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REVIEW ARTICLE

Ecosystem services in conventional farming systems. A review

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Abstract

Ecosystems worldwide are being disrupted under increased pressure from human activities. Nevertheless, most conservation studies and restoration efforts have so far focused on ecosystems of high heritage value related to their species diversity and/or the rarity of their habitats and/or species. However, "ordinary nature" (all the everyday, non-spectacular and non-protected landscapes, species and ecosystems) is also threatened by ecosystem disruption, which could affect major ecological functions and thus the supply of ecosystem services (ES). Conventional farming systems, which are mostly composed of agroecosystems characterised by ordinary nature, are already known to deliver some ES (e.g. pollination, carbon sequestration). Nevertheless, no systematic search has been done yet to determine which ES are identified and how there are studied in these conventional farming systems. We thus performed a first systematic evidence map (review of key articles to show, at a glance, the points that have been most studied, and highlight key gaps in the evidence base) to identify characterisation and measurement of ES provided by conventional agroecosystems from the review of 189 key international scientific articles. We excluded production for economic benefit, as this topic is already well documented in conventional agriculture systems. We found that most studies identified nutrient cycling (49.7%), carbon sequestration (46.6%), pest reduction (48.1%) or pollination (36.5%) as ES supplied by conventional agroecosystems. Correlations were also found between spatial scale and ES studied: for example, carbon storage was determined more at agricultural plot scale, while cultural services were determined more at landscape level. Our map also yielded 74 frequently used ES indicators, 50 of which are easily measurable and operational indicators of significant ES. Afterwards, one challenge that could be addressed in further studies is to determine for each indicator the range of measurement values that should be considered positive for ES provision, which is likely ecosystem-dependent.

Keywords Conventional agriculture · Ordinary nature · ES indicators · Ecological indicators · Biodiversity

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1 Introduction

Human activities have strongly modified ecosystems and biodiversity since the Neolithic Age (Diamond 2002; Skoglund et al. 2012), with the beginning of the Industrial Age marking an intensification of ecosystem disruption (Lewis and Maslin 2015). Over-exploitation of natural resources, consumption of fossil fuels, urbanisation, industrialisation and agricultural intensification all led to a greater human impact on all ecosystems. Today, human activities are known to have altered about one-third to one-half of Earth's land surface (Vitousek et al. 1997). Moreover, we now face global environmental change, a major threat to biodiversity and human well-being leading to for example a loss of habitats and species (Lewis and Maslin 2015; Scholes et al. 2018). Such alterations could impact major ecological functions, thereby affecting the supply of ecosystem services (ES) long before global extinction (Millennium Ecosystem Assessment 2005).

ES are the benefits people obtain from ecosystems (Millenium Ecosystem Assessment 2005). These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth (Costanza et al., 1997; Millennium Ecosystem Assessment 2005). The Millennium Ecosystem Assessment (2005), which is the first synthesis of the state of knowledge on the connection between sustainable use of ecosystems and human well-being commissioned for by the United Nations Secretary-General Kofi Annan, showed that 60% of the examined ES are being degraded or used unsustainably. Several authors have thus already called for the inclusion of ES in conservation plans (Singh 2002; Balvanera et al. 2005; Chan et al. 2006; Egoh et al. 2007).

However, until recently, conservation studies and restoration efforts have so far focused on preserving biodiversity in ecosystems whose species-richness and/or rarity of habitats and/or species gives them high heritage value such as pristine wetlands and species rich grasslands (Scott et al. 1993; Devictor et al. 2007; Inger et al. 2015). Less attention has been paid to more common species or habitats, despite their greater importance in terms of area, ecosystem function and service provision (Grime 1998; Geider et al. 2001; Gaston and Fuller 2008; Gaston 2011). Moreover, "ordinary nature" too, defined only in opposition to "extraordinary nature", which is "nature" composed of common species and habitats and characterized with low ecological complexity (Pellegrin et al. 2018), and related ES are also impacted by environmental change and ecosystem disruption. They are, for example, threatened by rapid changes in genetic diversity, specialisation losses and species range shifts (e.g. Inger et al. 2015; Radchuk et al. 2019; Scholes et al. 2018).

Ordinary nature is largely composed of agricultural land (e.g. intensive crops, species-poor and artificial pasture), which currently covers 37.4% of the total land surface of Earth (FAOSTAT 2016; Leff et al., 2004). Agroecosystems not only produce food but also have the potential to generate several ES and obtain ES from non-agricultural land. Both generated and obtained ES are determined by the management decisions and agricultural practices implemented at field scale (Tscharntke et al. 2005; Dale and Polasky 2007; Swinton et al. 2007). While several studies have interestingly reviewed ES provided by non-conventional agricultural systems such as, for example, organic (e.g. Sandhu et al. 2010) or conservation (Palm et al. 2014) agriculture, no systematic search focusing only on ES identified in conventional agricultural systems (Fig. 1), which is a substantial form of farming management, has been found in the international scientific literature.

The Millennium Ecosystem Assessment synthesis (2005) forecasts an increase in agriculture-related biodiversity loss and ES degradation during the first half of this century, mainly due to habitat loss through development. Because common species and habitat contribute disproportionately to ecosystem biomass and functions (Gaston and Fuller 2008; Gaston 2011), there is an urgent need to also consider and deepen the knowledge on ES provided by conventional agriculture. This would allow the development of a holistic and more sustainable approach in conservation and restoration studies, which takes into account both rare and common components of nature. Therefore, the first step is to identify provided ES, their characteristics and indicators.

Currently, ES are mainly measured through a biophysical approach (Dale and Polasky 2007). In ES characterisation studies, Seppelt et al. (2011) demonstrated a lack of consistent methodology and particularly stressed the importance of biophysical realism for ecosystem data and models. To ensure that ES are properly identified and measured, target components of biodiversity and ecosystems need to be defined. In addition, appropriate indicators and their characteristics, such as the method of measurement, need to be identified, along with appropriate baselines for calculating losses and gains, time-related issues and uncertainties in assessment (Quétier and Lavorel 2011; Dale and Polasky 2007).

Fig. 1 Comparison of a species-poor mowed artificial meadow (conventional farming system, on the left) with a species-rich grazed semi-natural grassland (traditional farming system, on the right), France. Photograph by Christel Vidaller, 2020.

The concept of ES considerably developed at the end of the 1990s following the ecological economics work of Costanza (1997) and Daily (1997) which led to a growing interest and debate around the valuation of ecosystem services. Subsequently, several studies have explored the integration of agricultural provisioning services from the viewpoint of yield, benefits and economic value; these services are then qualified as "direct ecosystem benefit-related ES" instead of ES (e.g. Costanza et al. 2017). Here, we thus explored only non-production and non-direct benefit-related ES as this topic was already and still well documented.

Our aim in this article was to set up and execute for the first time a systematic evidence map on the ES identified in conventional farming systems. This included agriculture based on monocultures, mechanisation and the use of agrochemicals. An evidence map allows to show, at a glance, the points that have been most studied, and highlight key gaps in the evidence base (McKinnon et al. 2015).

Then, we present and discuss easily measurable and operational indicators of identified ES that should improve existing methods of ES from conventional farming measurement and allow better incorporation of ES into conservation and restoration programmes.

We specifically sought to identify:

(1) Growth trends in research on ES from the conventional agricultural landscape,
(2) Agricultural land ecosystems focused on and their characteristics,
(3) ES proxies that could be used as indicators.

2 Materials and methods

2.1 Selection of studies

The systematic literature search and screening was performed in April 2019 by generating keyword combinations in the ISI Web of Science database (Core Collection, 1985–2019). No language restrictions were applied to the search. Three keyword strings were applied concomitantly to the article "TITLE":

"ecosystem service*" OR "agroecosystem service*"
AND "agricultu*" OR "farm*" OR "agr*" OR "arable*" OR "orchard*" OR "cultiv*" OR "vineyard*" OR "plantation*" OR "crop*" OR "past*" OR "rangeland*" OR "grove*"
NOT "wind farm*" OR "urban"

Alternative search strings (e.g. including all agricultural system types and not only conventional ones) or a "TOPIC" search were performed but resulted in an unmanageable number of articles suggesting a topic too broad to be covered in a single article. Moreover, this search also often yielded not relevant articles to our topic.

We have thus decided to use a screening approach with a title search to obtain a purposive sample of the literature rather than a comprehensive analysis of all potential articles. Using a purposive sample of the literature allowed us to select relevant and information-rich articles appropriated to our article goal. The title search was also chosen to only include references where the authors had used with intent the search terms to entitle their work (Johnson et al. 2002; Huber-Stearns et al. 2017; Sattler et al. 2018). To achieve representativeness of our literature sample and even if we acknowledge the importance of other form of knowledge such as so called grey literature and written in other languages than English, we chose to base our analysis only on an international scientifically validated corpus by peer review (Johnson et al. 2002; Pirard and Lapeyre 2014; Huber-Stearns et al. 2017; Sattler et al. 2018). We are aware that Web of Science database has its own biases related to an incomplete corpus of journal and the absence of "grey literature"; however, it is not presumed to yield any specific point of view concerning ecosystem services provided by conventional agroecosystems (Pirard and Lapeyre 2014).

The initial search yielded a total of 616 publications, many of whose contents were not relevant to our research questions.

To include only articles measuring ecosystem services identified in conventional agroecosystems, we therefore screened studies through three reading steps: (1) title and keywords, (2) abstracts and (3) full publication content. Articles that did not meet our inclusion criteria were removed from the final list of articles. We thus excluded articles only examining (1) non-conventional agriculture, (2) production and ecosystem benefits (already well documented), (3) disservices, (4) ES economic valuation and (5) trade-off between services and disservices, because identification of ES is a fundamental first step before studying these topics (Cowling et al. 2008).

After reading the title, keywords and abstract, the number of studies was narrowed down to a total of 191 articles. Ultimately, after reading the full articles, 189 articles were included in the study: 123 original articles and 66 reviews, editorials or opinion articles (see Supplementary material A, Table A.1).

The full dataset of the 189 articles was used for the bibliometric analysis in order to perform a first systematic evidence map showing the points that have been most studied and highlight key gaps in the characterisation and measurement of ES provided by conventional agroecosystems. The inclusion of reviews, editorials or opinion articles is crucial because it is informative of the focus of research efforts. Thereafter, quantitative analysis was only performed on data extracted from the subset of original articles (123) in order to avoid replication bias in the statistical analyses.

2.2 Bibliometric analysis of the selected articles

To quantitatively assess the productivity and quality of the conventional agroecosystem service research field, we applied bibliometric methods from R package "Bibliometrix" to the 189 articles. We measured annual scientific publication growth from 1985 to April 2019, the most productive countries, the collaboration index, the journals in which scientists most frequently published their articles and the conceptual themes within the field.

2.3 ES identification and characterisation from the selected articles

To determine the ES and their characteristics that are studied in conventional agroecosystems, we checked each article for the presence or absence of supporting, provisioning (excluding production for economic benefit), regulating and cultural services, based on the Millennium Ecosystem Assessment (2005) conceptual framework. These categories were recorded following Costanza et al. (1997) and the Millennium Ecosystem Assessment (2005) classification (Table 1 part A). Lastly, we recorded (also coded presence/absence) the type of agricultural land use studied, the study scales, the ES measurement methods and the ES beneficiaries specified in the consulted articles (Table 1 part B). When articles compared conventional farming systems with other types of agricultural management, we only extracted data concerning conventional farming systems whether or not the supply of ES was significantly different between agricultural management types. Indeed, no quantitative comparisons were planned in this study in which identification of ES provided by conventional agroecosystems was the major aim.

2.4 ES proxies from original articles: identification and selection of ES indicators

We recorded each ES proxy (i.e. indirect measurement of an ES) detected in the 123 original articles. After homogenising terms (i.e. classifying under the same term identical proxies for which authors used different terms), a total of 349 proxies were identified. The measurements most commonly applied to ES, and the appropriacy of these proxies as indicators (i.e. the identification of proxies showing strong relationships with ES), were assessed through analysis on extracted data.

2.4.1 Quantitative analysis of data extracted from original articles

ES identified from the subset of original articles (123) were subjected (Table 1 part A) to ordination analysis based on non-metric multidimensional scaling (NMDS). NMDS is used over a large number of scientific fields because it is a potent statistical tool which allows to visualise complex multivariate datasets in a lowered number of dimensions. Moreover, it is an adaptable technique for analysing many different data types which produces a handily interpreted output and is robust to out of distribution data (Borg and Groenen 2005). NMDS analyses (metaMDS function) based on Jaccard distances were run using 40 random starting configurations in 1 to 15 dimensions. The run with the lowest stress value was applied. All recorded parameters (Table 1 part B) were further fitted onto this ordination (envfit function). The significance of the correlation between ordination variation and fitted parameters was assessed using 999 permutations. All statistical analyses were run in R (version 3.6.3) using the vegan package.

2.4.2 Indicator criteria

A first subset of "indicators" was selected from significantly correlated ES proxies on NMDS axes. The Dale and Polasky (2007) criteria for the definition of ecological indicators of ES were then used to select a second subset of "indicators". The proxies selected thus met the following criteria: (1) easily measured; (2) sensitive to changes in the system; (3) anticipatory, i.e. signify an impending change in key characteristics of the ecological system; (4) predict changes that can be averted by management actions; (5) integrative: the full suite of

Table 1 (**A**) Recorded ecosystem service types and ecosystem services (ES) and (**B**) ES characteristics, following Costanza et al. (1997) and the Millennium Ecosystem Assessment (2005) classification.

A ES type	ES	ES code	B ES characteristics	Modality
Regulating	Pest control	Pest con	Agricultural land use	Arable crop
	Carbon sequestration	Carb seq		Permanent crop
	Water regulation	Wat reg		Grassland and pasture
	Pollination	Pol	Study scale	Landscape
	Climate regulation	Clim reg		Multi_plots
	Water purification	Wat pur		Multi_farms
	Weed regulation	Wat reg		Farm
	Disease regulation	Dis reg		Plot
	Protection from disturbance	Prot dist		Country
	Air purification	Air pur		Global
	Toxic waste retention	Tox ret		Europe
	Human health	Hum hea	Measurement method	In situ measurement
	Pesticide retention	Pesti ret		Modelling
	Seed dispersal	Seed dis		Spatial or geographic
Supporting	Nutrient cycling	Nut cyc		Interview questionnaire
	Soil structure	Soil str		Database literature
	Primary production	Prim pro		Synthetic indicator
	Soil formation	Soil for		Lab experiment
	Sediment trapping	Sed tra	ES beneficiary	Farmer
Provisioning	Biodiversity	Biodi		Local society
	Habitat	Habi		Global society
	Fresh water	Wat		
	Genetic resources	Gen res		
	Medicines	Med		
	Wild food	Wfood		
Cultural	Aesthetics	Aes		
	Recreation, ecotourism	Rec eco		
	Cultural heritage	Cult her		
	Sense of place	Sense pla		
	Spiritual, religious	Spiri		
	Educational	Edu		
	Inspirational	Insp		

indicators provide a measure of coverage of the key gradients across the ecological systems (e.g. gradients across soils, vegetation types, temperature, space, time, etc.) and (6) have known response to ecological system changes.

3 Results

3.1 Growth trends in research on ES from the conventional agricultural landscape

The literature search resulted in a total of 189 articles of which 65.1% were original articles ($N = 123$); 31.7% were reviews, meta-analysis, or book chapters ($N = 60$); and only 3.1% were editorial or opinion articles ($N = 6$). The articles were mainly published in environmental sciences, ecology and environmental studies Web of Science categories (see Supplementary material B, Table B.1). It is only since 1999 that interest has been shown in ES from the agricultural landscape. There was a slight increase from 2004 to 2011, followed by a sharp increase that reached a peak in 2018 with 40 publications (Fig. 2). The annual growth rate was 15.5%, with a collaboration index which is a co-authors per article index calculated only using the multi-authored article set of 4.8.

The USA, France and Spain were the three most productive countries in the field (Fig. 3). Multiple country publication

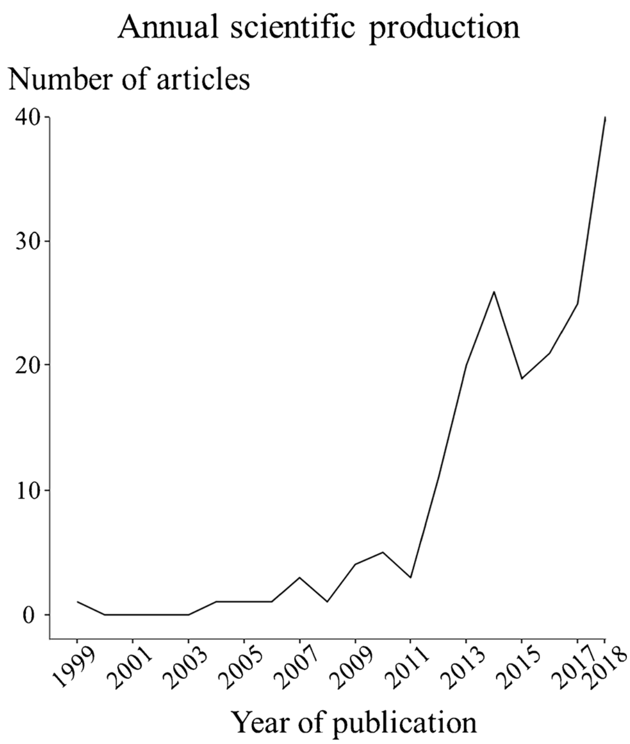

Fig. 2 Growth of absolute publication output concerning ecosystem services from agricultural land from 1999 to December 2018.

was frequent. Australia, the UK and Denmark are three remarkable cases where most of the papers were from multiple countries.

3.2 Agricultural land ecosystems focused on and their characteristics

In most cases, multiple types of ES were addressed in the same article (73%) (Fig. 4A). Regulating services were the most frequently studied (85.7%), followed by supporting (58.7%) and provisioning services (excluding production for economic benefit), (55.6%), while cultural services received the least attention (24.9%).

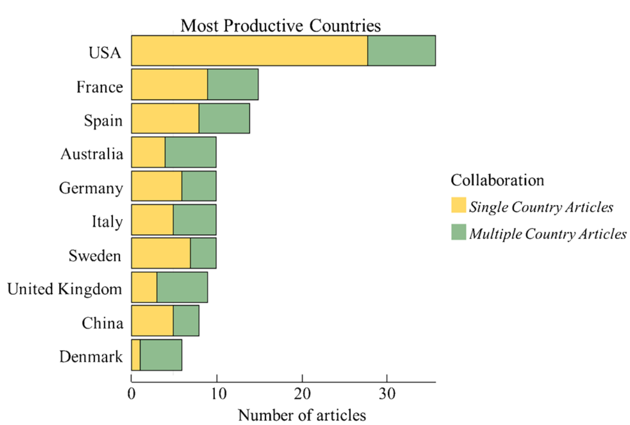

Fig. 3 Number of articles concerning ecosystem services from agricultural land produced by the ten most productive countries, and number of articles from multiple countries.

The aspects of ES that were focused on include nutrient cycling (49.7%), pest control (48.1%), carbon sequestration (46.6%), biodiversity (40.7%), water regulation (37.03%), pollination (36.5%), soil structure (35.4%) and climate regulation (30.2%) (Fig. 4B).

Studies focussed most on ES in arable crops (68.8%), followed by permanent crops (51.1%) and grasslands-pastures (43.9%). Remarkably, most studies addressed several agricultural land uses (54%) (Fig. 5A).

The most common study scales were landscape (63%), multi-plot (43%), multi-farm (42%) and farm (29.1%) scales, while plot, country, global and European scales accounted for under 10% of occurrences. Almost half the articles (48%) used several of these scales (Fig. 5B).

The method most frequently used to measure ES was in situ measurement (74.6%), followed at some distance by modelling (34.9%), and well behind them spatial or geographic measurement (20.6%), interview-questionnaire (16.4%), database literature (12.7%), synthetic indicator (6.3%) and lab experiment (4.2%). Half the studies involved multiple measurement methods (51.9%) (Fig. 5C).

The main beneficiaries of ES identified in our dataset were farmers (95.2%), then local society (88.4%) and global society (61.9%). Multiple beneficiaries were found in 87.3% of the articles (Fig. 5D).

Concerning the NMDS, the greatest reduction in stress was achieved with a six-dimensional solution. ES distribution along the NMDS axes was related to a certain degree to ES type (Fig. 6). Cultural ES, and to a lesser extent supporting and provisioning ES (excluding production for economic benefit), were mainly explored in studies devoted to them alone. On the other hand, regulating services were examined together with provisioning and supporting ES. Within regulating services, weed regulation, pest control and pollination were often studied together. Disease regulation, human health and pesticide retention were another group of ES explored jointly (Fig. 6). Moreover, carbon sequestration, water regulation, water purification, toxic waste retention, climate regulation, air purification and protection from disturbance were studied together.

Agricultural land use fitted on NMDS revealed that grasslands and pastures were significantly correlated with cultural ES, while arable crops were correlated with weed and pest regulation and pollination. Studies on biodiversity, genetic resources and habitat provision mainly referred to permanent crops (Fig. 7A).

Concerning study scale, landscape scale was significantly correlated with cultural ES while multi-plot scale was significantly correlated with supporting services such as soil formation, primary production and nutrient cycling. Carbon sequestration, water purification and

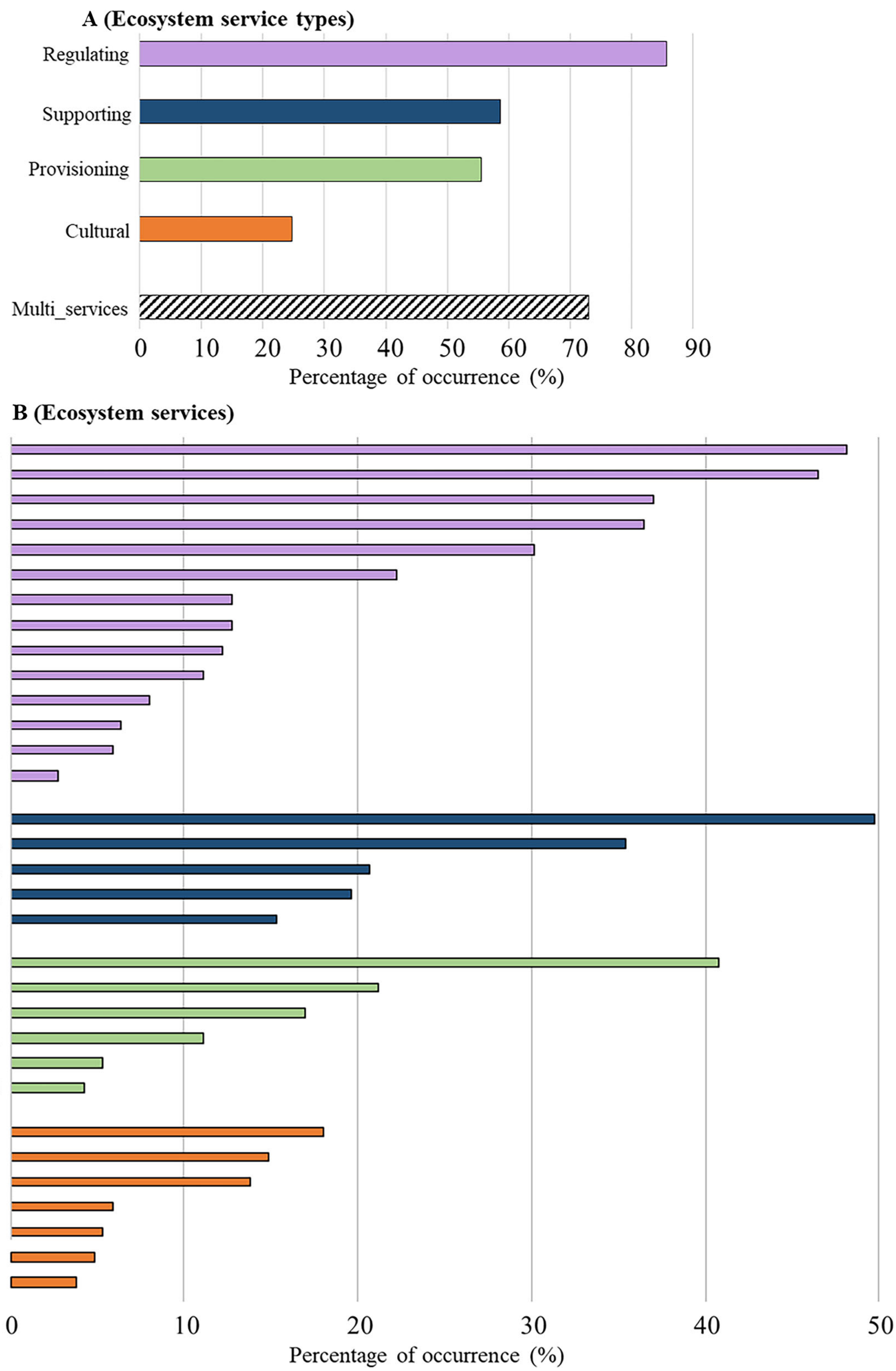

Fig. 4 Percentages for ecosystem service (ES) types (**A**) and ES (**B**) in all articles on ES from agricultural land.

regulation, toxic waste retention, climate regulation and air purification were studied at plot scale but also at country or more global scales. Disease regulation, human health, weed and pest regulation and pollination were more often examined at farm or multi-farm scales (Fig. 7B).

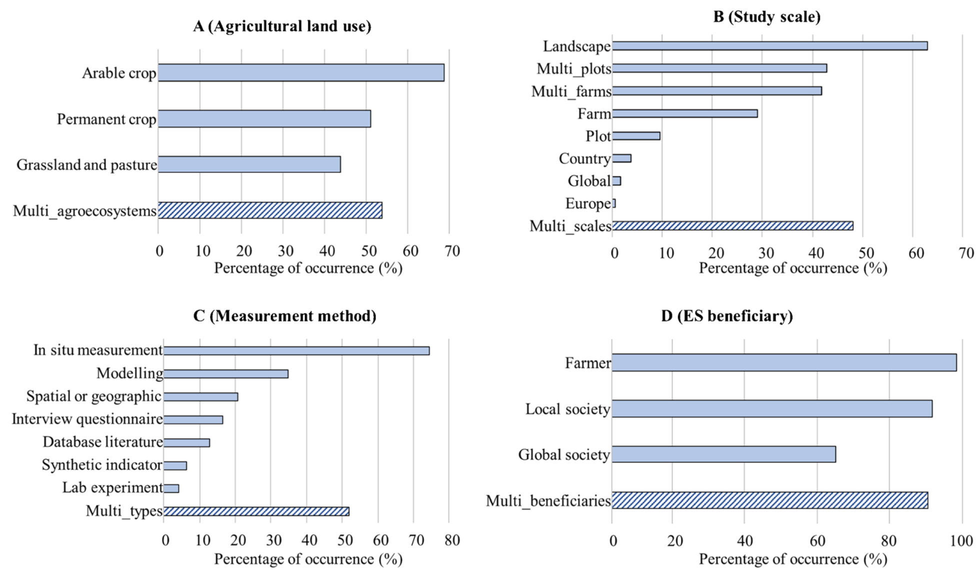

Fig. 5 Percentages for (**A**) agricultural land use, (**B**) study scale, (**C**) measurement method, and (**D**) beneficiary of ecosystem services (ES), in all articles studying ES from agricultural land.

In terms of measurement methods, NMDS also revealed that weed and pest regulation, pollination, pesticide retention, human health and disease regulation were significantly correlated with in situ measurement and, to a far lesser extent, with lab experiments. Interviews and questionnaires were significantly used to measure cultural ES. Modelling, spatialized information and database literature were mainly used to measure carbon sequestration, water regulation and purification, soil structure, water provision, toxic retention, climate regulation, air purification and sediment trapping. Protection from disturbance was often assessed via synthetic indicators (Fig. 7C).

All three ES beneficiaries were significantly correlated with NMDS axes. Farmers benefited the most from soil formation, primary production and nutrient cycling. Water regulation and purification, soil structure, water provisioning, toxic retention, climate regulation, air purification and sediment trapping were of benefit to global and local society. Carbon sequestration was of the greatest benefit to global society and protection from disturbance to local society (Fig. 7D).

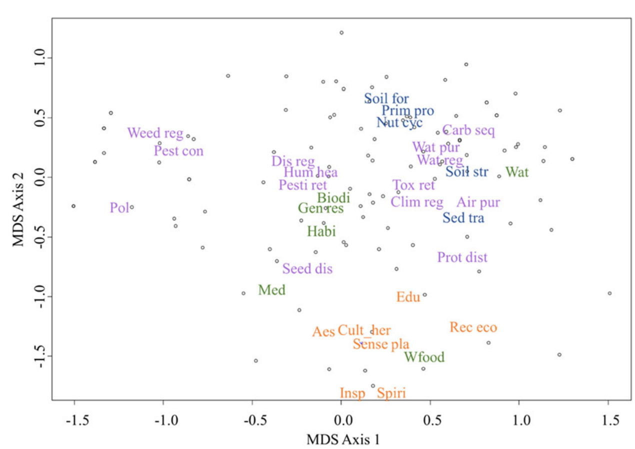

Fig. 6 Non-metric multidimensional scaling (MDS) based on Jaccard distance of ecosystem services (ES) identified in the original article subset. Only the first two axes (MDS1 and MDS2) are shown here. Colours represent ES types: purple for regulating services, blue for supporting services, green for provisioning services and orange for cultural services (NMDS stress: 0.05, six dimensions). For ES codes, see Table 1 part A.

3.3 ES proxies that could be used as indicators

A total of 74 out of 349 proxies were significantly correlated with NMDS axes such as land cover, pest damage, pollinator visit rate, bulk density, erosion rate… (see Supplementary material B, Table B.3). After applying the Dale and Polasky (2007) criteria, we selected a total of 50 indicators from these proxies such as land cover, pest damage, fruit set (pollinator visit rate for example did not meet the criteria), bulk density, erosion rate, pH… (see Supplementary material B, Table B.3). Seventeen involved biodiversity provision by ES associated with a species and/or a taxon (e.g. honeybee). As the validity of the proxies identified could not be tested statistically, their use as indicators is only discussed below.

4 Discussion

4.1 Growth trends in research on ES from the conventional agricultural landscape

The growing number of references and the growth rate found in our study attest to increased interest in this field, despite a history of neglect of agricultural land ES compared to ES from “natural” ecosystems (van Zanten et al. 2014). The first reason is scientists’ growing interest in and knowledge of functional approaches and ES (e.g. Lavorel 2013; Nelson and

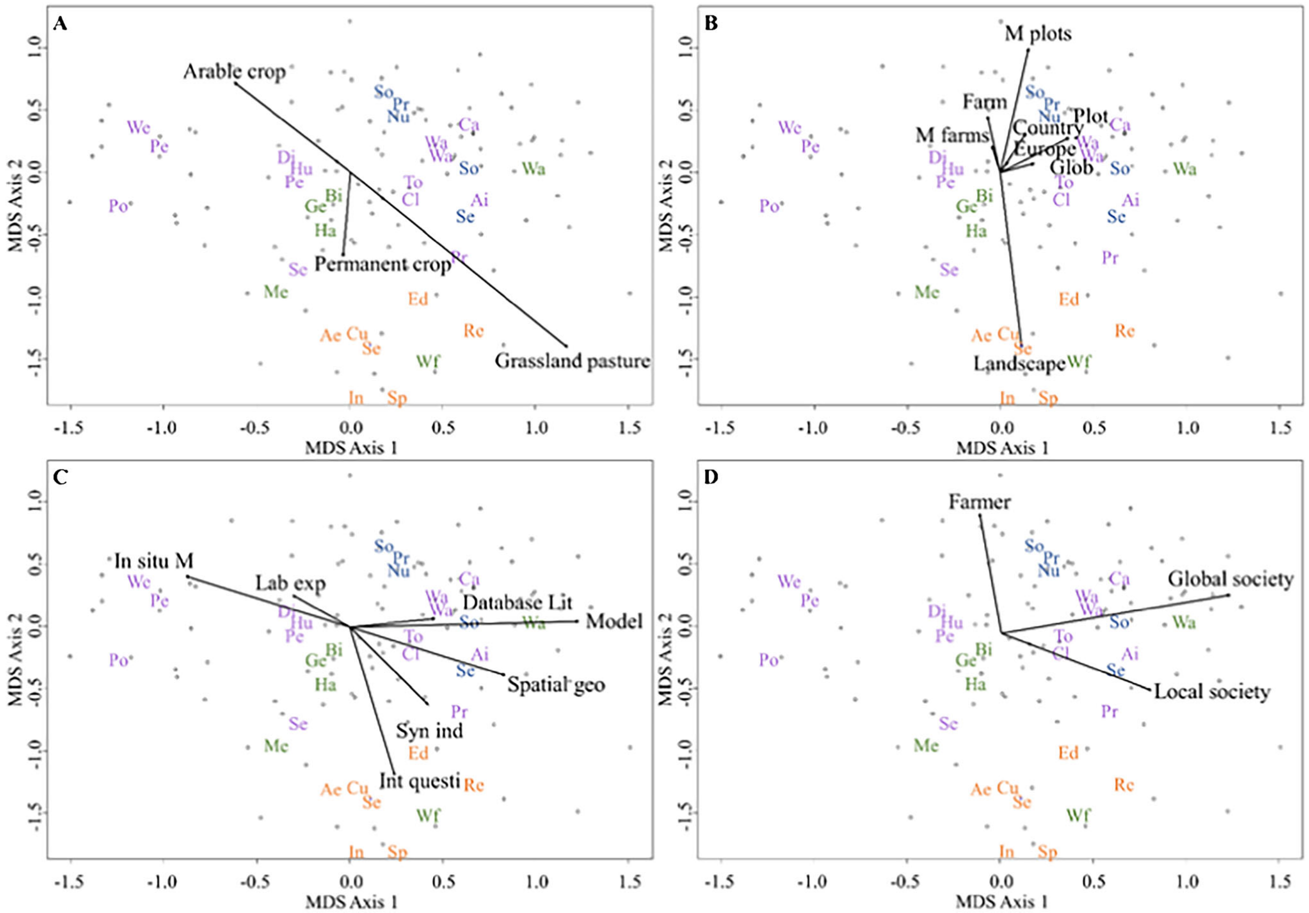

Fig.7 (**A**) Agricultural land use, (**B**) study scale, (**C**) measurement method, and (**D**) beneficiary of ecosystem services (ES), fitted on non-metric multidimensional scaling (MDS) of ecosystem services identified in the original article subset. Only the first two axes (MDS1 and MDS2) are shown here. Colours represent ES types: purple for regulating services, blue for supporting services, green for provisioning services and orange for cultural services. For ES codes, see Table 1 part A. For correlation significance of variables see Supplementary material B, Table B.2.

Daily 2010; Seppelt et al. 2011; Vihervaara et al. 2010). Added to this, the synthesis by the Millennium Ecosystem Assessment (2005) stressed the decline and unsustainable use of ES, leading to awareness of the urgent need to conserve and restore ES. This likely explains the increase in such studies in the early 2000s. Later, the Convention on Biological Diversity, which set the maintenance of ES as one of its main objectives in the Strategic Plan for Biodiversity 2011–2020, was probably the driver of the sharp increase observed after 2011.

Scientists' heightened interest in this field is also due to heightened recognition of ES from agricultural land. The amount of land covered by farming and its human management provide opportunities to deepen our knowledge of ES and to improve the provision of services and their sustainability (Tscharntke et al. 2005; Zhang et al. 2007). Moreover, the collaboration index and the number of multiple country articles found here show that research in this field is collaborative. All the scientific output descriptors revealed solid growth within this research field, with increasing scientific production and research collaborations. The research is mainly performed by rich countries, a large percentage of whose land is occupied by conventional agricultural systems; Sweden is the only exception. Seven of the ten most productive countries are European (Table 2). This result is consistent with previous reports that research production concerning ES is largely driven by the USA, China and European countries (FAO 2016; Seppelt et al. 2011).

4.2 Agricultural land ecosystems focused on and their characteristics

Studies focused mainly on regulating services from agricultural land, as found in previous reviews of multiple ecosystems studies (Egoh et al., 2007; Martínez-Harms and Balvanera, 2012; Malinga et al. 2015). In contrast to their findings, however, here, supporting services were the second most frequently studied ES type, followed by provisioning services (excluding production for economic benefit). This result is probably linked to the fact that we excluded

Table 2 Ten countries producing most research on ecosystem services (ES) from agricultural land, and percentage of agricultural land in each country from FAO (2016).

Productivity ranking	Country	Agricultural land (% of land area) in 2016
1	USA	44.37
2	France	52.45
3	Spain	52.58
4	Australia	48.24
5	Germany	47.68
6	Italy	43.23
7	Sweden	7.44
8	United Kingdom	71.71
9	China	56.21
10	Denmark	62.01

production and direct ecosystem benefit-related ES from this article. The interest in regulating and supporting services is likely due to their association with production, human well-being and commonly valuable services (Millennium Ecosystem Assessment 2005). It follows logically that the studies focused mainly on services that could support and/or provide a benefit, such as, for example, pollination services, pest control and nutrient cycling. Moreover, it must be specified that our study is focused on conventional farms, where agrochemicals are used to eradicate pests and weeds. The identification of ES related to pest and weed control might therefore be the result of the use of external inputs, which can have a negative impact on other ES and human health, rather than a natural pest and weed control (Stavi et al. 2016; Palomo-Campesino et al. 2018).

Carbon sequestration (46.6%) was often measured, testifying to the recent high concern over rising atmospheric CO2 levels. Biodiversity provision (40.7%) was often assessed, indicating that species approaches remain popular even within the ES framework and in species-poor conventional farming systems. This may be linked to evidence from several studies that high species diversity is then needed to maintain ES (Isbell et al. 2011; Harrison et al. 2014).

Cultural services from the agricultural landscape received the least attention, contrary to findings from other ES reviews (Egoh et al. 2012; Martínez-Harms and Balvanera 2012). Even though agroecosystems are recognised as important cultural ES providers (Assandri et al. 2018), the more conventional agricultural systems do not preserve cultural ES. This could explain the lower cultural benefits derived from such agricultural land, which is mainly composed of ordinary nature (species-poor open-field grasslands and intensive arable crops, intensive vineyards or orchards). Moreover, cultural ES do not sustain agricultural production and are thus underexplored (Swinton et al. 2007).

4.2.1 ES from different agricultural land uses

ES were primarily studied in arable crops, which use 11.6% of global land area, and in permanent crops, which only use 1.3%. Although grasslands and pastures occupy the largest land area (25.8%), ES studies there were less common. This could be explained by the fact that grasslands have received substantially less attention in the ES framework compared to other production systems (Bengtsson et al. 2019). Semi-natural grasslands and pastures do not have a central place in the debate on delivery of ES, despite their generally high value in terms of biodiversity, production and cultural heritage in comparison with intensive arable crops. Moreover, while arable crop and permanent crop areas have increased in response to higher demand for food production, grassland and pasture areas have decreased through conversion to arable land for annual cropping and/or abandonment and scrub encroachments (FAO 2016).

Our results indicate that it is the agricultural management system that drives the relationship between agricultural land use and the ES types studied. For instance, ES supporting and/or of benefit to agriculture, i.e. weed and pest control and pollination, was more frequently studied in arable crops, which are the most intensively managed ecosystems. Moreover these services are also particularly threatened by agricultural intensification (Dale and Polasky 2007; Zhang et al. 2007). In the articles we reviewed, biodiversity provision was studied principally in permanent crops composed of agroforestry systems, olive groves and vineyards. This is likely due to the fact that these systems support higher levels of biodiversity compared to arable crops and artificial grasslands alone (Torralba et al. 2016). For example, the heterogeneity and diversity of the agroforestry system vegetation also create varied habitats useful for conservation (Jose 2009). Cultural ES, on the other hand, tend to be linked to grasslands and pastures, which are mainly under traditional extensive management and are recognised as a major cultural factor. Despite the large number of studies demonstrating that semi-natural habitats in agricultural landscapes enhance other ES such as pest and weed control or pollination, there are few studies explicitly relating grasslands to other ES (Bengtsson et al. 2019).

4.2.2 ES and scales of measurement

We found that studies on ES from agricultural land mainly used the landscape scale, relating services such as pollination or cultural services to landscape structure and composition (e.g., Steffan-Dewenter and Westphal 2008; van Berkel and Verburg 2014; van Oudenhoven et al. 2012). Although heritage and aesthetic values are conceptualised as landscape-related and largely expressed through features within cultural landscapes, they are often under-used in landscape decision-making. (Millennium Ecosystem Assessment 2005; Tengberg et al. 2012).

Several authors have already argued that in agricultural land, it is often the ecosystem landscape pattern and the spatial structure of patches that is important for service provision (Termorshuizen and Opdam 2009; Willemen et al. 2012; van Zanten et al. 2014). Nevertheless, landscape-based metrics of structure and composition are often the most cost-effective indicators of ecological systems (Dale and Polasky 2007). Furthermore, Zhang et al. (2007) showed that scarcely any ES are provided at one scale alone. ES can be measured at different scales, as our study shows: for instance, carbon sequestration can be measured at multi-plot scale from direct soil carbon content or proxies derived from vegetation cover (Dale and Polasky 2007). The choice of an ES study scale is related to the ES scale of occurrence and the feasibility of its measurement (Hein et al. 2006).

4.2.3 ES and measurement methods

In situ measurement was by far the most common method used in the assessed articles. However, several other methods were often used, likely chosen after weighing up their limitations and reliability (Seppelt et al. 2011). Cultural ES measurements mainly involved interview and scoring methods, as demonstrated in other studies (e.g. Boerema et al. 2016). There was greater variety in the methods used to measure other ES, but overall, biological control and pollination were studied in situ, while other ES like carbon sequestration or air quality were mapped and/or modelled. Furthermore, several different measurement types were used to quantify the same ES. This is consistent with other findings and demonstrates the complex reality of ES and the need for universally accepted indicators and methods (Boerema et al. 2016).

4.2.4 ES and beneficiaries

Agroecosystems are managed to improve the supply of services, so it is natural that farmers were the main beneficiaries of ES in our article. However, we found that most of the studies addressed multi-beneficiaries. As ES is scale-dependent, ES beneficiaries are also scale-dependent (Wratten et al. 2013). Farmers stand to benefit from small-scale ES and local and global society from larger-scale ES. Moreover, while several ES are produced, consumed and managed at the same scale, e.g. soil organic matter, other ES are produced at one scale but of benefit to people at several different scales, e.g. carbon sequestration (Raudsepp-Hearne and Peterson 2016).

4.3 ES proxies that could be used as indicators

Proper but also easy quantification of ES is fundamental. According to Cowling et al. (2008), this should be the first step before either monetary valuation or evaluation of trends, trade-offs, synergies and disservices. First, ES need to be properly defined (Boyd and Banzhaf 2007); here, we found that several different terms were often used for the same ES. Only one set of terms, such as those provided by the Millennium Ecosystem Assessment (2005) framework or by the Common International Classification of Ecosystem Services (CICES 2012) classification, should be used, to avoid misunderstandings when ES are studied and/or incorporated in conservation and restoration plans. Second, ES quantification implies the use of several relevant indicators (Dale and Polasky 2007). Almost three quarters of the studies in this article analysed several ES types in concert. Future perspectives include using these identified bundles of ES, i.e. sets of positively correlated ES, as indicators (Raudsepp-Hearne et al. 2010). Our evidence map yielded 74 frequently used indicators, 50 of which are easily measurable and fulfil the Dale and Polasky (2007) criteria (see Supplementary material B, Table B.3).

However, one challenge that could be addressed now in further studies is to determine for each indicator the range of measurement values that should be considered positive for ES provision, which is likely ecosystem-dependent. Moreover, the scale of production and the beneficiaries need to be determined before selecting the measurement scale. As indicators are often proxies for non-measurable ES, it is important to know which part of the ES "cascade" is being measured (i.e. ecosystem property, function, service, benefit or value), to ensure reliability (Boerema et al. 2016).

4.4 Conclusion: perspectives and constraints for researches on ES from conventional farming systems

In agricultural land, unlike natural ecosystems, ES provision and variation over temporal and spatial scales is often the result of interactions between agricultural management and ecological structures. It is thus important to know how land management impacts ES provision (van Zanten et al. 2014; Duru et al. 2015; Rey et al. 2015). Overall, it has been already proven that agroecological practices provide more non-provisioning ES than conventional farming practices (Stavi et al. 2016; Palomo-Campesino et al. 2018), and we thus must be aware that non-conventional types of managements are important in conservation and restoration plans. However, in this study, we wanted as a first crucial step to identify ES supplied even under conventional agriculture. This acknowledgement would allow taking into account ordinary nature from species-poor ecosystems. Then, identified indicators of ES provided by ordinary nature from conventional agriculture systems should be included into conservation and restoration plans. A following step would be to evaluate trade-offs, synergies between ES and disservices (Therond et al. 2017). Today, in a context of global change, it is also important to understand and consider the evolution of ES driven by changes such as agricultural intensification and increased drought duration.

Moreover, ES have multiple dimensions, i.e. biophysical, sociocultural and monetary. To date, studies on ES have been often based on monetary approaches and have taken a provisioning point of view (van Zanten et al. 2014). Now, there is a need for more integrated approaches considering all three ES dimensions of sustainability (de Groot et al. 2010; Millennium Ecosystem Assessment 2005).

To conclude, we are aware that there are limitations to our approach related to the literature screening method we used. Indeed, the conducted search by title yield a limited number of articles, and the exclusion of "grey literature" reduced the access to important other form of knowledge on ES. Nevertheless, we think that an evidence map was needed as a first stating point to understand the state of knowledge on ES, to suggest easily measurable and operational indicators of significant ES for conventional farming system and then to allow better incorporation of ES into conservation and restoration programmes.

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Authors' contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Christel Vidaller. The first draft of the manuscript was written by Christel Vidaller, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Declarations

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