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Agrosystem Services: An Additional Terminology to Better Understand Ecosystem Services Delivered by Agriculture

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Abstract

To discriminate between the contributions of ecosystems and the human subsidies to agricultural systems, we propose using an additional terminology to bring clarification into the controversial discussion about i) ecosystems versus agrosystems and ii) ecosystem services versus agrosystem services. A literature review revealed that with the exception of some very recent publications, this has not yet been sufficiently reflected, neither within the scientific nor in the policy discussion. The question remains whether to spoil the discussion with new terms again and again. We reason that it makes sense to underpin the case-specific share of agricultural inputs to the supply of agroecosystem services and to add "agro" to the terminology. We conclude, that there is a need to promote the new terminology of agrosystem services and to strengthen the use of the already established term agroecosystem services within this context.
To emphasise the production patterns behind the multiple benefits agricultural systems provide to humans (commodity and non-commodity outputs) and to guarantee a reasonable weighting of related externalities in policy processes, we suggest to introduce the term agrosystem services into the discussion on ecosystem services. Agrosystem services in this context describe the anthropogenic share of agroecosystem services' generation. Agroecosystem services include multiple provisioning, regulating and cultural services from agricultural ecosystems. The inclusion of agrosystem services might accommodate the ecology-based ecosystem services concept to the specificity of managed agricultural ecosystems and therefore could be better implemented by mostly economy-driven agricultural production systems and agricultural policy.

Keywords:
agrosystem, agroecosystem, agricultural ecosystem, agro-ecosystem, agro(eco)system, services, disservices

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1 Introduction

1.1 Ecosystem services from agricultural ecosystems

The necessity to strengthen the anthropogenic share within the characterization of ecosystem service supply and to adapt the ecosystem services concept has increasingly entered the scientific debate (Albert et al. 2015; Burkhard et al. 2014; UK_ NEA 2011; von Haaren et al. 2014) and is particularly necessary for agricultural ecosystems, whose ecosystem service supply strongly depends on additional anthropogenic inputs and human-derived capital (Fischer & Eastwood 2016; Jones et al. 2016; Power 2016). This fact has been elaborated during different conferences, workshops and scientific networks (e.g., the Ecosystem Services Partnership ESP[1]). Therefore, this paper joins the discussion and mirrors it with the currently existing definitions and a systematic review of relevant publications.

To cover the complex interactions between ecosystem structures, processes and human benefits as well as the integration of related values in decision-making are challenging claims of the ecosystem services concept. Due to their case-specific application (Burkhard et al. 2012; Costanza 2008a), ecosystem services have been defined and categorized in many different ways (Polasky et al. 2015). The most commonly applied classifications have been provided by the Millennium Ecosystem Assessment (MEA 2005), CICES (Haines-Young & Potschin 2012) and The Economics of Ecosystems and Biodiversity (TEEB 2010), although the MEA's list of ecosystem services was criticized for not presenting a coherent set of services (Wallace 2007).

Applying a very basic definition for ecosystem services to agricultural systems would lead to the benefits people obtain from agricultural ecosystems; and therewith providing a definition of agroecosystem services. This definition is best in terms of provisioning services, including the provision of food and feed, natural fibre, timber, biomass fuels, pharmaceuticals and other biochemicals as well as products from floriculture like pot plants, hardy perennial plants and bulbs and corms. However, maximizing these essential provisioning services from agroecosystems normally results in trade-offs with other ecosystem (i.e. regulating and cultural) services (Elmqvist et al. 2013). Therefore, agricultural management practices are a key to realizing the benefits of ecosystem services and reducing disservices from agricultural activities (Power 2010). It is important to draw attention to the services supplied by agricultural ecosystems or - as the case may be - to ecosystem disservices (e.g., plant diseases or crop pests and competition for water and nutrients by undesirable species) reducing productivity or increasing production costs and management efforts (Zhang et al. 2007). The concept of (agricultural) ecosystem disservices does not systematically cover negative external effects of agricultural production, which influence the balance between the supplies of different ecosystem goods and services. For example, intensive farming tends to negatively influence different regulating ecosystem services (Gordon et al. 2010; Harrison et al. 2010) and cultural ecosystem services (Raudsepp-Hearne et al. 2010). Supporting services are basic ecosystem functions (ESF) that set limiting conditions for a viable ecosystem. According to the state-of-the-art in the ecosystem services debate (Haines-Young & Potschin 2012), we use the term ecosystem functions below instead of supporting ecosystem services. Intensive agricultural activities alter the biodiversity and landscape heterogeneity and influence soil and water quality through irrigation systems, soil tillage, fertilizer application, and pesticide use (Dale & Polasky 2007). The fact that ecosystem services, especially from an agricultural context (agroecosystems), are achieved by human work and inputs of matter and energy (Matzdorf & Lorenz 2010) instead of flowing from natural ecosystems to human society through a self-driven cascade (Haines-Young & Potschin 2010) has to be reflected. This characteristic is also covered in an updated definition of ecosystem services from the so-called Salzau-Message developed at the 3rd international ESP Conference[2] : "Ecosystem services are the contributions of ecosystem structure and function – in combination with other inputs – to human well-being" (Burkhard et al. 2012).

[1] http://www.es-partnership.org

[2] http://www.uni-kiel.de/ecology/projects/salzau/

In support of this concept development, ecosystem service potentials have been distinguished from ecosystem service flows in more recent works (Bastian et al. 2012; Burkhard et al. 2014; Schröter et al. 2014). The concept of flows reflects the time-dependency of 'harvesting' a service and therefore is closer to an economic perspective (of e.g., agricultural enterprises) in contrast to a more ecology-driven perspective with (theoretical) capacities of an ecosystem to provide services. Because an economic perspective is demand-driven, whereas the potential ecological perspective is supply-driven, the concept of ecosystem service flows may bridge this gap. Ecosystem service potentials are in this context comparable to natural capital stocks, yielding a (hypothetical) future flow of ecosystem services (Burkhard et al. 2014; Costanza 2008b).

When using the ecosystem services concept within agricultural systems, we must recognize that agriculture is the most dominant form of land use. In 2012, worldwide, more than 37% of the terrestrial surface was covered by agricultural ecosystems (FAOSTAT 2015). Grazing land accounts for 26% of the Earth's surface, and animal feed crops account for a third of all cultivated land (Steinfeld et al. 2006). In this context, the related fields of forest ecosystem services and (strongly anthropogenic) urban ecosystem services should also be included to frame an overall categorization of ecosystem services. Nevertheless, ecosystems under agricultural use represent humankind's largest "engineered ecosystems" (Dale & Polasky 2007). This term contrasts with natural ecosystems, accentuating the specificity of agricultural, managed ecosystems.

To discriminate between the contributions of ecosystems and the human subsidies to the system, we propose using an additional terminology. We suggest to introduce **agrosystem services** into the discussion to bring clarification into the controversial discussion about i) ecosystems *versus* agrosystems and ii) ecosystem services *versus* agrosystem services, albeit agrosystems in the classical meaning are ecosystems. In the political arena the terms are used in different sense, to specify the respective politics.

A literature review was used to clarify whether the term has already been sufficiently reflected within the scientific or in the policy discussion.

1.2 Methods for the literature review

To determine how far this new terminology has been introduced within the discussion of ecosystem services in the context of agricultural production and agroecosystems, a tripartite review was conducted. The review considered:

- Peer-reviewed scientific articles (including their sum of citations);
- Scientific articles in general (potentially including grey literature); and
- Publications from the political contexts (governmental databases, policies).

The literature database was updated on February 16th in 2015 for the Web of Science (WoS) and on February 23rd in 2015 for Scopus and for Google Scholar.

1.2.1 Mining peer-reviewed scientific literature

A systematic literature review was undertaken for the 10 years from 2004 to 2014 on WoS from Thomson Reuters, supplemented by the Scopus data bank driven by Elsevier. Using the subscription level through the Leibniz Centre for Agricultural Landscape Research (ZALF) in Müncheberg/Germany, all available databases were used. For all final search terms in use, the following WoS databases response, listed in order of number of hits (in brackets), was: CABI (65), Web of ScienceTM Core Collection (50), BIOSIS Citation IndexSM (46), BIOSIS Previews® with last updates 2004 (45), Biological Abstracts® (39), Current Contents Connect® (39), Zoological Record® with last updates 2006 (12), Data Citation IndexSM (2), and KCI-Korean Journal Database (1).

We started to search in TOPIC for the exact term „agrosystem service*". Therefore, the term must appear in the title, abstract, author keywords or keywords plus®. To cover a broad range of scientific work supposed to be adjacent with agrosystem services, we used several search terms linked with

OR in another query in TOPIC as follows:

- „agroecosystem service*“
- „agro-ecosystem service*“
- „agricultural ecosystem service*“
- „ecosystem service* in agroecosystem*“
- „ecosystem service* in agro-ecosystem*“
- „ecosystem service* in agricultural system*“
- „agrosystemic service*“.

These terms were derived from a screening with the WoS NEAR-function with TOPIC: (agr* NEAR/3 ecosystem) AND TITLE: (ecosystem service*). This resulted in more than 300 hits and covers the majority of terms in use within the research field of ecosystem services in agricultural (eco)systems. Nevertheless, the term "ecosystem service* in agricultural system*" was not detected and was added due to semantic logic in comparison to the other terms.

The query with the above-mentioned search terms was refined by the database. Using only one database would remove at least a quarter of all hits. However, the databases Web of ScienceTM Core Collection, CABI and BIOSIS Citation IndexSM covered almost all unique hits, excluding only two databases and one article from the Korean Journal Database Citation. Using more than one database is known to create duplicates. Excluding duplicates and other artefacts (e.g., not including one of the search terms or incomplete information) left 75 usable papers.

The same query for the ten years from 2004 and 2014 with no further refinement was performed within Scopus, and only new articles (7) were added to the literature database, resulting in 82 usable papers. Additionally, the cumulative number of citations of all articles grouped together was calculated for each category to determine the relative importance of the terms in use.

1.2.2 Mining general scientific literature

Both WoS and Scopus provide data from the vast majority, although not all, of the peer-reviewed scientific journal articles and many books, book series and book chapters. An additional search on Google Scholar complemented the search for scientific output on agrosystem services and related terms and included a broader range of books, reports, magazine articles, newspaper articles, and other forms of publication and can be used to find additional articles. However, the search does not ensure scientific standards; therefore, the numbers of hits may show a low level of confidence. Due to the severe limits in Google Scholars search options, the search was i) bounded to titles and ii) covered all mentions somewhere in the article, excluding hits based on citation or patent alone. Searching for the same time period of the years from 2004 to 2014, five queries were performed, once in title ("allintitle") and once for all mentions. The queries included: „agrosystem service“ OR „agrosystem services“ OR „ecosystem services in agrosystems“. Two other queries were performed, exchanging the term agrosystem with agro-ecosystem and agroecosystem. To maintain coherence with the search performed on WoS and Scopus, a fourth („agricultural service“ OR „agricultural services“ OR „ecosystem services in agricultural systems“) and a fifth („agrosystemic service“ OR „agrosystemic services“) query were added.

1.2.3 Mining literature from political context

To gain insight into the usage of different terms related to agrosystem services in politics on i) a European level and ii) a global level, several important online-search engines and relevant major reports have been investigated. These include, in the European context:

- the search page of the European Commission (EC, retrieved 22.03.2016 from http://ec.europa.eu/geninfo/query/),
- the first two EC reports on Mapping and Assessment of Ecosystems and their Services (2013 and 2014, retrieved 22.03.2016 from http://biodiversity.europa.eu/maes/#REPORTS)
- the search page of the European Joint Research Centre (JRC, retrieved 22.03.2016 from https://ec.europa.eu/jrc/en/search/site)

• JRC Feasibility Study on the Valuation of Public Goods and Externalities in EU Agriculture (2013, retrieved 25.02.2015 from http://publications.jrc.ec.europa.eu/repository/handle/JRC83468)

• the search page for publications of the European Environmental Agency (EEA, retrieved 22.03.2016 from http://www.eea.europa.eu/publications)

• the EEA Environmental Terminology and Discovery Service (ETDS , retrieved 22.03.2016 from http://glossary.eea.europa.eu/),

• the online access to European Union law (EUR-Lex, retrieved 22.03.2016 from http://eur-lex.europa.eu/content/welcome/about.html),

• the General Union Environment Action Programme to 2020 (2014, retrieved 25.02.2015 from http://bookshop.europa.eu/en/general-union-environment-action-programme-to-2020-pbKH0113833/),

and on the global level:

• the search page for publications of the Food and Agricultural Organization of the United Nations (FAO, retrieved 22.03.2016 from http://www.fao.org/publications/en/),

• the search function on the homepage of the Organization for Economic Co-operation and Development (OECD, retrieved 22.03.2016 from http://www.oecd.org),

• the OECD iLibrary (retrieved 22.03.2016 from http://www.oecd-ilibrary.org) and

• the United Nations Sustainable Development Knowledge Platform (retrieved 22.03.2016 from https://sustainabledevelopment.un.org/).

1.2.4 Categorization

All records from WoS/Scopus were categorized in accordance to these five terms: i) agrosystem services, ii) agroecosystem services, iii) agro-ecosystem services, iv) agricultural ecosystem services, or v) agrosystemic services. Two Chinese articles mixed the terms agricultural ecosystem services with agro-ecosystem services. Because this was the exception and was an inconsistency wording, the term in the title was accounted for. Records using "ecosystem services in agroecosystems" were categorized as agroecosystem services because the two terms are actually the same (Jarvis et al. 2013). A comparable treatment was applied to the terms "ecosystem services in agro-ecosystems" and "ecosystem services in agricultural systems". One article used the term "agro ecosystem services", which was categorized as agro-ecosystem services because search engines treat spaces and hyphens similarly.

The records from Google Scholar were not categorized separately but by their automatic assignment to the terms in the query. Therefore, the results are not as reliable as the records from WoS/Scopus because double-counting of articles (in different queries and within one query), incomplete information, or wrong indications could not be excluded.

The results in the several policy search engines showed a relatively low number of related articles. Therefore, all hits were individually checked for double-counting, improper category (e.g., job announcement), incomplete information, or wrong indication.

1.3 Results from the structured analysis

No records were found for the terms agrosystem services or term agro(eco)system services in any of the available databases in WoS or Scopus (see Table 1). The term agrosystemic services may have a similar meaning but was recorded only once by Gebhard et al. (2013), making the term an outsider. This result was confirmed by the search on Google Scholar. Instead, the adjacent terms returned several results, as can be seen in Table 1. The terms agroecosystem services and agro-ecosystem services were found most often and in a very similar number of papers in both scientific articles in general and in exclusively peer-reviewed articles. The term agricultural ecosystem services accounts for the same range of hits but slightly lags behind. A surprisingly strong differentiation between the terms agroecosystem services and agro-ecosystem services appeared when weighting by the sum of citations. From this point of view, agroecosystem services is preferred by the most cited (and therefore thought to be the most influential) papers.

Our search for agrosystem services or adjacent terms within policies, government documents, laws and policy-related reports had little success. Only a few references for the use of the investigated terms were found. Table 2 gives a quick overview on the origin of the terms we found. More important, it shows where none of the tested terms related to agrosystem services were found, e.g., the glossary (ETDS) of the EEA or the FAO. In the sources that had some use of the examined terms, both 'agricultural ecosystem services' and 'agro-ecosystem services' were favoured, but no other terms, although this statement is weak in consideration of the very low number of publications. In comparison to the results from the scientific articles, a remarkable contradiction appears: the term agroecosystem services, which received the greatest acceptance in scientific papers, found a loose mention in the political context.

Beyond this literature review it has to be figured out, to what extend the agricultural issues within the discussion about ecosystem services does have an excessive focus onto the provisioning part only and therewith is drawing much more emphasis onto the economic and political dimensions as other aspects do.

Table 1: Results of the terminologically mining of WoS + Scopus and Google Scholar (2004-2014)

	agrosystem services	**agrosystemic services**	**agroecosystem services**	**agro-ecosystem services**	**agricultural ecosystem services**
WoS/Scopus [topic]	0	1	31	29	21
WoS/Scopus [sum of citations]	0	2	236	71	44
Google Scholar [allintitle]	0	0	25	24	24
Google Scholar [all mentions]	0	0	394	456	240

Table 2: Results of the terminologically mining of the political context on a European (lines 1-8) and on a global level (lines 9-12). For the definitions of abbreviations, see methods section 1.2.

searched policy documents or databases	**ecosystem services (ES) terminology with reference to agricultural systems**
EC (online search)	agro-ecosystem services/ agricultural ES
MAES reports (2013, 2014)	agro-ecosystem services
JRC (online search)	N/A
JRC (report_public goods, 2013)	agricultural ES
EEA-publications	agricultural ES
ETDS (EEA)	N/A
EUR-lex	N/A
Environment Action Plan/Programme	N/A
FAO	N/A
OECD	agro-ecosystem services/ agricultural ES
OECD iLibrary	N/A
sustainable development knowledge platform	N/A

2 Background: Agroecosystem services in politics and economy

The operationalization of the complex conceptual framework of ecosystem services is not an always well-balanced approach. Furthermore, ecosystem services sometimes display an ecological bias (Schößer et al. 2010), and the separate, downstream analysis of socio-economic issues conflicts with the principles of the three pillars within the sustainability approach. On the global scale, ecosystem services are a good way to discover future trends and to raise awareness of the pressing issues to be addressed in the political arena. For the sub-global, regional and local scales, the transfer of the complex, conceptual structure is difficult for analyses and communication to decision makers (Albert et al. 2015). Thus, the challenge remains to integrate complex systems knowledge into clear, easy-to-comprehend information on the one side, while maintaining necessary details about systems relations on the other. The studies steered by the global TEEB (2010) initiative are milestones in elevating ecosystem services into political, financial and public awareness and decision-making. These studies might be considered as starting points for introducing ecosystem services for socio-economic consideration into public debates and embedding them in practical land use strategies (TEEB_DE 2016). In this way, the public's awareness of the consequences of policies and the business' awareness of ample utilizations affecting the long-term ecosystem functionality and of the uniqueness of the surrounding landscape can be increased.

Policy makers ask for understandable science-based information and a significant terminology that can be used for the assessment of the impacts of their decisions on human well-being (Helming et al. 2013). By linking ecological structures and processes to human well-being, the concept of ecosystem services offers an opportunity to pre-process research knowledge into a usable format. Researchers need to condense their process-understanding of human-environment interactions and transfer this knowledge into a consistent valuation framework for multi-criteria analyses and solution optimization (e.g., Schößer et al. 2010). Within this study, multi-criteria analyses have been chosen as a tool for a (comparative) evaluation of ecosystem services (Fontana et al. 2013; Gasparatos & Scolobig 2012; Koschke et al. 2012). Human well-being and economic development largely depend on the provision of the full portfolio of ecosystem services. Systemic land use strategies may create opportunities for adequate weighting of ecosystem services in political processes (Helming et al. 2013). Land use strategies suffer from disciplinary approaches as well as from sector-specific responsibilities, which are barriers to a systemic approach and have to be resolved. This approach might also be the way to combine ecological understanding and economic considerations to protect natural capital (Chee 2004; Munda 2005).

3 Finding an appropriate terminology

The integration of the ecosystem service concept in day-to-day policy making is still not yet achieved (Carpenter et al. 2006; Helming et al. 2013). The integration requires a conceptual framework and a specific terminology and may involve participatory processes and be expert-based (Diehl et al. 2016). The requirement is that the evaluation framework describes causal relationships between human activities and their impacts on sustainability. Thereby, a comparative trade-off analysis of different kinds of impact areas must be possible. An attempt to define such evaluation framework has been suggested by van Zanten et al. (2014). In the context of agricultural policy making, the terminology must support the societal debate and deliberative decision-making. Additionally, a proper terminology should be coherent with the existing terms from economics, ecology, social sciences and politics and should consider specifically the benefits people obtain from agricultural production (Jones et al. 2016). The benefits are covered by the notion that agricultural products (commodity outputs) are inherently linked with (positive and negative) externalities, called non-commodity outputs (Wüstemann et al. 2008). However, this is not an ecosystem-based approach, and the desired link between an anthropogenic-shaped system and ecosystem functioning is not clearly established (Fischer & Eastwood 2016). An ecosystem-based approach has been proposed by the Convention on Biological Diversity (CBD 2004) and the United Nations Framework Convention on Climate Change (UNFCCC) as a guiding principle in dealing with environmental problems, like biodiversity loss or climate change, using ecosystem-based adaptation (EbA) and mitigation (EbM) (cf. Bonn et al. 2014).

Contracting the agricultural production system to the term agrosystem is based on a systemic perspective while maintaining the anthropogenic notion. Agrosystems in this sense are actively managed (Matzdorf & Lorenz 2010) or engineered (see above) to optimize the quality and quantity of the above-mentioned provisioning services.

Apart from the above-mentioned general recognition of the anthropogenic inputs in (especially intensively managed) agricultural ecosystems, a specific term was missing until Burkhard et al. (2014) conceptualized agroecosystem services consisting of (natural) ecosystem services and (anthropogenic) agrosystem services. In their sense, agrosystem services are identical with additional anthropogenic system inputs, like fertilizer, water, energy, technology, labor and knowledge.

Establishing the term agrosystem services (and disservices) may sensitize the broader public for this discussion. The lack of a – from our point of view - sufficiently detailed discussion is a reason why non-commodity outputs as contributions to human well-being have not yet been properly established in sustainability politics (Daily et al. 2009). Another reason to talk about agrosystem services is the recent discussion about future agricultural management schemes and the urgent necessity to change, for example, the European Common Agricultural Policy (CAP). Policy decision-making is mostly driven by economic concepts based on products and marketing services with monetary values. Because ecosystem services are rarely integrated into commercial valuation systems (e.g., payments for ecosystem services (PES) (Kinzig et al. 2011) and as public goods are often free of charge, they are regularly neglected or even ignored, as Costanza et al. (1997) stated years ago and was repeated recently (Burkhard et al. 2012; Costanza et al. 2014). The consequences of underestimating the value of functioning ecosystems can be observed all over the world. This prompts a debate about whether strategies should address the marketing potential of ecosystem services. Speaking about agrosystem services *per se* would include this economic aspect.

The economic perspective in agricultural systems is also reflected in different data. Mainly farm-related measures, like yield, use of energy and of fertilizer, soil treatment, and crop rotation, conflict with the purely ecosystem-based approach inherent in ecosystem services. Therefore, a more economic- and externality-related discussion about ecosystem services from agroecosystems seems to be necessary. Spatially explicit information about yields, crops, nutrient and water balances, soils and species abundances helps to link the necessary economic information with the environmental information.

Due to recent discussions, the terminology of ecosystem services in an agricultural context has to be put on trial. To cover the specificity of agroecosystems and their services that are provided only due to significant inputs of work, machines, matter, water and energy, the term agrosystem services is up for discussion (Burkhard et al. 2014). The hypothesis says that such an adapted terminology may help to develop the ecosystem services concept further and to strengthen the links between science, agricultural management and policy making. Therefore, the term agrosystem services is needed to underpin the large anthropogenic share to the supply of agroecosystem services.

In this discussion, the evidence for the occurrence of this more specific term i) in science and ii) in politics has been analyzed in this study via a structured review. The results were used to obtain a clearer picture of the agrosystem services concept's application potential and to draw first conclusions for future use.

4 Discussion

When dealing with sophisticated differences of terms, it is helpful to provide a contextualization. Because the topic of agrosystem services is less established, its terminological relation to state-of-the-art knowledge is not yet fixed. The originality lies in the definition of what an agrosystem is, which distinguishes the dichotomy of i) natural, unmanaged ecosystems and ii) agricultural, managed ecosystems. Agrosystems focus on the agricultural production system as a whole, making use of an ecosystem environment.

Power (2010) stated that agricultural ecosystems provide ecosystem services (e.g., food, forage, fiber, bioenergy, pharmaceuticals) and 'consuming' ecosystems services (e.g., energy, water, nutrients). We suggest that strictly speaking, the agrosystem 'consumes' the mentioned services. Biodiversity results in a double dividend, from the agronomic as well as from the environmental point of view (Daily 1997). Maintaining biodiversity can provide a range of ecosystem functions and regulating services to an agrosystem, e.g., by regulating weeds, pests and diseases, maintaining soil fertility, countervailing erosion or recycling of nutrients. The production of agricultural goods is dependent on services provided by neighboring natural ecosystems (Power 2010). There are well-known 'candidates' like i) biological pest control (Tscharntke et al. 2005), ii) pollination (Klein et al. 2007), iii) water quantity and quality (Rockström et al. 2009; Rost et al. 2009), and iv) soil structure and fertility (Zhang et al. 2007). These services are essential for crop production, and they sometimes substitute directly for purchased inputs. However, as long as these (especially regulating) ecosystem services and basic ecosystem functioning beneficial to agricultural production are not valued correctly, this topic will remain a scientific discussion only.

Agrosystem services can be defined as services *to* the ecosystem (with the aim of enhancing agroecosystem service supply). Indeed, 'services' in the context of ecosystem services are usually understood as benefits people obtain (Fisher et al. 2009; MEA 2005). Nevertheless, this is in line with the objective of the anthropogenic inputs that enhance, for example, plant growth or plant health. Additionally, such a notion escapes the argumentation that agrosystem services, identical to anthropogenic inputs, do not make sense when considered in isolation: without the natural components, no agroecosystem service can be delivered. Therefore, the term agrosystem services should not be understood in a direction leading to the false implication of being a shorter version of the term agroecosystem services or referring exclusively to agricultural production systems in a totally artificial environment (bioreactor). Because agrosystem services do not have a clear, intuitive meaning, this raises the question of why a new term should be introduced instead of using the common terms. In general, the introduction of new terms leads to further splitting of the terminology instead of uniting it. The diversity of terms in use is already a problem. The scientific community should use a common set of terminology for ecosystem services from agricultural ecosystems. We suggest that – on the one hand – the most cited terminology (agroecosystem services) should be supported. With the development of the term ecosystem services in mind, we have a rough idea of how long it may take to anchor the term in the political context.

Due to differences in management cultures, climatic and soil conditions, and socioeconomic conditions, agroecosystems vary in structure and function. Additionally, because ecosystem services are joint products (or bundles, cf. Raudsepp-Hearne et al. 2010) from intact ecosystems, the relative rates of production of each service vary from system to system, from site to site, and from time to time. Mono-functional uses due to recent agricultural production schemes are favored because of economic profit. Thus, – on the other hand – the consideration of agrosystem services and their specific share (and costs) for the delivery of agroecosystem services can help to identify the true costs (including externalities) and benefits in agricultural production systems. More natural systems have a relatively lower share of (anthropogenic) agrosystem services, whereas intensively managed systems have a relatively lower share of natural production factors and a higher share of human inputs. Croplands with restored ecosystem services profit from synergies between the different services (Foley et al. 2005; TEEB_DE 2016) and are less dependent on agrosystem services (see Figure 1).

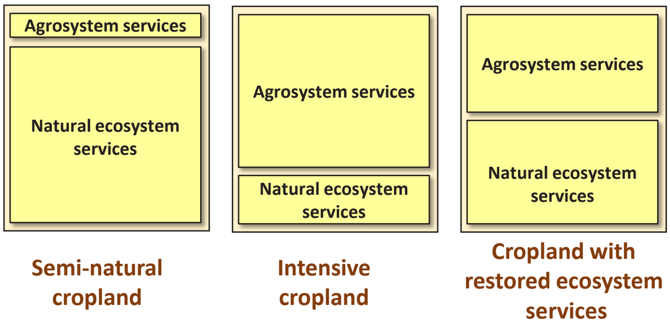

Figure 1: Share of agrosystem services and natural ecosystem services in differently managed cropping-systems. The outputs of all three systems are different amounts of agroecosystem services.

Because ecosystem services are very case-specific (Burkhard et al. 2012; Costanza 2008a), it is beneficial to design a site-specific land use strategy that considers the full range of services and the characteristics of their bundling to avoid creating dysfunctional incentives. Going beyond this high aggregated level would require addressing the specifics of agricultural production and would result in a specific terminology.

Due to the discussion on ecosystem services within the context of agricultural production, environmental protection has been given a new status: it has become a goal of societal development rather than being treated only as a limiting factor (European_ Commission 2011). By relating ecological, economic and social problems to one another, the concept of ecosystem services has successfully expanded the ecological discussion into the socio-political dimension. Nevertheless, the ecological aspects of the problem require different operational strategies than those needed to address the social questions. This emphasizes the need to develop a terminology that helps to meet the involved protagonists in their own living room. There must be a reason that none of the tested terms related to ecosystem services from agricultural ecosystems was found in the glossary of the EEA, the OECD-Library, the EUR-Lex or the FAO. The FAO does not explicitly emphasize ecosystem services from agricultural systems. One reason for this fact may be that other concepts also cover the integrative perspective of sustainable agricultural land use. For example, the concept of multifunctionality (Wüstemann et al. 2008) is favored by the FAO and has been extensively discussed in European Agricultural Policy contexts covering this conceptual field to a considerable degree. The underlying rationale for multifunctional land use is to consider the social, economic, and environmental effects of any land use action simultaneously and interactively, including those of commodity production and those of negative and/ or positive externalities (Wiggering et al. 2003). However, by linking the supply-based concept of joint multifunctional production to an estimation of social demand for such functions, the concept can be useful for policy design (Bills and Gross 2005). Even if the concept of multifunctional land use covers the demand of site-adequate land use systems, the political intention poses the problem of decoupling of land use from the specific site situation and does not address the suggestion of ecosystem services of agroecosystem and agrosystem services.

5 Conclusions

Based on our literature review and the discussion about political and economic relevance, the debate about a discrimination between the contributions of ecosystems and the human subsidies to the system, entering the controverse discussion about i) ecosystems *versus* agrosystems and ii) ecosystem services *versus* agrosystem services, does not seem to be sufficiently established yet.

The discussion on the drawbacks of the ecosystem services concept's application in agricultural ecosystems suggests further exploiting the term agrosystem service and employing it for lobbying the ecosystem services discussion within the scientific and political arenas. The fact that agriculture is the most dominant form of land use justifies talking about agroecosystems. With an integrative perspective into this discussion and emphasis on the anthropogenic share of ecosystem service supply, the opportunity to install a more balanced management, covering the provisioning services complementarily to regulating and cultural services and in relation to ecosystem functioning and biodiversity, is more likely.

Nevertheless, the term agrosystem services has not been really reflected within the scientific or the political discussion. Its meaning is not intuitively clear, and misunderstanding could compromise its original aim to help in the communication between science and policy, i.e., the society and concerned land users in particular. Additionally, introducing new terms poses the risk of further splitting up the terminology instead of uniting it. However, we believe that it is needed to underpin the case-specific share of agricultural production to the supply of ecosystem services and to add "agro" to the terminology. We conclude to strengthen the use of the term agroecosystem services for ecosystem services from agricultural production systems and agrosystem services for the anthropogenic inputs to agroecosystem service supply.

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Author Contributions

All authors contributed equally to this work. Hubert Wiggering provided the initial idea of the hypothesis, Peter Weißhuhn was responsible for the structured literature search, and Benjamin Burkhard provided the integration into the ongoing ecosystem service debates.

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