CHAPTER ONE

Conflicts between agriculture and biodiversity conservation in Europe: Looking to the future by learning from the past

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Advances in Ecological Research, Volume 65
ISSN 0065-2504
https://doi.org/10.1016/bs.aecr.2021.10.005

Abstract

Conflicts between agriculture and biodiversity conservation in Europe are increasing, due to multiple demands from agricultural ecosystems, including a growing need for high quality and good-value agricultural products, as well as the provision of biodiversity and ecosystem services. Currents trends such as globalization, European policies, and global change, such as climate change and nitrogen atmospheric deposition are potentially driving the emergence or evolution of biodiversity conflicts in Europe. These trends are interwoven with continuing debates around land-sparing and land-sharing, that often lead to conflicting perspectives and social dynamics that influence how local actors interact with each other over agriculture. Whilst some strategies have been put in place to address the potential competition between agriculture and biodiversity, such as reglementary and market-based mechanisms, and non-monetary voluntary approaches, these need to be reflected upon and improved for a future agriculture where the negative impacts of conflicts are minimized. This paper provides a comprehensive update on the current and future trends and evaluates current strategies, to highlight the importance of addressing conflict not only through technical fixes but by developing approaches that involve profound changes in agricultural systems and a shift in how people collaborate, perceive conflict and address it. We propose three emerging pathways—agroecology, a shift to partnerships, and conflict transformation—that would support a positive change for the future of biodiversity conflicts in agriculture.

1. Introduction

Agriculture covers approximately 40% of the EU land surface area (Eurostat, 2018), producing biodiverse habitats (Lomba et al., 2014; Pe'er et al., 2014) but is also considered to be the main driver of environmental degradation (Pe'er et al., 2020; Stoate et al., 2009), with land abandonment and the adoption of more intensive, mechanized, and chemically based farming production techniques further putting biodiversity under pressure (Henle et al., 2008; Stoate et al., 2009; Zabel et al., 2019). With global demand for agricultural commodities projected to require overall food production to rise by 70% by 2050, the challenge will be to maintain biodiversity whilst ensuring food security (Kastner et al., 2012; Tilman et al., 2011). The frequent trade-off between productive agriculture and farmland biodiversity has led to biodiversity conflicts (Henle et al., 2008)—understood here as *social conflict among actors with different, and often conflicting, attitudes to biodiversity conservation, and where one of these actors acts against the interest of others* (Redpath et al., 2013), henceforth, shortened to 'conflict'. In the wake of the new Common Agricultural Policy (CAP) program and European Green Deal, it is timely to explore how conflicts between agriculture and biodiversity conservation in Europe have evolved over the last few decades, and discuss the implications for the future of European agricultural landscapes.

Whilst previous research has contributed to understanding the conflict between biodiversity and agriculture (Henle et al., 2008), current trends are leading to rapid changes and the emergence of new challenges. Globalization and neoliberalism have altered trade and markets for agricultural products in Europe (Zabel et al., 2019). Dietary changes, such as a shift towards plant-based diets and an increase in processed and ready-made foods, as well as the use of agricultural land to grow biomass and materials (willow, hemp etc.), have interwoven agricultural demands and impacts around the globe and caused further changes in Europe (Billen et al., 2021; Vieux et al., 2018). Associated with increased globalization, trade and climate change, increased pests and pathogens pose a threat to farming (Anderson et al., 2004). In Europe, the withdrawal of some pesticides is causing replacement of some crops with possible changes in rotations, pest management and other responses (Ortiz et al., 2021). Moreover, interest in 'rewilding' of abandoned rural landscapes is growing in Europe, creating uncertainty for the future of traditional agricultural landscapes and livelihoods (Navarro and Pereira, 2012) and new opportunities for ecosystem restoration (Helmer et al., 2015). These profound changes have, in turn, led to modifications in social structures and/or attitudes pertaining to farming and the use or conservation of biodiversity in and around these agricultural landscapes, potentially leading to conflict (Skrimizea et al., 2020).

The future of European agriculture will depend on our capacity to learn from the above drivers, but also from strategies implemented to better address potential future conflicts, such as regulatory, market-based, and non-monetary voluntary mechanism. For example, the CAP 2021–2027 program was expected to lead to major changes through the increased implementation of agri-environment-climate measures (AECM) (Pe'er et al., 2020; Peeters et al., 2020), seen by many as the main tool to conserve biodiversity on European farmland (McCracken et al., 2015). Their role has shifted over time, from the protection of threatened habitats or species to improving and maintaining ecosystem services, such as pollination and biocontrol (Ekroos et al., 2014). However, AECM have become subject to fundamental criticisms for their insufficient ability to deliver biodiversity gains (Herzon et al., 2018; Kleijn et al., 2011; Leventon et al., 2017; Moran et al., 2021; Moxey and White, 2014). Progress has also been made regarding the implementation of the Natura 2000 network, which is considered the most important European conservation strategy to protect habitats and species (European Environment Agency, 2019), but which is still struggling with acceptance and is an arena for many new conflicts linked to its conservation successes (e.g., Bonsu et al., 2019; Kuijper et al., 2019). Finally, whilst calls for more participatory approaches to address biodiversity conflicts in agricultural landscapes have been made repeatedly (Henle et al., 2008), stakeholder participation is laden with difficulties of poor process design, lack of resources, different understandings and expectations of processes and outcomes (Jager et al., 2020; Reed et al., 2018; Sterling et al., 2017; Young et al., 2013). Building future strategies on lessons learned from the past will be essential to support improved strategies for sustainable agriculture and biodiversity conservation.

Many possible ways forward have emerged over the last decades. These include the call for a transformed and nature-based agriculture (e.g., agroecology), including many alternative agri-food movements and biodiversity-focused marketing (Vanbergen et al., 2020). There has also been a shift towards promoting empowering forms of participation emphasizing discussion and research on questions of partnerships, governance, and justice (Coolsaet, 2016; Gavin et al., 2018; Runhaar, 2017). These share a vision that acknowledges diverse stakeholder objectives, pluralistic worldviews, institutions at different scales, and the need for partnership-based, pluralistic and dynamic approaches to conservation (Gavin et al., 2018). Finally, conflict transformation is emerging as an alternative to conflict resolution (Madden and McQuinn, 2014). This proposes a paradigm shift to a longer-term process that can generate greater justice and reduce the negative impacts of conflict in relationships and society by understanding and addressing the relational and historical patterns in which conflict is embedded (Lederach, 2003; Rodríguez and Inturias, 2018).

Based on the acknowledgement that both agriculture and biodiversity conservation are required for human existence and well-being, this paper takes conflicts as a lens through which to examine possible futures that promote synergies for a more sustainable agriculture and maintenance of biodiversity. To understand the context, growth, and management of conflicts as defined earlier, it is important to understand what drives harmful interactions between agriculture and biodiversity, resulting in divergent interests from different actors. Seeing conflict as a human endeavour includes approaches that address the difference between objectives and values instead of technical solutions. However, changing agriculture practices and the different strategies to protect biodiversity will be inherently part of those processes. Based on this understanding, the paper is divided in three sections: a review of current trends of drivers of conflicts, including international trade, policies, climate change, land-sparing and land-sharing, and social dynamics; an analysis of the role of existing strategies, such as agri-environment schemes, Natura 2000 and participation, in addressing the conflict between agriculture and biodiversity conservation; and finally a reflection on pathways and emerging approaches that can address the more profound social dimension and challenges to the future of biodiversity conflicts in agriculture.

2. Current trends of drivers of biodiversity conflict

2.1 Economic factors and international trade

Most of the proximate causes of biodiversity loss due to agriculture, such as expansion of farmed land, intensive cropping practices and application of agrochemicals (Vanbergen et al., 2020), are driven by economic factors, acting either to increase farming outputs or the competitiveness of the agricultural enterprise. Increasing populations and changes in diet are driving an increasing demand for agricultural produce, with different trends both between Europe and other regions, and between different European countries (Kearney, 2010). Food production in Europe (AGRI, 2021) and food imports (Eurostat, 2021) have increased to match this demand. There has also been a substantial rise in food exports from the European Union (EU) (Eurostat, 2021). Agricultural productivity has also increased, which is part of a long-term, global trend. For example, cereal production rose about 9% in the EU between 1997 and 2021 whilst the area used to grow cereals dropped by 14% (AGRI, 2021), the rise in production being achieved by an increase in productivity. It has long been recognized, however, that increasing productivity has not been matched by increasing farming incomes, resulting in a market treadmill: a continual drive towards further productivity that further weakens farmers' relative income (Czyżewski et al., 2019) and increases pressure on biodiversity (Rebanks, 2020). Finally, the combination of globalization, increased trade, climate change and changes in permitted chemical use (including pesticides, fungicides and herbicides) in Europe means that plant and animal pests and pathogens are presenting new and increasing threats to agriculture and the natural environment (Freer-Smith and Webber, 2015; Marzano et al., 2017).

Although economic conditions and policies within individual countries and in Europe as a whole, particularly through the influence of the CAP (see below), are major drivers of production, productivity and the impacts of agriculture, international trade is an additional force. Recent trends in globalization and neoliberalism are having major impacts on trade in agricultural products, with consequences for crops and livestock production in Europe and globally (Zabel et al., 2019). In the context of globalization and neoliberalism, European agriculture is at a competitive disadvantage. Agriculture in the majority of EU countries is not capable of meeting direct competition from US agriculture (Pawlak et al., 2021) and Australia relies on unsubsidized, highly productive agriculture in contrast to the European Union, which has sought to maintain trade barriers in order to protect European agriculture from other markets (Dibden et al., 2009). Despite such protection, farming systems now face many challenges such as more volatile prices in liberalized markets and sudden changes in access to markets (Meuwissen et al., 2019).

The impact of international trade and economic conditions has many possible outcomes for European agriculture and its conflicts. First, increasing competitiveness is contributing to changing agricultural practices in existing cropping and animal husbandry systems. For example, the number of farms in Europe has continued to decline and farm size has increased (Eurostat, 2021). Associated with this, there has been an increase in intensive practices such as agrochemical usage, which appears not to have declined recently despite European policy seeking to limit the use of plant protection products (EEA, 2018), and a decline in traditional practices such as crop rotation and mixed farming (Marini et al., 2011; Stein and Steinmann, 2018).

Although the contribution of individual drivers such as globalization is unclear, increased competition amongst producers (both within and between agricultural products), continues to drive the long-term trend towards more intensive and less environmentally-sensitive agriculture, as demonstrated both by agricultural statistics (AGRI, 2021) and accounts from within the farming community (Rebanks, 2020). Furthermore, although food processing and other phases of food production contribute to environmental damage, life cycle assessment demonstrates that the agricultural phase has the greatest impact (Notarnicola et al., 2017).

A second outcome of globalization and other drivers of change in agricultural practices is that particular cropping or animal systems become uneconomic, resulting in, for example, land abandonment or the cessation of traditional practices such as transhumance. These trends have been occurring in Europe for many decades but globalization may be accelerating them: Perpina Castillo et al. (2018) estimate a loss of 3% of agricultural land between 2015 and 2030, but 7% under a more extreme scenario with a lack of CAP or other support for extensive farming and tough global competition amongst agricultural products. Thus, international trade and economic conditions within Europe leading to a combination of increased intensification and land abandonment may create opportunities for allowing natural succession of abandoned farmland (e.g., Broughton et al., 2021), a form of what is now often referred to as rewilding, or the expansion of protected areas, perhaps conceived within a policy of land sparing, explored later in the paper (Adams, 2019; Phalan, 2018; Vannier et al., 2019).

Thirdly, although the focus of this paper is on European agriculture and its impact on biodiversity, globalization, particularly the increased global trade in agricultural produce to meet the increasing demands of European food consumption, has an impact on biodiversity globally (Crenna et al., 2019). For example, trade in cattle and oilseed products to Europe and elsewhere is a major driver of recent tropical deforestation (Fehlenberg et al., 2017; Pendrill et al., 2019). Much attention has been placed on the potential impacts on biodiversity of oil palm expansion. However, as with other crops, the impact depends on what type of land is converted to oil palm, whether, for example, primary forest, secondary logged forest or rubber plantation (Koh and Wilcove, 2008).

As discussed below, the future of European agriculture depends not only on the international context but also on the EU's Common Agricultural Policy (CAP). If farming becomes more influenced by international trade agreements, the influence of the CAP on some parts of the agricultural sector could be quite significant. Analysis of the impact of removal of CAP support on UK agriculture, for example, suggests that net exporters, such as sheep farmers, would be particularly harmed (Hubbard et al., 2018). Agricultural policies and practices vary across the world and although European policy ensures common standards across the EU, environmental and welfare considerations may be integrated in international trade agreements, such as preferential trade agreements (PTAs) (Kolcava et al., 2019). Certification could play an increasing role in setting standards for food production in relation to biodiversity, for example within organic agriculture. However, organic crop certification systems vary between the European Union and elsewhere and the lack of experience, complexity and high cost of certification can limit the involvement of small producers in organic farming (Esteves et al., 2021).

2.2 The new Common Agricultural Policy (CAP)

As seen above, the CAP has had far-reaching structural impacts on conflicts between agriculture and biodiversity conservation. The CAP is divided into two pillars. The first pillar consists mainly of general income support and market measures, but encompass direct payments that are given to agricultural practices that covers activities related to climate, environment, animal welfare and antimicrobial resistance and contribute to reaching the EU green deal targets (e.g., see Eco Schemes). The second pillar comprises funds addressing more directly actions that can contribute to environmental protection, e.g., rural development programs, Agri-Environmental-Climate Measures (AECM—see Section 3.2.1) and payments for organic farming (Pe'er et al., 2020). Despite numerous reforms in the last decades, its core—market stabilization and support of food production—has remained remarkably stable.

Evidence indicates that the CAP has led to biodiversity loss in Europe (Assandri et al., 2019; Emmerson et al., 2016; Reif and Vermouzek, 2019) with measures to counter this trend found to be largely ineffective (Gamero et al., 2017; Scown et al., 2020). For example, the ecological effects of greening (Ekroos et al., 2019; Hristov et al., 2020) and AECM were smaller than expected with regard to reversing the trend of biodiversity loss (Pe'er et al., 2017), largely due to an underfunded, insufficient and partly equipped second pillar of the CAP, with impractical indicators (European Court of Auditors, 2020). Another critique on the 2014–2020 CAP relates to direct payments being linked to farm size (Heyl et al., 2020), preventing smaller farms from taking a greater role in biodiversity conservation (Peeters et al., 2020).

Although minor changes in distribution measures have been introduced in the post-2020 CAP negotiations, direct payments remain linked to farm size, potentially promoting further social inequalities. Other changes in the post-2020 CAP include 'Eco-Schemes', or annual payments per hectare bound to climate and environmental measures making up 20–30% of the financial budget of the first pillar (Heyl et al., 2020), but critics highlight these are underfunded and compromised by too many 'exception' rules to have a significantly higher impact on biodiversity than the existing greening measures. Whilst 40% of the CAP budget is labelled as 'climate friendly', this includes 'Payments for Natural Constraints' that do not have explicit climate objectives. Finally, Member States have greater scope to shape implementation of the CAP through national Strategic plans, but this may reduce standards in relation to biodiversity with a possible 'race to the bottom' regarding regulations between states (Šumrada et al., 2020). Nonetheless, with the new CAP due to start in 2021, predicting the impact of the new CAP measure is difficult (Pe'er et al., 2019, 2020), as are likely conflicts arising from these new measures.

2.3 Global change

2.3.1 Climate change

The impacts of climate change on biodiversity influence socio-ecological processes and are already giving rise to new biodiversity conflicts. Climate change is rapidly becoming driver of biodiversity loss, causing shifts in species' distribution and altering species abundance, composition and food webs (Arneth et al., 2020; Bellard et al., 2012; Henle et al., 2010; Reino et al., 2018; Renner and Zohner, 2018). For example, warming temperatures have contributed to the emergence of conflicts over the conservation of Greenland barnacle geese (*Branta leucopsis*) and agriculture on the Scottish island of Islay (Mason et al., 2018); whilst the upslope shift of climate zones in the Italian Alps is expected to intensify conflict between recreation and biodiversity conservation due to an increase in the degree of overlap between threatened bird species habitat and the areas most suitable for future ski infrastructure (Brambilla et al., 2016).

Climate change also introduces or intensifies biodiversity conflicts through more indirect social-ecological interactions such as climate change mitigation measures (Watson, 2014; Arneth et al., 2020). Gasparatos et al. (2017) demonstrated how different renewable energy technologies (e.g., wind, solar, geothermal, hydro) link to at least one of the five direct drivers of ecosystem change and biodiversity loss identified in the Millennium Ecosystem Assessment namely habitat loss/change, overexploitation, introduction of invasive species, pollution and climate change. In this context, it is worth noting that in Western Europe, renewable energy facilities under development largely overlap with important conservation areas (Rehbein et al., 2020) and also come in competition with agricultural land, resulting in conflicts amongst actors (Huber et al., 2017). Shifting crops from food to biofuels may also have indirect land-use change effects such as the release of sequestered carbon, increased pressure on biodiversity, soil, water quality, food prices and supply, concentration of land tenure, displacement of workers and local communities, and cultural disruption (Tamburini et al., 2020). Another land-based climate change mitigation strategy, converting diverse natural vegetation to monoculture forestry plantations to capture GHG emissions, may adversely affect biodiversity (Shoyama et al., 2013), whilst also increasing competition for land thereby putting pressure on conservation areas, agriculture systems and ultimately food production (Arneth et al., 2020). Mitigation of climate change can also result in further intensification of production, often to the detriment of agricultural biodiversity, because intensive production tends to have lower GHG emissions when measured per unit of product produced (e.g., Ripoll-Bosch et al., 2013).

Other potential conflicts linked to climate change are the water use efficiency of crops, the geographic distribution, seasonal phenology and overwintering capacity of fungi, and the decline in agricultural soil fertility (Benaud et al., 2020). Whilst some authors fear these trends may lead to increased cultivation of Genetically Modified Organisms (GMO) (Henle et al., 2008), many highlight the recent efforts in the collection and development of new cultivars and new technologies around crop breeding (Lopes et al., 2015; Miedaner and Juroszek, 2021; Raza et al., 2019). Organic farming along with other forms of sustainable farming with reasoned crop rotation and buffer zones may have an important role in terms of addressing agricultural soil fertility, by promoting soil C sequestration (Diacono and Montemurro, 2010) and biodiversity in the production fields (Schneider et al., 2014). Further measures to promote habitat richness at larger scales will also play an important role in maintaining biodiversity (Schneider et al., 2014).

Some of the examples above illustrate that agriculture is adding another layer of complexity in the climate change-biodiversity nexus, with different impacts varying in significance and across Europe. Climate change is projected to reduce crop productivity in parts of southern Europe, whilst improving the suitability for growing crops in other parts of Europe, especially in northern Europe. The projected increase in extreme weather and climate events is expected to increase crop losses and reduce livestock productivity across all regions in Europe (Hoegh-Guldberg et al., 2019). However, certain adaptation measures at farm level could have positive effects on climate change mitigation and develop synergies with biodiversity conservation, for example through the design of climate change-resilient farming systems, the increase in the demand for diversification or the development of agroforestry systems (Altieri et al., 2015; Hoegh-Guldberg et al., 2019; Isebrands and Richardson, 2014).

2.3.2 Nitrogen atmospheric deposition

Although nitrogen is a naturally limiting element for animals and plants in many ecosystems (Vitousek and Howarth, 1991), agriculture contributes to the continuous increase of reactive nitrogen (Nr) creation, a major threat to European terrestrial biodiversity causing eutrophication in water bodies, reactive nitrogen emission into the atmosphere and deposition on ecosystems (Dise et al., 2011; Galloway et al., 2008). The decline of biodiversity in ecosystems, particularly studied in semi-natural grasslands in Europe, is directly linked to this nitrogen pollution (Dupré et al., 2010; Stevens et al., 2004). The mechanism is simple: atmospheric deposition acts as a fertilizer, favouring productive species which competitively eliminate slower growing plants. The consequences are diverse: more biomass and growth for some productive species such as grasses, fewer flowering plants, with the consequence of accommodating fewer pollinating insects—and the ecosystem services they provide.

Whilst this phenomenon has been recognized as a conservation issue in Europe since the Habitats Directive in 1992, reactive nitrogen production has increased tenfold in 100 years, and the trend is accelerating, resulting in a situation where although traditional agriculture has created historical species-rich ecosystems, the intensification of agriculture is on the verge of causing them to disappear through an indirect and distant effect. To compound matters, nitrogen ‘leaks’ are numerous throughout agricultural processing chains: at the source of fertilizers during their production, around livestock buildings and when spreading in fields. The longer the chain, the more numerous the leaks and the harder it is to understand the full consequences of these continuous nitrogen inputs on ecosystems. Finally, it would appear that interactions with climate change (see previous section) are synergistic, so that the changes encountered by ecosystems add up under the effect of the two pressures (e.g., Boutin et al., 2017). Whilst there is a mobilization of the research communities (see the International Nitrogen Initiative (INI); Sutton et al., 2011), the translation into efficient policies is lacking.

2.4 The continuing debate between land-sparing and land-sharing

Surrounding the question of conflicts between agriculture and biodiversity conservation is the ongoing debate around 'land sparing' (i.e., different landscapes have discrete primary objectives, e.g., food production or biodiversity conservation) and 'land sharing' (i.e., integrating conservation targets into sustainable human land-use, e.g., organic agriculture, close-to-nature forestry) (Erz, 1978; Grass et al., 2020; Habel et al., 2015; Shackelford et al., 2015). As already pointed out by Erz (1978), the different dependencies and sensitivities of species on/to agriculture, with many species including threatened ones depending on (extensive) agricultural use of the land for their survival (Henle et al., 2008; Kleyer et al., 2007), may require a spatially differentiated combination of land sparing and land sharing. However, the recently renewed international debate around land sparing and land sharing has led to discussions around new approaches for agriculture production, such as sustainable intensification and new approaches for biodiversity conservation, such as rewilding, and also resulted in new conflicts regarding which option should be adopted and how.

2.4.1 Sustainable intensification

Sustainable intensification is considered part of the land sparing approach, according to which biodiversity is an environmental good that is potentially valuable for eco-agricultural methods (Levidow, 2018), and where increasing yield in a land-sparing context does not systematically imply wildlife-unfriendly farming systems (Phalan, 2018). In this context, sustainable intensification has attracted much attention as a term that describes management practices or systems 'designed to achieve higher and/or more stable agricultural yields whilst simultaneously reducing or reversing the negative impact of food production on the environment' (Dawson et al., 2019; Wezel et al., 2015). This means producing more from less

(Lal et al., 2015) through synergistic opportunities for the co-existence of agricultural production and so-called natural capital (Pretty et al., 2018), such as boosting agricultural yield potential; improving nutrient use efficiency; enhancing soil fertility, enhancing biodiversity and ecosystem services, and minimising greenhouse gas emissions (GHG) (Tilman et al., 2011). Whilst sustainable intensification does not refer to any single management practice or system per se (Thomson et al., 2019), it can include integrated pest management, conservation agriculture, integrated crop and biodiversity, pasture and forage systems, tree incorporation, irrigation management and small/patch farming (Pretty et al., 2018; Purvis et al., 2012). Sustainable intensification is expected to bring significant benefits to further sustainable development and environmental protection, regarding for example the negative effects of bioenergy (Creutzig et al., 2015; Scarlat et al., 2015). To do so, different sustainability criteria (e.g., land use efficiency, production life cycle analysis, efficient energy conversion technologies) should be considered. For example, introducing non-native but high-yield plants to Europe (e.g., *Miscanthus* sp.) is better for both soil and water quality, and local biodiversity than growing current annual crops (Haughton et al., 2016; Winkler et al., 2020). However, according to principles for sustainable development, usage of biomass crops from natural species more adapted to local conditions and ecosystems, should also be considered (Heinsoo et al., 2011). Another approach includes utilization of biomass mixtures of native grassland perennials from abandoned or degraded agricultural lands that provide a reasonable amount of energy with positive environmental impact and without conflict relative to competition for food security (Tilman et al., 2006). A potential underutilized agricultural source for bioenergy feedstock is the herbaceous biomass from semi-natural grasslands that is not required for husbandry feed (Heinsoo et al., 2010; Herzon et al., 2021; Melts et al., 2019). Such grasslands are important for biodiversity and provide a broad range of ecosystem services (Bengtsson et al., 2019; Dengler et al., 2014; Kleyer et al., 2007). Finally, improving the agricultural rotations with legumes could provide feedstock for more advanced bio-based products through biorefinery options whilst supporting climate change mitigation (Jensen et al., 2012).

However, studies have argued that sustainable intensification can lead to diverse socio-ecological trade-offs across multiple spatiotemporal scales and rarely eliminate those between biodiversity and agriculture (Barnett et al., 2016). For instance, even moderate application of nutrients to increase the hay yield from semi-natural grasslands can decreased plant biodiversity

(Heinsoo et al., 2020). Moreover, in the context of industrial agriculture in the global north, crop yield increase due to sustainable intensification does not decrease the arable land area at the regional scale (Ewers et al., 2009), calling into question the assumption that the land 'saved' will necessarily increase the area of arable land left to biodiversity conservation (Hamant, 2020). In addition, from a social sustainability perspective, sustainable intensification as a 'technological fix' often ignores consideration of livelihoods' sustainability and justice, which implies that vulnerable social groups can suffer disproportionately from the abovementioned loss of ecosystem services and trade-offs of sustainable intensification (Barnes et al., 2016; Rasmussen et al., 2018; Shackelford et al., 2015). Sustainable intensification may also fail in improving actual food security with its focus on food production instead of food accessibility (Loos et al., 2014). High yields are a condition for land sparing, and not by themselves a particularly effective lever by which to make it happen, implying that other, more effective levers such as spatial planning, economic incentives, certification, and strategic deployment of infrastructure, knowledge and technology should be considered (Phalan, 2018).

2.4.2 Rewilding

Farmland abandonment is an important land-use change process in Europe which to-date has primarily been concentrated in Eastern and Southern Europe (Estel et al., 2015) and has long been perceived as a threat to biodiversity conservation and a trigger to biodiversity conflicts (Henle et al., 2008). With a loss of 19% of cropland and 6% of pastures and semi-natural grasslands between 1950 and 2010 (Fuchs et al., 2012), due in large part to a decrease in rural population (Navarro and Pereira, 2012), rural abandonment has led to landscape and biotic homogenization and loss of valuable species and habitats (Honrado et al., 2017). As a consequence, semi-natural vegetation types like some scrublands and woodlands have increased and the process of vegetation succession has led to the loss of species-rich grassland and other open habitats (Lasanta et al., 2015; Queiroz et al., 2014). The loss of such habitats has ecological but also social impacts as the cultural landscapes of Europe are the result of the agricultural activities of previous generations and are closely associated with rural inhabitants' identity and sense of place (Agnoletti, 2014; Barnaud et al., 2021; Quétier et al., 2010). In order to preserve biodiversity and social aspects in this changing landscape, much of current European policy and legislation on biodiversity focuses on land-sharing strategies, with the protection of habitats and species characteristic of extensive farmland, through mowing, subsidized grazing, and the maintenance of traditional agricultural practices. In recent years there has also been greater recognition that securing a future for some High Nature Value (HNV) farmlands will also need to involve improving social services in rural communities, designing new uses for HNV goods, and developing new business opportunities on HNV farmlands (Lomba et al., 2020).

Agricultural and pastoral abandonment can, however, be seen as an opportunity for rewilding European landscapes, supporting ecological benefits for both nature conservation and the provision of ecosystem services (Ceauşu et al., 2015; Navarro and Pereira, 2012; Perino et al., 2019). As a land sparing strategy, rewilding 'recognizes that the majority of ecosystems have been modified by humans, but identifies opportunities for decreasing the human pressure on ecosystems and restoring the more natural biodiversity dynamics and ecosystem services associated with wilderness' (Ceauşu et al., 2015, p. 1024). Rewilding can provoke strong emotional responses to wild nature and wild ecosystems, both positive and negative (Holmes et al., 2020). For example, the relatively recent and accelerating expansion of large carnivores (mainly wolves) across Europe, seen by some as a conservation success-story (e.g., Chapron et al., 2014), has been increasingly controversial (Linnell et al., 2015). For the people living and working in areas undergoing rewilding, the return of unfamiliar and potentially dangerous large carnivores can be a significant source of conflict due, in part, to increased risk of predation on livestock (and valuable game species), its direct and indirect costs, and the resulting individual and social trauma (Dorresteijn et al., 2016; Salvatori et al., 2020; Skogen et al., 2017). Rewilding questions the multiple worldviews and value for biodiversity and how can we integrating those different values in policies, governance systems and political structure (Leventon et al., 2021; Pascual et al., 2021), but also some more profound moral and philosophical dimensions, including the appropriate ways in which humans should interact with nature (Mace, 2014).

2.5 Social dynamics

The future of European agricultural landscapes and of conflicts between agriculture and biodiversity conservation will be greatly affected by social dynamics and broad societal trends, and farmers' willingness and capacity to adapt to these trends. The arrival of a neo-rural population, for example, can amplify existing conflicts, bringing new demands for alternative land-uses that focus more on nature protection and recreation, and which can come in conflict with locals' practices and expectations (Mann and Jeanneaux, 2009; Phillips, 2005). Urbanization, as another example, has created a 'distance of the human population from the site and process of food production altering social and ethical attitudes pertaining to farming and the use or preservation of nature' (Vanbergen et al., 2020, p. 199), and different dietary expectations and choices such as increased demand for meat due to greater economic affluence, or reduced or zero meat-based diets (IPBES, 2019; O'Keefe et al., 2016; Willett et al., 2019). These new societal concerns and the values that societies place on food, biodiversity and ecosystem functions, goods and services add new complexities and external pressures on farmers' decisions and livelihoods.

Indeed, biodiversity conservation on agricultural land will depend on the capacity and willingness of farmers to adapt to environmental conditions and social expectations (Moser and Ekstrom, 2010). For instance, under changing climatic conditions farmers might decide to adapt their practice by changing their business model (or even stop farming) or changing the location of key activities (Vermeulen et al., 2018), which will have different consequences on the landscape. Those decisions do not depend solely on technical consideration but are deeply embedded in social aspects, such as farmers' identity and peer pressure (Marshall et al., 2014), but also in the wider agricultural and institutional contexts that will create opportunities or limitations for farmers to adapt (Dowd et al., 2014; Martin et al., 2018; Park et al., 2012; Vermeulen et al., 2018). Previous studies have shown that involving farmers in decision-making as equal participants has often proved difficult. For example, in different sustainability assessment frameworks analysed by Slätmo et al. (2017), farmers have limited ability to set the agenda (e.g., to choose the questions in focus and/or indicators calculated). Farmer response will often result in difficult trade-offs in their views on their practices, environment, roles, responsibilities and social norms which might result in conflict with other actors and their ability to participate (Mann and Jeanneaux, 2009).

When thinking about conflicts between agriculture and biodiversity, it is also important to recognize that agricultural systems and farmers are diverse and may range from large agribusinesses to small-scale farmers with varied socio-economic status and often diverging values, interests, alliances, and power (Coolsaet, 2016; Hervieu and Purseigle, 2012). As mentioned above, in Europe farms are disappearing, mostly for economic reasons, with small and medium-scale farms being confronted by competition for and appropriation of land and water resources by other actors/sectors, market forces, and external factors, such as climate change and disease (Caron et al., 2018). Many farmers live in increasingly economically precarious situations, whilst at the same time not being able to partake in direct and empowered forms of participation creating threats to their knowledge and livelihoods. For example, despite the key role of large-scale agribusinesses and concentrated supply chains, the public identifies farmers as being the most direct cause of environmental damage (Harris and Bailey, 2002). This leads to farmers often being simultaneously seen as custodians of the rural countryside and its polluters, whilst their knowledge and contributions can be often marginalized by scientists and industry (Fonte, 2008; Rodrigo and Ferragolo da Veiga, 2010). This results in a social malaise within the profession reflected through high suicide rates (Deffontaines, 2014), protests (van der Ploeg, 2020), the low number of young farmers (White, 2012) and more hidden struggles related to knowledge and recognition (Coolsaet, 2016; Janker, 2019; Pimbert, 2018) (also see the recent report from Copa-Cogeca 'Farmer's Confidence Barometer' that show through a survey with 2,500 farmers in Italy, Hungary, France and Germany that the feelings of outside criticism is felt differently in different country, with France farmer being the most affected). Whilst this issue is rarely addressed in the literature addressing conflict between biodiversity conservation and agriculture, we contend it is part of the deep-rooted nature of the conflict and that future approaches, including those undertaken as part of CAP, should better address social justice and equitability between producers, workers and consumers (Feola, 2015).

3. Existing strategies addressing conflicts between agriculture and biodiversity conservation

To halt biodiversity decline in Europe, different strategies and tools have been applied such as the implementation of protected areas or the development of agri-environmental schemes. They rely on regulation, which involves the creation of legislation and the prohibition or enforcement of certain behaviours by law; market-based mechanism which propose economic incentive to changes behaviour through different channels; and finally, voluntary non-monetary approaches where farmers are encouraged to undertake activities that can benefit biodiversity without financial reward or coercion. Whilst those strategies do not directly try to reduce conflicts, they are important as they propose protection and practices that reduce the threat on biodiversity and enhance the synergies for biodiversity conservation on farmland. Here we review those strategies and principal associated tools and emphasize how they can trigger or reduce conflict. We finish this section with a review of participatory processes, a strategy promoted to directly address conflict relative to agriculture and biodiversity.

3.1 Reglementary mechanisms

Regulations such as the Nature Directives and Water Framework Directive have been used in Europe to protect biodiversity but also to control farmers' practices, for example through the ban on certain pesticides or the establishment of Nitrate Vulnerable Zones (NVZs) under the European Union (EU) Nitrates Directive. Here we review two such regulations: the Natura 2000 network; and mitigation strategies including biodiversity offsetting.

3.1.1 Evolution of Natura 2000

The Natura 2000 network aims to 'enable the natural habitat types and species' habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status in their natural range' (Habitats Directive, Article 3(1)). In order to achieve this aim, it consists of Special Protection Areas (SPAs) set up under the auspices of the Birds Directive, and Special Areas of Conservation (SACs) to comply with requirements under the Habitats Directive. As of 2019, 18% of the EU's territory was part of the Natura 2000 network, making it one of the largest networks of protected areas in the world (EU Barometer, 2021). In spite of notable success-stories (e.g., Princé et al., 2021), there are, however, concerns over the implementation of the network, including insufficiently tailored EU funding mechanisms, inadequate monitoring and evaluation systems, and insufficient partnership with local authorities and other stakeholders in the Member States (European Commission, 2016; European Court of Auditors, 2017).

The latter concern reflects the slightly unusual characteristic that Natura 2000 is, in theory at least, not a network of strictly protected areas but a network of areas managed for the purposes of conservation but where certain human activities can be allowed, and even promoted, provided they are beneficial to biodiversity (Young et al., 2013). The integration of local actors is therefore not only important in securing their help in managing sites, but also in more general acceptance and ownership of protected areas and species. However, the top-down, scientifically driven selection of Natura 2000 sites initially led to widespread resistance to the network (e.g., Alphandéry and Fortier, 2001). In Finland, for example, the network caused major conflicts between landowners and environmental authorities, leading to hunger strikes by forest owners of Karvia (Bergseng and Vatn, 2009) and ultimately affected countrywide attitudes towards biodiversity conservation. This trend was repeated in newly accessed EU Members states, with conflicts reported in Slovenia, Poland and the Czech Republic to mention a few, over restrictions to human activities (e.g., farming, forestry, hunting etc.); an increase of bureaucratic procedures; ill-defined institutional roles; and conflicts due to a lack of information about Natura 2000 requirements (Gallo et al., 2018; Maczka et al., 2021; Schneider et al., 2020). Over the last few years, there has been more information on the form public participation is actually taking in the implementation of Natura 2000 (e.g., Blondet et al., 2017; Kovács et al., 2017; Young et al., 2012) but doubts remain over the long-term acceptance and willingness to engage by stakeholders (Salvatori et al., 2020). This is particularly topical as we are increasingly seeing conflicts emerging linked to conservation successes of the network now that the Natura 2000 network is getting better established (e.g., Bonsu et al., 2019; Nilsson et al., 2019).

Looking to the future, a number of commitments and actions regarding nature conservation and restoration are outlined in the EU Biodiversity Strategy. As part of this, a key ambition is to enlarge the existing Natura 2000 network to 30% of the EU's land and sea area by 2030, with strict protection for areas that have high biodiversity and climate value (European Commission, 2020). The EU's nature restoration law, currently being prepared, is likely to put forward plans to restore degraded habitats and ecosystems whilst contributing to other ecosystem services such as carbon sequestration and disaster risk reduction. Considering the challenges of establishing the current Natura 2000 network, it is likely that such an expansion of area and ambition will lead to further conflicts, unless lessons are learned from the initial selection and implementation of SACs and SPAs.

3.1.2 Mitigation strategies and biodiversity offsets

In the past decade in Europe, there has been a move towards the development of mitigation strategies, including biodiversity offsetting as a way of halting biodiversity losses caused by the development of infrastructure and urbanization. Increasingly, government and corporate policies (e.g., from agri-businesses) refer to the 'mitigation hierarchy' that requires developers, including proponents of some agricultural projects, to reduce adverse outcomes for biodiversity through sequentially following four steps, the first three of which are to avoid and minimize biodiversity losses, and then, as far as possible, restore/rehabilitate areas that were damaged. Avoidance is a crucial first step because rehabilitating or replacing many biodiversity features is often either impossible or unfeasible (Milner-Gulland et al., 2021). Only after completing the first three steps, should the fourth be taken, which is compensating for any residual losses through biodiversity offsetting. When applied as the final step of the mitigation hierarchy, biodiversity offsets are typically intended to achieve a net outcome in which there is (at least) 'no net loss' of the impacted biodiversity as a result of a particular project (BBOP, 2012; Bull et al., 2016; IUCN, 2016). Increasingly though, mitigation policy including ecological compensation, requires project developers to achieve more than no net loss, and is framed around net gain objectives (Bull and Brownlie, 2017; de Silva et al., 2019; Rainey et al., 2014; zu Ermgassen et al., 2021). This policy shift towards net gain outcomes seems well-timed and neatly aligned with the increasing ambition of the Post-2020 Global Biodiversity Framework, where no net loss alone will be insufficient to achieve the biodiversity increases called for by 2030 and 2050 (Milner-Gulland et al., 2021). Whilst being a positive evolution, it is important to remember that the underlying logic of biodiversity offsets are based on the 'polluter-pays' principle, and not the 'beneficiary-pays' such as in the payment for ecosystem or environmental services contract. The objective of offsets is not to benefit from the actions implemented by farmers but to compensate for the impacts of a development project or program, as part of a regulatory obligation (the origin of the process is not voluntary in most cases).

Those policies directly affect the relationship between agriculture and biodiversity. At the beginning, restoration activities aiming at ecological gain for offsets were often conducted on agricultural land specifically acquired for this purpose by developers (Le Coent et al., 2017). The result was that it directly increased the competition for land availability and potential social conflict with farmers; with farmers perceiving these policies as another threat (in addition to urbanization) causing them to lose land. Furthermore, as well as being subject to requirements to mitigate their impacts, farmers can also be involved in delivering biodiversity gains aimed at offsetting impacts on biodiversity by third-parties (e.g., infrastructure, energy or extractive projects) (Calvet et al., 2019). Farming practices that are favourable to certain target species or habitats, often identified in the context of AECM or Natura 2000 management plans, can be extended in the context of offsets. This is a widely adopted approach to offsetting in countries such as Germany and France (Wende et al., 2018).

The use of contracts between developers and famers in the context of biodiversity offsets include different opportunities and challenges. The opportunities identified relate to a lower cost for developers than buying land, more flexibility and adaptability due to the contract format in case of environmental or institutional changes, and finally, a better acceptance by farmers as it reduces the pressure on land and is an additional source of outcomes for them (Calvet et al., 2019). However, there is also a strong limitation regarding the potential for biodiversity conservation. Vaissière et al. (2018) found that farmers seemed to prefer measures that were short-term and lacking ambition, that could only compensate for temporary impacts on natural or semi-natural environments whose biodiversity has already been degraded. One of the main challenges also lies in the possibility to control and monitor the results as they are implemented under a contract and no direct management (Calvet et al., 2019). Furthermore, some situations even led to windfall effects, meaning that farmers only adopt under those contract practices favourable to biodiversity that they would have adopted anyway, which raise serious questions on the ecological additionality of the implemented actions, and risks crowding out AECMs (Calvet et al., 2019). Finally, whilst the contract can last 25 years, there is no guarantee from any party that offset measures will be sustained, although the ecological damages provoked by the infrastructure will remain.

Questions then remain on how to best implement such mitigation strategies. The expansion of offsetting outside of the Natura 2000 network in the European Union (EU) that occurred in the early 2010s encountered strong opposition from environmental groups and the business sector (Corbera et al., 2021). In 2014, the European court of Justice took a landmark decision clarifying the limits of restoration action and stopping the potential for flexible mitigation that did not consider the precautionary principle (Schoukens and Cliquet, 2016). However, offsetting policies are still present in many European countries and are after the drawback due to the European court of Justice decision in 2014, start to be included again in national policies (Corbera et al., 2021). If those policies have to be implemented, special attention should be given to not increase the already existing land-use competition on agricultural land and integrate a better understanding of the acceptability of such policies by farmers. For example, whilst farmers show economic motivation to enter into such processes, the moral and social norms, including their personal opinion on such policies, but also other farmers' decisions, are important determinants of participation (Calvet et al., 2019).

3.2 Market-based mechanism

Environmental regulation can have limited success in positive behavioural change unless combined with other approaches, such as market based- mechanisms that use 'prices or other economic variables to provide incentives for actors to reduce environmental damage, support better environmental practices, and prevent the depletion of a natural resource' (Chobotová, 2013, p. 42). In this section, we focus on agri-environmental schemes and other market-based mechanisms together with their implications for biodiversity conflict.

3.2.1 Learning from agri-environmental schemes

Agri-environmental schemes (AES) or, presently, agri-environment-climate measures (AECM) have been one of the most important strategies to try to protect and improve biodiversity on agricultural land. They can be traced back to 1985 and were conceived as a mechanism to compensate farmers for loss of income associated with introducing more appropriate, less intensive management of environmentally sensitive areas (Batáry et al., 2015). They are proposed and funded through the CAP and whilst they became compulsory for all EU Member States in 1992, each Member State designs its own scheme. They remain voluntary for land managers, although in the 2014 CAP reform certain management practices designed as AES became obligatory for farmers to qualify for their basic subsidy (Pe'er et al., 2014). The schemes can be considered horizontal, for actions that apply throughout the country, such as support for organic management, or zonal if they target areas of high nature value (Batáry et al., 2015). They can apply to productive areas, such as arable crops, or non-cropped areas, such as wildflower strips, in agriculturally marginal areas or in intensively farmed areas.

A major criticism of classic management-based AES is that participation rates rather than actual environmental benefits are the major indicator of success (Herzon et al., 2018; Keenleyside et al., 2011; Reboud et al., 2022). This has led to a new focus away from management based or action-oriented schemes, which involve payment for management actions or farming practices that are known to support the conservation of biodiversity without a direct link to the outcomes of such action, to result-based approaches and payments, which offer payment to farmers who achieve a certain outcome for biodiversity conservation (Burton and Schwarz, 2013; Herzon et al., 2018; Keenleyside et al., 2014). Results-based schemes have proved successful in the case of specific biodiversity targets, such as lynx (*Lynx lynx*) in Sweden, or national biodiversity priorities (Keenleyside et al., 2014), but do require clear biodiversity objectives (and associated indicators) based on the most accurate and up-to-date data. Such approaches seem less suited to common farmland biodiversity (but see Arponen et al., 2013) or target areas that need restoration or recreation of habitats (Moxey and White, 2014).

An example of the challenge of management and result-based AES is that of ground nesting birds in Europe. Initial awareness of the declines of many European farmland bird species (Donald et al., 2001) resulted in efforts to reverse these trends using a range of different tools including legislation, economic instruments (e.g., agri-environment schemes) and community-based initiatives (Tanentzap et al., 2015). However, data show that many European bird species are still in decline (Inger et al., 2015), with agricultural intensification and specialization likely to still be the major cause of declines (Bas et al., 2009). Habitat management through improvement for conservation of agricultural birds is seen as the desirable approach but the available data indicate that this has been difficult to achieve through agri-environment policy. The requirements of ground-nesting species can be complex and therefore, multiple strategies may need to be employed to restore populations including the application of systematic, lethal predator control and habitat management as part of community-based initiatives linked with a result-based approach (McMahon et al., 2020).

For AES to work, they need to be palatable to farmers (for example, in terms of fit with farm practice or payment rates) to effect farmer behaviour change (Brown et al., 2020; Defrancesco et al., 2008; Sattler and Nagel, 2010). Recent studies show that a result-based approach that increases innovation, flexibility and new forms of governance allowed farmers to improve their skills, they felt more flexible in their farming choices and perceived the system as fair and respectful of their knowledge, which in turn led to longer-term positive attitudinal changes (Moran et al., 2021). This, however will also be dependent on providing sufficient farming training and advice on AES implementation (Moran et al., 2021; Moxey and White, 2014). Finally, the scale at which AES are implemented will be important. AESs often only target action at the individual farm level (Leventon et al., 2017), but biodiversity outcomes of AESs are widely agreed to be improved when implemented across a landscape scale, requiring farmers to collaborate at larger scale (Arponen et al., 2013; Dallimer et al., 2010; Rundlöf et al., 2010). In the Netherlands, Environmental cooperatives have been created to have large regional groups of farmers perform AES, improving the scale at which action can be taken and also facilitating more generally the farmers intention to participate in collective AES (Van Dijk et al., 2015). Such collaboration can also lead to improved local social capital (Moran et al., 2021). Research has, however, repeatedly advocated the need for better spatial targeting, payment differentiation (e.g., Arponen et al., 2013) and monitoring and shown the potential of hybrid approaches that combine results-based payment with payments for supporting actions (Herzon et al., 2018).

Such approaches highlight the importance of trust between farmers and institutions, the lack of which can act as a strong barrier to farmer involvement in such schemes (Herzon et al., 2018). Furthermore, disputes can occur related to the perception of the different participants on how well results have been achieved, on which the payment depends. To avoid those potential conflicts, it is crucial then to involve all participants (farmers, NGOs, researchers, institutions) throughout the whole process, based on best practice in participatory policy process. Careful consideration should also be taken on developing 'fair' mechanisms to address conflict (Herzon et al., 2018; Klenke et al., 2013). Bringing different types of knowledge together, framing situations for joint learning and planning in a collective manner, and engaging civil society organizations are all essential elements (Bruckmeier and Tovey, 2008; Meyer et al., 2016). Taking the example of ground-nesting birds again, this could translate into farmers and agricultural ecologists contributing knowledge on the importance, functional or otherwise, of bird species to align their conservation with human imperatives (Young et al., 2020), but also setting up discussion for a with various stakeholders to allow an open dialogue to facilitate transparent actions for the benefit of these species whilst still maintaining agricultural production. By doing so, AES schemes can go further than being perceived as a tool for biodiversity conservation resulting in them also being seen as a threat to agricultural practice. Instead, AESs need to be seen as part of the composition of modern-day, European agriculture, facilitating the existence of both farming communities and biodiversity and being used to contribute to socio-economic co-benefits by building community cohesion and multi-party networking around agricultural land-use (Herzon et al., 2018).

3.2.2 The potential of other market-based mechanisms

One strong potential to obtain income in recognition of efforts for biodiversity conservation is through agri-tourism, a growing trend in Europe

(Potočnik Slavič and Schmitz, 2013; Streifeneder and Dax, 2020). Whilst some farms have embraced this new revenue stream, others resent the pressure leading to the need for diversification, including economic struggle and agricultural system erosion (Di Domenico and Miller, 2012). Furthermore, the arrival of tourism in rural areas often can lead to other social conflicts relative to the multi-use of landscape (e.g., Potet et al., 2021). Whilst having a real potential to bring incentives for farmers to adopt practices that ensure the long-term conservation of the biodiversity and landscape on which the agritourism rest, appropriate implementation and monitoring is essential.

Eco-labelling and certification are other tools that can create economic incentives by recognizing those who preserve biodiversity. Such instruments can have a positive influence on conflicts, creating closer cooperation between consumers, farmers and private actors, and creating a sense of partnership and shared responsibility for biodiversity conservation (Baker and Eckerberg, 2008). They can also constitute a mechanism for allowing new forms of governance to emerge by improving the role for non-state actors (businesses, NGOs). However, their effectiveness at delivering real biodiversity effect can be low as demonstrated by a screening of 54 regional, national and international standards for the food sector and requirements of food companies for their supply chain (Global Nature Fund, 2017) Furthermore, there is the risk that farmer's behaviour change is dependent on continued consumer demand for certified wildlife-friendly farming, and questions over whether such initiatives only reach farmers with pre-existing sympathetic behaviours towards biodiversity (De Snoo et al., 2013).

3.3 Exploring voluntary non-monetary approaches

Concern that regulatory or market-based approach may discourage actors taking an active approach to environmental stewardship has led to increased interest in shifting farmers' extrinsic motivations for undertaking environmental management activities to more intrinsic ones to ensure sustained and widespread biodiversity outcomes (Mills et al., 2018; Runhaar et al., 2018; Santangeli et al., 2016; van Dijk et al., 2016). A large majority of farmers conduct self-initiated conservation activities on their farmyards and fields and their motivation to do so differ from those with economic incentives. Research to understand the motivation of farmers towards voluntary non-monetary approaches suggests that predictors of farmers' intentions include self-identity, attitude, perceived social norms and perceived personal ability as well as farm size, the quality of the surrounding area and the absence of external constraints (Runhaar et al., 2018; van Dijk et al., 2016).

The recent interest in exploring voluntary, non-monetary approaches suggest that a number of actions could be potentially implemented that would support biodiversity. As those actions are bottom up and decided directly by farmers, their potential lie also in the fact that there is little chance that such action can create conflict, and instead highlight the potential synergies between agriculture and biodiversity conservation. In the future, it will be important then to diffuse information around those actions and encourage the potential for role models.

3.4 Participatory approaches

Over the last few decades, participatory processes have become one of the most prevalent mechanisms in efforts to manage conflicts over biodiversity objectives, and achieve the sustainable management of natural resources (Agrawal and Gibson, 1999; Aldashev and Vallino, 2018; Klenke et al., 2013). Prior to their development, dominant tactics were to lead from the top-down, or 'command-and-control'—where decisions were technocratic, driven by 'rational' experts (Villamayor-Tomas et al., 2019). Such approaches alienated and marginalized local voices, engendering resistance, non-compliance and ultimately the further loss of biodiversity (Agrawal and Gibson, 1999; Brown et al., 2020; Kohler and Brondizio, 2017). There are now multiple arrangements that can be used as learning experience to approach participatory process relative to agriculture and biodiversity, including (but not limited to) co-management (Butler et al., 2015), collaborative contracts under AES (Westerink et al., 2017), knowledge co-production (Ainsworth et al., 2020), multi-stakeholder fora (Kusters et al., 2018), innovation platforms (Dabire et al., 2017), Integrated Conservation and Development Projects (ICDPs) (Aldashev and Vallino, 2018) and Community-Based Natural Resource Management (CBNRM) (Nelson et al., 2021).

The central concept of these approaches is the involvement of multiple stakeholders—particularly non-state actors—in the decision-making and implementation of conservation strategies to enhance their legitimacy and relevancy, and achieve mutual understanding (Méndez López et al., 2020), enhanced rule compliance (Newig et al., 2018; Sanginga et al., 2004) and social learning (Johnson et al., 2012; Van der Wal et al., 2014). In some cases, such efforts have proved successful at bringing groups together and stimulating constructive discussion and cooperation (Dabire et al., 2017; Mathevet et al., 2014). For example, AES compensation payment under the CAP is now open to groups of farmers, with an expectation that more collaborative groups of farmers should emerge to enhance landscape approach and hence biodiversity conservation (Westerink et al., 2017).

However, scholars have criticized participatory approaches and the assumptions on which they are based (e.g., López-Bao et al., 2017). Firstly, participatory approaches may be less effective unless deep-rooted inequalities such as power imbalances and politics between stakeholders are addressed (Von Essen and Hansen, 2015). In the case of conflicts over the conservation of large carnivores, farmers highlighted the need for a deeper and mutual understanding of issues prior to any implementation of participatory processes (Salvatori et al., 2020). Secondly, there is often too little consideration on how participatory processes are governed (Hodgson et al., 2020), with processes still often initiated and implemented by governments, corporations and international NGOs, and so still effectively top-down models, skewed towards the interests of the organizers (Agrawal et al., 2008). Velten et al. (2018) propose that for better biodiversity outcomes in agricultural landscapes, we should move towards a blended governance approach where decisions on objectives take place in a top-down, centralized manner and for ecologically defined units, whilst decisions on achieving the set targets are taken in a bottom-up, decentralized manner within existing administrative boundaries. However, as highlighted by the authors, this proposition does not answer all the questions and issues related to the degree of stakeholder participation in decision-making. In fact, participatory processes can suffer from issues such as the recentralization of state power, corruption, co-optation and elite capture—especially in non-democratic countries (Bluwstein et al., 2016). Thirdly, problems arise when those participating are not fully representative of the whole community, thereby excluding key voices. For example, there may be selective inclusion of actors who adopt a more 'neutral' stance, are more compliant and less 'extremist' to create an illusion of success or consensus (Grey and Kuokkanen, 2020; Salvatori et al., 2020). In other cases, key voices remain unidentified due to social or cultural constraints (De Pourcq et al., 2019), or self-exclusion (Hodgson et al., 2018). During participatory processes on wolf management in Italy and Spain, farmer unions holding an anti-wolf platform declined to participate (Salvatori et al., 2020). Self-exclusion by certain actors can be due a wish to avoid conflicts, or due to a lack of real outcomes from previous processes causing stakeholders to disengage (Young et al., 2016).

Based on the above, scholars are now increasingly calling for more grass-roots approaches to participatory conservation to address these issues. This includes not just involving local actors but also empowering them to make decisions, and have a hand in the design of the process itself to identify all relevant stakeholders and who represents them (Fisher et al., 2020). Further, significantly more evaluation and long-term analyses of participatory approaches are needed to assess shortcomings, learn from mistakes, and adapt (Cox et al., 2020).

4. Emerging approaches and the future of biodiversity conflicts in agriculture

Reducing future negative consequences of conflicts between agriculture and biodiversity will be a priority to ensure sustainable food systems and the conservation of biodiversity in Europe. Firstly, only addressing conflict through the lens of the agricultural technical solutions such as new sustainable practices, will not be sufficient and we need more holistic approaches that strive for multiple synergistic socio-ecological-technical goals. Secondly, we might avoid or manage early conflict through the implementation of true partnerships, in which mutual understanding, trust and knowledge exchange reduce the likelihood and impacts of conflict. Thirdly, we might use points of conflict to highlight issues of contention and then undertake processes of conflict transformation to address underlying drivers of conflict and overcome the challenges faced by individuals and groups, achieving better instrumental and substantive benefits as a result. We explore some examples of each of these strategies in this section.

4.1 The rise of agroecology

Agroecology was first introduced as an agronomic and technical alternative to conventional agriculture (Wezel et al., 2009) seen as replacing input-intensity through knowledge-intensity and biodiversity-based practices (Altieri and Nicholls, 2012). Agroecology can include a wide range of practices such as crop diversification, agroforestry, crop-livestock integration, the reintroduction of natural and semi-natural landscape elements at field or farm-level (hedgerows, woodland, grassland) (Altieri et al., 2015). Such practices have been advocated as a potential solution to support biodiversity. For example, the (re)integration of natural or semi-natural landscapes elements provides valuable ecosystem services, especially biological control, pollination, and soil conservation (Holland et al., 2017), whilst reduced or no-tillage practices can improve soil biodiversity, water retention and carbon storage (Thiele-Bruhn et al., 2012). In the Mediterranean region, farm diversity also reduces vulnerability of regional yields to climate variability (Reidsma and Ewert, 2008).

However, the reason that agroecology is emphasized here as a pathway that would allow an improvement in how we approach conflict between agriculture and biodiversity is because agroecology is more than a set of agricultural practices and goes further than an alternative path to conventional farming. Many perceive it as a science, practice and movement that reconfigures and establishes new linkages between knowledge, practice, and power (Pimbert, 2015; Wezel et al., 2009). This is reflected in important movements in Europe around food sovereignty and access to land and seeds that try to include social and political aspects such as autonomy, self-sufficiency, redistribution of power, bottom-up place-based organization, and equal access to decision making, to ultimately achieve social-ecological innovations and sustainable food systems (Anderson et al., 2019; Olsson et al., 2017). In opposition to other labelling such as organic farming or movement such as rewilding that concentrate on practices or tools and strategies to improve biodiversity conservation, agroecology questions the structure of the entire food system by trying to reduce dependence on corporate suppliers of external inputs and distant global commodity markets and deepening democracy.

Going further, concepts like 'political agroecology' (De Molina et al., 2019) can help promote agroecology as part of a European-wide conflict reconciliation strategy, combining regulatory approaches but also incentives and participatory approaches. Agroecological diversification strategies often include a commitment to multi-stakeholder participatory approaches. It encompasses a more radical, transformative potential championed by grassroots initiatives and peasant movements (De Schutter, 2010), emphasizing the democratization of food systems, the rights and autonomy of farmers, food sovereignty, and encouraging collective and peer-based learning (Anderson et al., 2019). These bottom-up initiatives can steer new developments in agronomic science centred around biodiversity-based innovation and knowledge sovereignty (Coolsaet, 2016).

Making agroecology mainstream, however, remains a challenge. As part of its draft Regulation of CAP Strategic Plans in June 2018, the European Commission proposed the introduction of 'eco-schemes', a new mandatory mechanism aiming at 'incentivizing and remunerating the provision of public goods by agricultural practices beneficial to the environment and climate'

(European Commission, 2021). Going beyond practices specifically covered by EU policy instruments (organic farming, integrated pest management), a more recent document written by the commission prominently features agroecology, and lists a series of practices (crop rotation, low-intensity livestock, permanent grassland, etc.) which are explicitly flagged as contributing to the protection of biodiversity (European Commission, 2021). Amongst EU member states, however, France is the only country to currently have an official strategy for an agroecological transition (Lampkin et al., 2020). In addition, whilst an increasing number of universities and research institutes in Europe conduct research or provide teaching on agroecology (Wezel et al., 2018), agroecological innovation at farm and field-level suffers from unfavourable public policies, path-dependency and lock-in mechanisms (Stassart and Jamar, 2008), as well as unbalanced funding opportunities (Vanloqueren and Baret, 2009).

To amplify agroecology in Europe in the coming years, policy development will be crucial and formal institutions will have to support participatory governance processes, co-production of knowledge and agroecological, individual and collective, initiatives (Anderson et al., 2019). Institutions and associated policies will have to act against land grabbing and land restructuring and ensure equitable access to natural resources (Castro-Arce and Vanclay, 2020), which is an important incentive for farmers, communities, and territorial networks to engage in long-term agroecological approaches (Anderson et al., 2019). Finally, such a transition will require a fundamental cultural and philosophical shift in what has been perceived to be a productive and efficient agriculture, not just by farmers, but by society as a whole.

4.2 From participation to partnership

In light of the importance of the social dimensions of conflicts surrounding agriculture and biodiversity conservation, engaging different actors to co-create conflict prevention or management strategies is critical, with a shift from participation to partnership offering one potential solution. Different forms of participatory approaches (see Section 3.4), along with knowledge exchange and effective communication, have long been promoted to address conflicts between biodiversity conservation and agriculture. Since superficial or poor implementation of participation can actually exacerbate conflict (Von Essen and Hansen, 2015), more empowering forms of participation have recently been emphasized including partnership (Gavin et al., 2018), defined as 'collaborative arrangements in which actors from two or more spheres of society (state, market and civil society) are involved in a non-hierarchical process through which these actors strive for a sustainability goal' (Glasbergen, 2007, p. 2).

Partnerships enable strong, pluralistic forms of governance, especially across state and non-state actors, and recognize not only the environmental parameters of sustainability, but also the need to structure governance around relationships (Glasbergen, 2007). Motivations for partnerships include perceived collaborative advantage or the threat of a hierarchical decision (Singleton, 2000). For example, a public-private partnership was set up between a state conservation agency and local farmers in Norway when the former wanted to impose the National Conservation Act (Hovik and Edvardsen, 2006). Partnerships linking biodiversity and agriculture could integrate, for example, initiatives between farmers, consumers and agri-businesses that would promote best practices for biodiversity conservation but also higher standards of living and rural developments for farmers, building awareness and trust and reducing the negative perception consumers can have of farmers. The success of such partnerships depends on actor types and relationships, the structure and phase of the partnership and the goals and context of the partnership (Glasbergen, 2007).

Partnerships are explicit in the UN Sustainable Development Goals (SDGs), with SDG17 focusing on partnerships to achieve the Transformative Agenda 2030 (UN, 2015). This global agenda could support greater partnerships across Europe to create more coherence across the different policies, sectors and scales regarding agriculture and biodiversity conservation. Institutional fragmentation is a current challenge, with the EU administration composed of sectoral directorates responsible for different aspects such as agriculture, forestry and biodiversity conservation, and often little coordination amongst separate national agencies and private landowners (Hodge et al., 2015). To address incoherent land-use policies both across and within sectors, linkage needs to be made between top-down legislation at the EU level, with coordination at the national level and bottom-up needs and preferences incorporated at more local levels (Burrascano et al., 2016). Finally, synergies and overlap with biodiversity conservation could be accentuated between policies. Henle et al. (2013) propose, for example, an overarching system for biodiversity monitoring prioritization that integrates the common and divergent needs of different policies.

Partnership also requires implementation and collaboration according to good practice at a local level. Good practice for community conservation (e.g., the PARTNERS (Presence, Aptness, Respect, Transparency, Negotiations, Empathy, Responsiveness, and, Strategic support) principles proposed by Mishra et al., 2017), can be adapted to develop local scale partnerships addressing conflicts between agriculture and biodiversity conservation. For example, 'respect' could support a recognition of local farmers and other local actors as part of the solution, not part of the problem, enabling them to be equal and autonomous partners rather than aid beneficiaries (see also Vermeulen and Sheil, 2007). The goals and purpose of the proposed partnership should be established at the beginning of the process to ensure 'transparency' (Mishra et al., 2017). Integrative 'negotiations' could allow discussion and agreement on the design and the implementation of decisions, for example in result-based payment AESs to ensure farmers' implementation (Moran et al., 2021). 'Empathy' requires potential partners to understand the situation from each other's' points of view, for example, external agencies recognizing increasing pressures on farmers, which preclude them seeing biodiversity conservation as a priority (see Deffontaines, 2014). 'Responsiveness' would enable timely and creative seizing of new opportunities and synergies, such as the Nature Based Solutions and agroecological approaches described above. Finally, 'strategic support' would ensure that processes and contracts are suitable for different scales and allow for more fluid, nimble local organizational structures (White and van Koten, 2016).

Partnerships are, however, not always an easy, effective or fair solution to conflicts. Power asymmetry is a potential risk when establishing partnerships across state and civil society or across national and local scales (Mercer, 2003). Context and local situation are important. As seen previously, whilst rewilding might be possible in some areas of land abandonment, when strong cultural attachment to the landscape exists (Linnell et al., 2015), rewilding partnerships might not always be the best approach. Representation and capacity can also limit some partners in contributing effectively and equally (White et al., 2018). Given the above reflection on participation, and acknowledging that partnerships are no panacea, the move from participation to partnerships processes may be an important step forward in addressing conflict between agriculture and biodiversity conservation through genuine multi-sectoral partnerships at different scales.

4.3 From conflict resolution to conflict transformation

Conflict is often seen as a problem that needs to be resolved through compromise and consensus (Kenis et al., 2016). However, ignoring conflicts or resolving them superficially through a technical or managerial solution may lead to reproducing inequitable social-ecological outcomes across society, time and space (Bennett et al., 2019; Blythe et al., 2018; Kenis et al., 2016). Often, in the conflict between agriculture and conservation, responses focus on the conflict episode rather than the underlying relational and structural factors (Harrison and Loring, 2020; Redpath et al., 2013; Rodríguez et al., 2019). In agriculture, a conflict episode would be a wolf attack on sheep whilst the underlying factors would be the feeling of disempowerment of rural people and their fear of losing their way of life (Skogen et al., 2008). Without ignoring short-term responses to conflict episodes (referred to as conflict resolution processes), conflict transformation proposes a long-term process that can address underlying factors and generate greater justice in relationships and social structures and avoid recurrence (Lederach, 2003).

Conflict transformation originated in peace studies, and sees conflict as a catalyst for social change by rendering injustice visible and signalling necessary changes in society (Lederach, 2003). As an analytical approach, it provides tools to understand conflict dynamics and the multiple levels in which it is expressed: in people, in relationships, leadership forms, organizations, political systems, the construction of narratives, and in cultural frameworks. Central to this view of conflict transformation is that conflict itself is a dynamic, continuously evolving phenomena, where incidental disputes are expressions of more deep-rooted, systemic issues and symptoms of unsatisfied needs and marginalization (Madden and McQuinn, 2014; Rodríguez and Inturias, 2018). Skrimizea et al. (2020) proposed conflict transformation as an approach to a more sustainable agriculture. One of the key aspects of conflict transformation is the importance of power as an underlying cause of conflict (Skrimizea et al., 2020), an issue well covered in the context of agriculture, both at EU level with the CAP designed around large landowners and industrial agriculture (Leventon et al., 2021; Toma et al., 2021), and at national levels of governance (e.g., Balázsi et al., 2019), leading to the need for an increased 'balance of powers […] to ensure that the system is not overly reliant on a few actors at either local or supranational level giving particular priority to biodiversity conservation' (Leventon et al., 2019).

We propose therefore that explicitly bringing the conflict transformation lens into the way we approach conflict between agriculture and biodiversity will help us address the power imbalance. Many methodologies are proposed to try to address plural values, such as deliberative approaches

(Lliso et al., 2020), co-creation and co-design of research (Mauser et al., 2013) and co-production of knowledge (Wyborn et al., 2019), sustainability scenario building (Raudsepp-Hearne et al., 2020) or visioning desirable futures (Wiek and Iwaniec, 2014). However, all those processes are subject to power imbalance. To overcome power asymmetries will require strengthening the capacity of vulnerable actors to transform conflict and create the conditions for more symmetrical and horizontal intercultural dialogue (Rodríguez and Inturias, 2018). As mentioned before, there is a growing social malaise in agriculture, with many farmers feeling marginalized from other farmers and the rest of society. Building capacity to overcome internal differences amongst farmers could be an important step to clarify local perspectives and knowledge and strengthen local actors' capacity to engage towards long-term solutions to reconcile agriculture activities and biodiversity conservation (Skrimizea et al., 2020). Global market and globalization, sometimes accentuated by European treaties, also lead to the marginalization of different initiatives that try to ensure biodiversity conservation at a more local scale. To use power as a force for conflict transformation, institutions should also support the empowerment of local actors, through inclusive and safe processes for deliberation and actions that enhance people's capacity to engage (Pimbert, 2015).

5. Conclusion

With continued biodiversity loss and agriculture facing increasing pressures, this paper provides a short review of drivers of change in agriculture, and some of the mechanisms put in place to address these drivers, before highlighting how we can learn from these to prepare for the future. The paper highlights that the economic conditions faced by farmers are a driving force behind the impacts of agriculture on biodiversity, both negative and positive. International trade is a significant component of the economics of food production so that globalization and neoliberalization are important factors. The response to globalization in the way that food is produced, particularly through sustainable intensification, and the policy environment provided by the CAP are critical to the relationship between agriculture and biodiversity. However, based on past trends, the biodiversity decline continues to be insufficiently addressed in the past and current CAP and no sufficient structural mitigation has been provided. In addition, social inequality in the farming sector is not mitigated through the CAP, which will heighten the pressure on small scale farms in future conflicts. It seems likely that farmers will still be under increased and conflicting pressure from market and conservation drivers.

Important global changes, such as climate change and nitrogen pollution, are also affecting agriculture and biodiversity in Europe as well as the inherently socio-political and multi-scalar nature of adaptation planning. Climate change adaptation processes in agriculture include diverse worldviews and framings of different actors (from scientists to farmers and policy makers), collectives and institutions; contested objectives (values and development priorities); diverse and unequally valued knowledge; asymmetric power relations; institutional legacies and policy frameworks; and multiple spatio-temporal scales. Adaptation planning as well as biodiversity conservation strategies that do not engage with such socio-political aspects and fail to intertwine adaptation with social justice, can exacerbate social vulnerabilities and ignore trade-offs embedded between local systems and global priorities.

Other trends are emerging, that, if managed well, could decrease conflicts around agriculture in Europe. In relation to the land sharing and land sparing debate, a useful strategy for addressing biodiversity conflict and optimal landscapes could be a mix of those land-use strategies. Such an approach, however, should recognize the blurred border between wild and domestic species and habitats in Europe, and be adaptive, pragmatic and vary in time and space. It will also require the development of evidence-based frameworks for optimal spatial combinations of land sparing and different shades of land sharing as well as considering the diverse actor perspectives in mobilizing policies and governance mechanisms capable of successfully implementing those.

To address the above drivers of change, it will be important for conflicts between agriculture and biodiversity to be recognized as multi-faceted symptoms of past and current underlying factors that go beyond specific disputes around biodiversity conflict. It is also necessary that regional and local trade-offs between biodiversity conservation and yield improvement for the different land-use strategies are made transparent and are negotiated. Finally, explicit and measurable conservation targets have to be integrated into local, regional and international agricultural policies to avoid biodiversity conservation being considered as a by-product of other policies, such as on sustainable intensification.

In addition, continued use of existing and new strategies used to address the relationship between biodiversity and agriculture (reglementary, market-based, voluntary non-monetary and participative process) all highlight the importance of adopting a structured and partnership approach that involves researchers, managers and stakeholders, and includes monitoring, adaptive management, economic and social assessments, as well as the development of a conflict reconciliation plan at an early stage will be essential—especially as land use changes emerge based on changing social structures. New approaches such as agroecology, partnerships and conflict transformation all emphasize the need for stronger bridges between practice, science and politics, creating a movement from 'working with others' to 'working together' that tackles deep rooted dimensions of conflict, including power asymmetries and dynamics, with conflict seen as natural and a positive opportunity for transformation. In Europe, both the survival of farming and biodiversity are closely interrelated, and working on common ground and shared vision will be essential for the future of agriculture.

Acknowledgement

This work was supported by the French 'Investissements d' Avenir' program, project ISITE-BFC (contract ANR-15-IDEX-0003).

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