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Pollinators and policy: the intersecting path of various actors across an evolving CAP

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Abstract

Pollinators are a crucial group of organisms due to their role in the maintenance of environmental biodiversity and crop production. Pollinators may be very diverse; however, in temperate areas they are mainly insects, and the most active and important are certainly the bees. Not only the well-known honeybee: there are almost 2000 species of wild bees in Europe, and about 1000 just in Italy. There is an increasing public worry related to their decline and to the impact that this decline may have on agricultural production. The way public perception of the pollinator issue arises is generally neglected, especially by important stakeholders such as the farmers. Moreover, direct actions were not indicated by the policy till recently. We surveyed the main steps that possibly drove the current political perspective at the European and national (Italian) level. We found an increased boost toward healthier environments through the release of various documents. To look for changes that may include pollinator protection, we need to address the Common Agricultural Policies (CAPs), the tool that shapes the European agro-environments. A new CAP document has been recently released, and the Member States are moving toward the definition of eco-schemes to be adopted by farmers after payments. Italy placed pollinators in pole position with a dedicated eco-scheme: will pollinators finally be acknowledged?

New Concepts and Case Studies

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Introduction

Pollinators are a hot topic often recalled in recent years. Pollinators like butterflies and moths, hoverflies, solitary bees and even managed honeybees are under considerable threat, showing drastic declines in Europe. The scientific claims on their decline (Potts *et al.*, 2010) finally reached the public and the newspapers headlines, turning on the public perception of the large importance that pollinators delineate in the maintenance of environmental biodiversity and crop production. Information on changes in the abundance of pollinators over time is generally lacking; however, some attempts to estimate the decrease are at work. For example, studies on bumblebees highlighted a negative pattern. Bommarco *et al.* (2012) reported drastic decreases in bumblebee community evenness on red clover fields in Sweden. The same trend was observed in Denmark by Dupont *et al.* (2011), which recorded changes in the abundance of workers and queens but also changes in species composition. Red clover pollination is currently carried out by fewer bumblebee species than 70–80 years ago, and it is resulting detrimental to stability in seed yield. Powney *et al.* (2019) reported evidence of declines across a large proportion of pollinator species in Great Britain, by analyzing species-level estimates of change at the national scale between 1980 and 2013. These authors warn of the high risk of deterioration in both wider biodiversity and non-crop pollination services.

Some keywords often go together. Pollinators are usually associated (just to cite some) with conservation, biodiversity, nature protection, biological control agents, crop pollination, wildlife, management plans and farming practice. However, a problem arises when coupling keywords: pollinators may lose the role of main target and the political effort of being more inclusive of natural diversity may obscure pollinators' special needs and the magnitude of the 'portion' of landscape that pollinators experience. Pufal *et al.* (2017) underlined the need to consider a complex matrix of elements in the landscape, so to build composition and configuration of agricultural elements that include nesting and feeding resources for pollinators. Without keeping in mind this magnitude, we record an increase in the failure of actions (maintain and restore semi-natural elements in the landscape, and/or other habitat features such as hedgerows, field margins, fallow, stubbles, plants, appropriate grazing, reduced fertilizer and pesticide use) somehow pointed toward improving pollinators survival and protection.

In the last decades, dealing with the decline of pollinators has been translated into several actions at different scales. The ones with the major impact are certainly those aimed at the management of the agroecosystems: because many pollinators live there, and because the agricultural sector covers a central role within society. Agriculture is responsible for guaranteeing food security, but also for mitigating impacts on biodiversity to preserve the environment for

future generations. Thus, a lot of attention is paid to actions directed toward its management and control. The Common Agricultural Policies (CAPs) were introduced back in 1957, as tools employed in the Eurozone to regulate the European Union's (EU's) agricultural sector and recall a vision shaped/mediated by stakeholders and citizens. The wide interest in the CAPs is well-reflected by the amount of literature investigating the policy contents and effects. The topic is certainly relevant for academics and a large stream of bibliography is available: a recent analysis underlined that the countries with the higher literature production on CAP issues are Italy and UK (Fusco, 2021). Any contribution helps to determine the scientific soundness of actions and therefore justifies the increasing trend in the number of articles since 2001. Concerning pollinators, we may recall the introduction of the agri-environment schemes in 1992 as the first attempts to contribute to environmental sustainability: the schemes supported environment-friendly farming practices (EEC Regulation No 2078/92). Since they did not result satisfactorily, the CAP 2014-2020 reform linked basic farm payments to greening measures, no longer optional (EU Regulation No 1307/2013). Again, results were scarce when considering the impact on pollinators. Cole *et al.* (2020) nicely described to what extent and which of the available greening measures contribute to pollinators' maintenance and conservation, depicting as critical issues a spatial configuration of agro-environments with complementary nesting and foraging resources to support bees, or a diversity of afforested and damp areas to support hoverfly larvae. As Pufal *et al.* (2017) then, Cole *et al.* (2020) pressed the need for more complex landscapes and direct actions sharpened for pollinators.

Our main aim is not to review all changes in the EU's reforms, policy measures or specific actions taken (EU Biodiversity Strategy for 2030, the EU Farm to Fork Strategy and the EU Zero Pollution Action), even if we will eventually mention some of them. We are also not interested in a comparison highlighting the *ad hoc* biodiversity strategies and pollinator conservation policies across European Member States (MSs). In this work, we tried to depict the path that possibly included the social perspective: to retrace the milestones that raised stakeholders' interest in pollinators and to underpin the public perception of threats related to their potential decline. We believe that in current literature the role of the public is frequently overlooked, while it is a pressing force behind many cultural and economic changes. This work will therefore contribute to understanding the need to accelerate and widen the implementation of actions precisely devoted to the conservation of pollinators' diversity since it is a request coming from citizens' perception of the system. We are confident that this implementation will find one's place precisely in the new CAP-post 2020.

Pollinators: a brief overview

From an evolutionary perspective, pollinators are a driving force behind most pollination processes on our planet. Angiosperms evolved the incredible variety of flower morphologies we appreciate, also thanks to the inputs of pollinators (Van der Niet and Johnson, 2012). Pollinators may be as diverse as a bee from a bat: however, they all play the fundamental role of providing the pollination service, i.e., transferring pollen from one flower to another and allowing the production of fruits and seeds. Co-evolution is the process that depicted the present networks of plant–pollinator interactions: given flowers visited by a given guild of pollinators. Both, the plants and the pollinators, also evolved functional traits especially developed to strengthen the relationship (Faegri and Van der Pijl, 1971). For example, papilionaceous flowers (as those of black locust and peas) developed a mechanism that the insect visitor needs to trig to reach the nectar at the base of the corolla, and mechanisms can be as complex as the lever one found in the sages, Lamiaceae (Claßen-Bockhoff *et al.*, 2004). Not all pollinators have the necessary strength or morphology to pay a visit to these flowers; however, adaptative behaviors may help individuals in overcoming physical barriers posed by the plants (Aronne *et al.*, 2012; Giovanetti, 2019). While some pollinators may adapt to visit and get resources even from plants and flowers they did not co-evolve with (Giuliani *et al.*, 2016), others are seriously limited by the evolution of an extreme specialization: i.e., some pollinators are linked to few flowering species and may become rare when these are unavailable. Bosch *et al.* (2009) underlined the essential contribution of depicting the floral specialization of rare species to better understand the structure underneath pollination networks and to design proper conservation measures to contrast biodiversity loss.

We are facing mounting evidence of the decline of pollinators, widely reported in the scientific literature (reviewed in Cane and Tepedino 2001; Kluser and Peduzzi, 2007). This decline is alarming at the global level and does not refer only to the potential loss of biodiversity. The decline of pollinators brings within wide economic losses that will hurt the market of important products, especially fruits, vegetables and stimulants. Gallai *et al.* (2009) investigated crops used for human food based on FAO categories and found that, out of 89 direct crops and 11 commodities, almost half of them ($n = 46$) were dependent on pollinators. For six of them, insect pollinators were essential, while pollinator contribution varied for the others: it was great for 13 crops, modest for 13 and little for 14, with the most pollinator-dependent crop categories being vegetables, fruits and edible oil crops. Interestingly, these categories are also the ones with the highest value per ton produced. Therefore, we need to address the issue of pollinator decline and provide measures of conservation to prevent heavy negative consequences (a) on biodiversity and the natural world, and (b) on the economy and health of mankind.

Where to start? Somehow obviously, by identifying the causes behind the decline. It has been a long debate deeply addressed back in 2001 in a special issue of the journal '*Ecology and Society*' (https://www.ecologyandsociety.org/issues/view.php?sf=7). Various causes have been pointed out in the last decades: habitat fragmentation, agricultural practices and use of pesticides, lack of floral diversity, competition from non-native species, diseases and pathogens spread and recently even climate change. Most of them lead back to agroecosystems, and the intensive cultivation approach often preferred: securing food safety and global competition are often the main reasons called to justify this agricultural model. Actually, some literature sustains the need of conventional agriculture to ensure food availability and farmers' income. For example, in its review Alvarez (2022) report a generalized reduction in yields obtained through organic management (an average gap of 25%), even if the reduction changes accordingly to the type of crop considered. The author also indicated the importance of considering productivity, often generating a gap greater than that of the yield. However, despite a higher yield per hectare, sales price of the product may be lower, at least for some food products where quality can be directly perceived by the consumer. Crowder and Reganold (2015) investigated the performance of conventional and organic farming, reviewing studies covering 55

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crops grown on five continents: they highlighted that organic agriculture was significantly more profitable than conventional one. Similar conclusions were reached by the meta-analysis of Sánchez *et al.* (2022): according to them, diversified farming systems are at least as profitable as simplified ones and may contribute to employment opportunities, sustainable food production, biodiversity conservation and climate mitigation. Moreover, we also know about the global problem of food waste: FAO (2011) reported approximately a third of all food produced for human consumption as lost or wasted. Possibly we are on the way to be able to modify the current conventional agricultural model maintaining satisfactory food production and farm competition. For such a change, different stakeholders need to interact: farmers and consumers in the first place. Farmers' perception of major environmental problems and problems with animal welfare was found to be contrasting between organic farmers and consumers *vs* conventional farmers in Norway (Storstad and Bjørkhaug, 2003). Farming decisions can also be strongly impacted by country-level decisions on investments (Azam and Shaheen, 2019). Consumers may have a greater willingness to pay for organic products, with respect to conventional ones: greater market appreciation can counteract a lower yield by increasing sale price, as was the case of lemon production in the South of Italy analyzed by Sgroi *et al.* (2015). In a near future, consumer attitudes may also be sustained by younger generations, more sensitive to dietary quality (Pelletier *et al.*, 2013) and sustainable production.

Agroecosystems deeply influence the environment and its content, in terms of the variety and distribution of floral resources. Not only the resources, actually: the structure of the environment itself has been modified, reducing the presence of suitable nesting sites and widening the areas that a pollinator should travel in search of food. Pollinators may have a hard time reproducing in such hostile surroundings. Moreover, the environment is becoming poisonous due to the spread of chemicals. Phytosanitary products have been introduced to reduce the pests on crops or increase soil fertility and productivity; however, their design often resulted highly toxic for organisms other than the target ones. Among all, neonicotinoids have certainly been the most dangerous in recent decades (Singla *et al.*, 2021): these molecules can act in synergy with each other or with other stress factors in determining the decline of pollinators (Goulson *et al.*, 2015; Azpiazu *et al.*, 2021). Consumers express concerns about potential residues of pesticides in their food, even if some recognition is paid to beneficial contributions to food security and the national economy, and this situation did not change in the last 30 years (Dunlap and Beus, 1992; Simoglou and Roditakis, 2022). *Ad hoc* and holistic crop protection strategies that keep parasitic disease damage under control, do not harm pollinators, respect the environment and are socio-economically sustainable should be implemented.

Europe: the pollinator perspective

In Europe, pollinators have been supported by different types of actions, such as project funding, legislation and protection measures, developed under subsequent Framework Programmes (Fig. 1a). The scientific community was supported through research funds to better understand biodiversity loss, as in the project ALARM (Assessing Large-Scale Environmental Risks For Biodiversity), under the 6th Framework Programme. In the following 7th Framework Programme, researchers' efforts

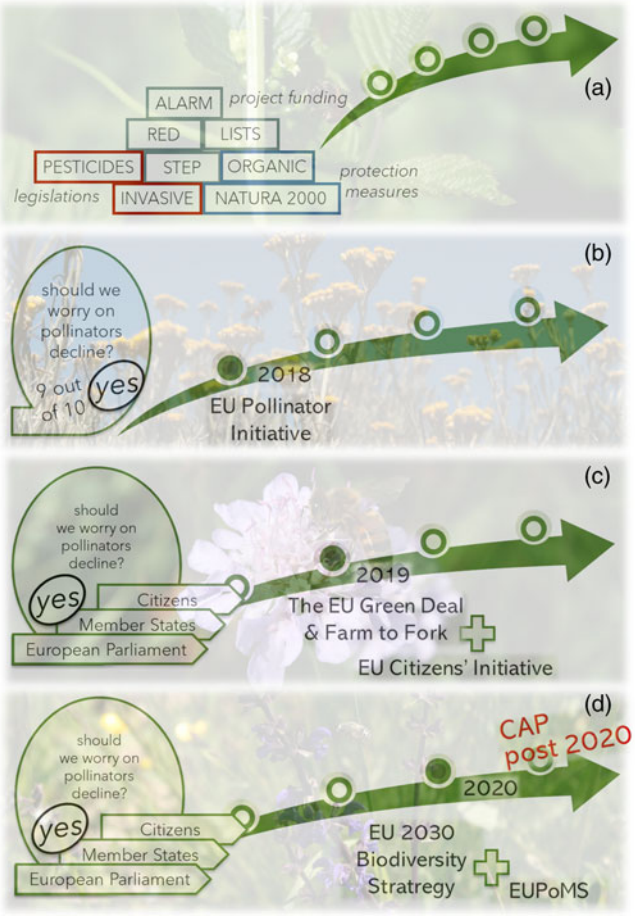

Figure 1. European temporal paths of documents and expression of interest from different stakeholders on the topic of pollinators or other topics possibly related to them (i.e., biodiversity). Documents cited were selected based on relevance. (a) Baseline made of legislation, project funding and conservation actions before 2018; (b) 2018 results of public consultation (on the left) as an impulse to move forward: the European Pollinator Initiative; (c) 2019: new documents (EU Green Deal, Farm to Fork) that deals (also) with the environmental protection and biodiversity with possible fallouts on pollinators, plus spontaneous citizens' interest in pollinators and farming practice evolution; (d) 2020: the EU Biodiversity Strategy and EU Pollinator Monitoring in member states; awaiting the new CAP-post 2020 implementations.

concentrated directly on pollinator decline in the project STEP (Status and Trends of European Pollinators). This project contributed to the publication of the first 'European Red List' (Nieto *et al.*, 2014), which recaps results for 1965 of Europe's native species of bees and points out the extinction risk of 9.2% of them. Research results helped in highlighting that threatened species suffer from agriculture intensification often linked to practices that include the use of pesticides and fertilizers, land and soil use related to urban development, the increased frequency of fires and climate change. Out of funds for research projects, the EU also contributed, even if indirectly, through protection measures for biodiversity (Directive 79/409/EEC for Bird protection and Directive 92/43/EEC for Habitat protection). These play a major role in targeting species and sites at risk and in need of direct actions of protection: pollinators are not a direct subject of these measures but may benefit from their application. So far protection measures were therefore mostly indirect; some measures that focused on protection/creation of beneficial habitats (by providing food resources or controlling invasive alien species) were

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considered a valid, almost direct contribution to pollinator protection. Alternatively, the few direct measures only referred to a single pollinator species, the managed honeybee. An example of such direct measures is the legislation on the employment of pesticides: acknowledgements related to their effects on the honeybees were included in Directive 91/414/EEC and the following Regulation (EC) No 1107/2009, and finally build up the Bee Guidance published by the European Food Safety Authority (EFSA 2013). The latter is currently under implementation, with ongoing meetings, technical reports and public consultations, including on bees other than the honeybee (e.g., bumblebees and wild bees Auteri *et al.*, 2022).

In recent years, we faced numerous initiatives toward pollinators (and biodiversity). Citizens are often involved to express their opinion, also when the initiative comes from a governmental level. First, we need to acknowledge the public perception of pollinators' importance and threats (Fig. 1b). The year 2018 is the recent milestone in acknowledging pollinators, with the public consultation associated with the EU Pollinators Initiative (COM/2018/395). Out of this consultation, nine out of ten respondents marked the reported decline of pollinators as alarming. The EU Pollinators Initiative, a framework with ten actions and 31 subactions, was intended to tackle the decline of pollinators. It was deeply discussed and recently prompted a revision, that started by going back to asking citizens' opinions through a new running questionnaire (https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13142-EU-pollinators-initiative-revision/public-consultation_en). Again, even in this second public consultation, 91% of respondents indicated as very urgent to protect pollinators in the EU and added a negative perception of how the loss of pollinator habitats in agricultural areas is tackled. Even worst the perception of MS policies: 91% of respondents are convinced that their country does not at all address the decline of pollinators, or at least not well. Initiatives may move in different directions (objectives, documents, campaigns) and from different baselines (citizens, MSs, The European Parliament; Fig. 1c). An example of an initiative that was started by citizens is 'Save bees and farmers! Towards a bee-friendly agriculture for a healthy environment'. It is promoting a campaign intending to protect bees and people's health, by discharging synthetic pesticides by 2035, restoring biodiversity and supporting farmers. This initiative is challenging considering that the first two objectives will need to be attained along a transition period, with farmers as the active component.

Governmental initiatives can be taken at the European or national level. The EU is widening its targets with important strategic documents: the EU Green Deal (COM/2019/640) to reduce greenhouse gas emissions by at least 55% by 2030, with the horizontal topic of the Farm To Fork strategy for an environment-friendly food system. Both the above-mentioned documents involve a goal to reverse the loss of biodiversity, but this has been implemented by the document EU Biodiversity strategy (COM/2011/0244), a long-term plan to protect nature and reverse the degradation of ecosystems (Fig. 1d). Directly related to pollinators, the EU is sustaining the proposal for a European Pollinator Monitoring Scheme (EUPoMS), inspired by the national UK PoMS. In May 2021, the SPRING project (Strengthening Pollinator Recovery Through Indicators and Monitoring) started to build recommendations for the future EUPoMS. Generally, the EU MSs behave as participatory units that may act independently or associated. For SPRING, Europe has been divided into seven biogeographical zones. However, monitoring can be carried out also at the national level, through national monitoring plans: in Italy, that is the case of the Italian BeeNet (Giovanetti and Bortolotti, 2021), fostered by the Ministry of Agriculture, Food Sovereignty and Forestry through the National Rural Network. Monitoring projects, at any landscape level, are exploding worldwide (Giovanetti *et al.*, 2021), dedicated to given pollinators (butterflies, bees, syrphid flies, honeybees) or all of them as a group, to given environments (agroecosystems, parks and urban contexts included), or individual plant species (cultivated and spontaneous). While it is certainly very important to raise awareness among citizens (i.e., through the citizens' science approach applied to pollinators monitoring), still, above all actions that the EU and MSs will foster, those of major and sudden impact on pollinators' conservation are related to changes in agricultural practices.

Actions on agroecosystems: the future to be expected

Agroecosystems should be evaluated for the resilience that the applied management brings within, possibly by introducing indicators of performance (Cabell and Oelofse, 2012). The indicators should span from an ecologically oriented perspective (e.g., spatial and temporal heterogeneity; local natural capitals) to a social- (e.g., learning; legacy) and economic-one (e.g., reasonably profitable). It is expected that an approach combining ecological–social–economic orientations may need to be sustained by a different set of laws and measures. Even if being intrinsically based on totally different characteristics, an ecological–social–economic orientation will ensure wider participation in changes to be applied. A very ambitious objective that in the European Community was supposedly addressed by the CAP.

The CAP has been introduced long ago; notwithstanding it undertook numerous reforms, its main effort finally translates into an agricultural funding policy (Pe'er *et al.*, 2020). Unfortunately, agricultural intensification and industrialization are key drivers of biodiversity decline and ecosystem services loss (IPBES 2019): on the one hand, conventional agriculture improved cropping efficiency, herbicide use and fertilizer use; on the other hand, we faced an abandonment of traditional agricultural land uses, including grazing and mowing. The last CAP (2014–2020) had already renewed the approach toward a more sustainable agriculture, by incorporating obligatory measures to support environment-friendly practices. These were compiled along two main pillars and included the cross-compliance, obligatory for farmers to comply with high EU standards for public, plant and animal health and welfare; the greening payment scheme, still obligatory, contributing to about 30% of direct payments, and including ploughing, permanent pasture, crop diversification and ecological focus areas; finally, the optional agri–environment–climate measures. These schemes were not directly involving pollinators, but as mentioned above they could have counterbalanced pollinators' decline by acting at the local environmental level. However, 'greening', possibly the most interesting to sustain pollinators, resulted mainly ineffective even if obligatory (Pe'er *et al.*, 2019). The European Court of Auditors (ECA) (2020) examined the progress in the protection of wild pollinators after the Commission Initiatives, finding so far that actions delivered on biodiversity conservation, agriculture and the use of pesticides (the only measurable units) did not halt the decline. Cole *et al.* (2020) and Mottershead and Underwood (2020) resumed similar findings: when considering especially pollinators, CAP 2014–2020 measures did not result effectively. An

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important reason behind this is the absence of direct actions or measures to protect pollinators and the absence of high-level strategic importance given to wild pollinators. Mottershead and Underwood (2020) reported no overt or limited mention of wild pollinators, or strongly geared toward biodiversity, in RDPs funding options, this way missing a crucial strategic overview in five out of six case-studies. Not always the faults at the institutional level are replicated downscale: in some of the same case-studies, authors found evidence of advice available to farmers, even focusing on pollinators in general or bees. Unfortunately, these favorable conditions were not replicated in the entire MS, when dealing at the regional scale. Other reasons that may have partly contributed to the failure in pollinators' enhancement and protection along the CAP may be an unbalanced distribution of incentives, a missing effort in pressing farmers' engagement, and poor monitoring and evaluation procedures. Since farmers can choose low-demanding options, greening does not trigger any substantial change in farming practices. A shortcoming of active promotion of the importance of change in agricultural practices is especially evident in studies that highlight success when applying communication tools more adequate to the farmers' audience: cooperation and social learning, social networks and agriculture-related organizations, technical advice or extension services, farming press news (Defrancesco *et al.*, 2008; Niens and Marggraf, 2010, Pascucci *et al.*, 2011, Dedeurwaerdere *et al.*, 2015).

A new CAP is on its way: CAP post-2020. The European Commission proposed the document in June 2018 (EC, 2018), acknowledging the urgency to address environmental and sustainability challenges. The absence of a substantial variation in agricultural practices induced to modification of the structure of the previous CAP. In the new one, cross-compliance is expected to be enlarged and reinforced: to obtain direct payments, farmers need to apply more stringent rules. Greening measures have been integrated into the eco-schemes, together with agri–environment–climate measures, and payments for them can be added up. Ideally, the combination may push the adoption of more schemes by individual farmers, fostering a real change at the local landscape context. The document also suggests the introduction of a new Green Architecture by proposing a model that offers MSs higher flexibility inside their boundaries. MSs are invited to present their list of priorities in the form of eco-schemes; therefore, the EC encourages a view that includes local peculiarities following local stakeholders' groups. This is a great opportunity to foster pollinator protection. In Italy, this opportunity is acknowledged by the eco-schemes proposed to the European Commission and included an eco-scheme on pollinators (national refs: Articolo 21; DM 23 dicembre 2022, n. 660087). Four out of five eco-schemes do include changes in agricultural practice that may sustain pollinators and predicted to be coupled with the eco-scheme on pollinators. For the eco-scheme specific for pollinators, farmers will commit to the cultivation of non-productive crops reach in nectar and/or pollen resources in arable land or in the inter-row of permanent crops, including a commitment not to use herbicides and other phytosanitary products in the field and the borders in the year of engagement. Another eco-scheme refers to the grassing of tree crops: in this case, the contribution toward pollinator protection will be achieved by selecting a proper floral mixture or legumes as grassing method. Rotation of legumes and fodder crops is expected also in another eco-scheme: therefore, again food for bees. Finally, a very special eco-scheme is that related to olive grows, in which the list of commitments already includes the ones related to the eco-scheme on pollinators.

Conclusions

Regarding pollinators, the path has been long and winding. Science, on the one hand, was raising its voice to alert on the decline of pollinators, a neglected reality of the environment which may affect so deeply biodiversity and the economy. Society and citizens, on the other hand, were increasingly asking for a more sustainable environment and lifestyle, including changes in farming options. Now it is certainly time for the institution and the economy to sustain the needed changes. The new CAP may represent a great option for each MS government to prove to its citizens the care for the country, a place we share with the very important, local pollinators. This change may only develop if other important groups of stakeholders are properly driven in understanding the call from society and nature. Farmers should be able to share the reasoning behind their agricultural decisions with all other stakeholders. However, this is not always the case, as with the choice of products used to protect crops from parasitic diseases, where it is multinational corporations that influence the decisions of farmers. Perhaps EU intervention would be more effective if conducted upstream with pesticide manufacturers. Farmers should be able to use production means that do not harm pollinators and are also socio-economically sustainable for them. Now we are facing a very critical moment, worldwide with the war in Ukraine and the heavy drought that is plaguing Europe; in Italy, often adding governmental instability. However, the beginning of 2023 may sign a mark for pollinators, and shortly a new story may be told.

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