varied from 0% to 48%, and increased linearly with log10-transformed annual seed production. The rates also increased with the species attractiveness to carabids and was higher for species maturing in July. Crop yield loss due to weeds and weed biomass both decreased by 5% (no-till systems) to 44–48% (if surrounded by grass strips) when seed predation was included in the simulations, and yields increased by 4–23%. Tillage was the most influential management technique: its suppression increased predation rates (+31%) compared to unmodified systems but the resulting weed regulation was insufficient to cancel out the increase in weed biomass in no-till (+88%), translating into a 24% yield decrease. Converting 4% of the outer field area to grass strips improved predation rates (+17%) and predation effects (+77%), resulting in lower weed biomass (–22%) and better crop production (+4%), despite reducing the cultivated area. The results were organized into an advice table summarizing and explaining the key management rules for improving direct weed suppression, predation-driven weed suppression, yield loss control and yield.

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Session 4: Biological control and agroecology

Thursday 29 October 2026

Chairs: Alexander Menegat & Bruno Chauvel

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Weeds in agricultural systems; promoters for and targets of biological control

Marion Seier[1], Philip Weyl[2]

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Commonly defined as “any wild plant that grows where it is not wanted” the role of weeds in ecosystems, including agroecosystems, is multifaceted. Whilst being beneficial for biodiversity, providing food for the associated fauna and enhancing soil health, weeds also compete with native plants and crops for resources and can harbour pest and diseases impacting on crop health. A classic example addressing the latter was the eradication programme for barberry (*Berberis spp.*), the alternate host of wheat stem rust (*Puccinia graminis*), in the proximity of grain fields in Europe and North America in the 19th and 20th centuries.

Within the complex ecosystem of crops and weed species, biological control using natural enemies to control injurious species can play an integral role. Conservation biological control aims to augment populations of beneficial arthropods attacking crop pests by conserving their weed hosts whilst classical and inundative biological control offer a sustainable option to manage harmful non-native and native weed species, respectively. Specifically non-native weed species can impact on both agro- and natural ecosystems either by being invasive and/or acting as secondary hosts for native or introduced pest; thus, the drivers to develop a classical biological control programme can also be manifold.

This presentation will showcase examples of the use of biological control strategies with respect to weeds in agricultural, as well as natural ecosystems.

Acknowledgements: EWRS

Can weakly competitive weeds buffer the impact of strong competitors in winter wheat?

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Ecological weed management relies on ecological levers to reduce herbicide use. Yet, most weed-crop competition studies have focused on single weed species, rather than weed communities. Non-transitive interactions, whereby a subordinate weed indirectly limits a dominant competitor, have been proposed as a potential mechanism attenuating the yield impact of a dominant competitor. We tested this by growing winter wheat with two weakly competitive species (*Veronica persica*, *V. hederifolia*) and two highly competitive species (*Alopecurus myosuroides*, *Sinapis arvensis*), alone or paired in the four resulting weak:strong combinations.

A two-year mesocosm experiment (2024–25, 2025–26) was conducted at INRAE Dijon (9 treatments × 4 replicates × 2 years, fully randomised). Wheat and weed biomass were sampled at flowering and maturity; grain yield was obtained by threshing. Total wheat biomass, which was highly correlated with grain yield (r = 0.92), was analysed with log-gaussian mixed models (glmmTMB), with treatment, weed density and year as fixed effects and mesocosm identity as a random effect. A parallel model set replaced treatment with continuous weed density to extract density-dependent slopes and test additivity via linear contrasts.

Wheat biomass differed significantly among treatments and years. Associating *A. myosuroides* with either *Veronica* species resulted in significantly higher wheat biomass than the additive sum of their individual effects (+64.5 g with *V. persica* and +68.1 g with *V. hederifolia* in 2024–25), indicating a non-additive, buffering interaction. Wheat biomass in these mixtures remained well below the weed-free control and did not differ from *A. myosuroides* monoculture: the interaction softened the additive prediction without making the mixture less harmful than *A. myosuroides* alone. Density-based models showed *A. myosuroides' negative slope* on wheat biomass flattening as *Veronica* density rose, and *A. myosuroides* biomass was consistently lower in mixture, suggesting mutual suppression. Effects involving *S. arvensis* were similar in direction but rarely significant.

These results show that pairwise weed interactions dampen the combined cost of two competitors below additive expectations, without reducing yield loss below what the dominant competitor alone causes. Field-scale validation across pedoclimatic contexts is needed before translating this into practice.

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Grassy semi-natural habitats influence weed seed removal in field crops through opposing predator- and weed resource-mediated pathways

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Semi-natural habitats support biodiversity in agricultural landscapes, but their effects on ecosystem services such as weed seed removal varies. In this study, we investigated how SNHs influence weed seed removal in 75 cereal fields across five European countries. Structural equation modeling showed that carabid seed predator abundance increased with crop-grassland boundary length, enhancing weed seed removal. However, a higher proportion of grassy SNHs also increased weed abundance within the fields, likely increasing seed density and reducing predator efficiency due to lower predator/seed ratio. This highlights an ecological trade-off: the same habitat feature can either enhance or reduce ecosystem services depending on the balance between predator- and resource-mediated effects. We conclude that ecosystem service delivery is shaped by the interaction between predator- and resource-mediated pathways. Recognizing this could help reconcile inconsistencies in landscape-ecosystem service relationships and offer insights into how landscape management can optimize biocontrol services by managing semi-natural habitats to enhance predators rather than weed spillover.

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COMBHERPIC: An Expert-Elicited Bayesian Network Model for Agroecological Weed Management - From Design to Field-Based Evaluation

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Agroecological Weed Management (AWM) aims to reduce herbicide reliance by combining diverse practices and ecological processes, but experimentally evaluating such long-term strategies across varied conditions remains costly and slow. To address this gap, we developed COMBHERPIC, a causal Bayesian network model built through structured elicitation with 19 weed science, agronomy and agroecology experts across 19 one-day workshops (2023–2025). The model integrates 89 interconnected variables — farming practices, pedo-climatic conditions and plant traits — linked by 115 conditional relationships, and uses conditional probability tables to estimate, under uncertainty, the effects of management strategies on weed biomass and harmfulness indicators such as yield loss and seedbank replenishment. Simulations of six contrasting cropping-system prototypes (varying in herbicide use, tillage intensity and AWM gradient), confronted with the literature, showed that reduced-herbicide or reduced-tillage strategies can achieve weed control comparable to conventional systems, whereas eliminating herbicides entirely requires a full redesign of the cropping system (crop diversification, pre-harvest weed seed management). The model also flagged elevated risks of yield loss and seedbank replenishment under herbicide-resistance scenarios when management stays herbicide-dependent.

We then assessed COMBHERPIC's predictive ability against real-world data from 10 cropping-system experiments and a network of 68 commercial farms, totalling 419 cropping systems across diverse pedoclimatic contexts in France and Switzerland. Cropping systems were described using the model's input variables, and predicted weed outcomes were compared with observed outcomes via chi-square tests, RMSE, MAE, bias and accuracy. The model predicted outcomes better for ploughing- and herbicide-based strategies than for direct-seeding systems, but predictions remained consistent with tillage and herbicide intensity gradients — greater intensity corresponded to lower predicted weed harmfulness. Despite room for improvement in predictive precision, COMBHERPIC already proves useful, in its current form, to support participatory cropping-system (re)design by comparing a baseline system against alternatives, and the evaluation yields concrete recommendations for refining the model.

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