Governing for Sustainable Agriculture in the EU: Promoting Multi-Stakeholder Collaboration

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Abstract

Over 25 years after the UNCED conference in Rio de Janeiro in 1992, agriculture in the European Union (EU) has below the line not come much closer to being sustainable. By now, efforts to promote sustainability in agriculture have predominantly been based on "mainstream science". This has resulted in strategies directed mainly at agricultural production, measures targeted at individual farms, and a major focus on technology-centered solutions. Yet, there have been many claims emphasizing that such approaches are insufficient to deal with wicked, sustainability-related problems. Rather, it has been argued, we need to question the governance of sustainability issues, i.e. who makes which decisions in which way. A central aspect of sustainability governance is collaboration, which has been lauded for its benefits but also criticized for its challenges.

The potential benefits of collaboration have apparently been recognized also in the context of EU agriculture. Yet, there has been a lack of holistic consideration of how collaboration can be systematically integrated and promoted in the governance of EU agriculture. Sustainable agriculture cannot only be encouraged through changes in the overall governance system but also through the support of existing and emerging small-scale collaborative initiatives for sustainable agriculture. Indeed, there has been substantial research on the conditions that influence success of similar collaborative initiatives. However, the knowledge resulting from this research remains rather scattered and does not allow for the identification of overall patterns. Additionally, little of this research specifically focuses on sustainable agriculture. What is more, the promotion of collaboration for sustainable agriculture is further complicated by the lack of clarity of the meaning of sustainable agriculture, which is an inherently ambiguous and contested concept.

This cumulative dissertation aims to address these gaps by contributing to a better understanding of how collaboration can be facilitated and designed as a means to govern for and advance sustainable agriculture. For this purpose, the dissertation addresses three sub-aims: 1) Advancing the understanding of the concept of sustainable agriculture; 2) scrutinizing the current governance system regarding its potential to facilitate or hamper collaboration; 3) assessing conceptually and empirically how actor collaboration can be facilitated as a means to govern for sustainable agriculture, both from a top-down and a bottom-up perspective. In doing so, this dissertation focuses on EU agriculture and applies a mix of methods, ranging from qualitative to quantitative dominant.

The findings of this dissertation highlight that collaboration has been underappreciated and even hampered as an approach to governing for sustainable agriculture. In contrast, this dissertation argues that collaboration offers one promising way to promoting and realizing agriculture and emphasizes the need to integrate different approaches to collaboration and to sustainable agriculture. Thus, the findings of this dissertation encourage and justify more research, discussion, and action around collaboration in the context of sustainable agriculture. Additionally, the dissertation provides first tangible insights both on principles for systemic change to promote governance for sustainable agriculture and on factors that are crucial for the successful management of small-scale collaborative initiatives. Most importantly, this dissertation advocates an 'integrative attitude' among and between scientists and practitioners which could enable more collegial, collaborative and hopefully more constructive research, discussion and action for sustainable agriculture.

Framework Paper

Governing for Sustainable Agriculture in the EU: Promoting Multi-Stakeholder Collaboration

1 Introduction

At least since the UNCED conference in Rio de Janeiro in 1992, sustainable agriculture has been – along the overarching guiding principle of sustainable development – an important topic on international and national agendas. Yet, more than 25 years later, agriculture in the European Union (EU) has below the line not come much closer to being sustainable. Indeed, there have been some advances and positive trends: For instance, the share of agricultural land under organic production has been increasing steadily; harmful emissions from pesticides and fertilizers have decreased recently; and 9% of the agricultural land of the EU is part of the Natura 2000 network of nature conservation areas (EEA, 2018). However, even without considering the small scale of these achievements – organic farming covers just a tiny fraction of the agricultural land (6.7% in 2016), emissions from agriculture are still high (EEA, 2018), and 80% of the Natura 2000 grasslands are in an unfavorable condition (EEB, 2017) – they are outweighed by numerous and continued detrimental trends: The EU is more than likely to miss its goal of halting biodiversity loss by 2020 (European Commission, 2011); agriculture continues to be the primary source of diffuse water pollution (EEB, 2017); there are ever less young farmers and less but bigger farms (European Commission, 2018b), and so on.

By now, efforts to address these negative trends and promote sustainability in agriculture have predominantly been based on "mainstream science" (Ravetz, 2004), which is characterized by reductionist, linear, instrumental and positivist approaches (Bawden, 2012). This has resulted in strategies that are directed mainly at agricultural production and therefore neglect interdependencies in the wider agri-food system (Dahlberg, 1993; Reisch et al., 2013). Also, measures have targeted mainly individual farms (Ferreyra, 2006; Robinson, 2009; Mills et al., 2011). As a result, a mismatch occurs between the spatial scale of management and the scale of ecological processes, which often extend far beyond the boundaries of single farms (Pelosi et al., 2010). Additionally, the focus on agricultural production at the farm level has directed the main attention towards the development of purely technology-centered solutions (e.g. biotechnology, precision agriculture) (Ferreyra, 2006; Garnett, 2013).

While there is little doubt about the importance of technological and on-farm solutions, there have been many claims emphasizing that they are insufficient to deal with wicked, sustainability-related problems – in general (e.g. Voß and Kemp, 2006; Schlaile et al., 2017) as much as in agriculture (e.g. Pretty, 1999; Dentoni et al., 2012; Chappell, 2018). Thus, "the future will be based not on the promises of whiz-bang technology, but on the more mundane features of the decisions our societies make about what we will do, how we will do it, and who will get to decide" (Chappell, 2018, p. 1) or in other words: on the governance of sustainability issues.

A central aspect of environmental and sustainability governance is collaboration (Newig and Fritsch, 2009; Schoon and Cox, 2018). Collaboration has risen to be a leading paradigm (Margerum, 2008) and been advocated to be the best way to address wicked problems (Waddock, 2012). This is due to its arguable ability

to integrate different kinds of relevant knowledge which are held by different stakeholders (Ansell and Gash, 2008; Abson et al., 2017). Therefore, collaboration is supposed to be able to address the challenges emerging from today's seemingly contradictory situation where social and ecological connections become ever more fragmented at the same time as social and economic connectivity and interdependence increase (Duit et al., 2010; Schoon and Cox, 2018). Nevertheless, the numerous assumed benefits of collaboration (Reed, 2008; Uetake, 2014; Prager, 2015) have been challenged by counterarguments disputing the claims about the effectiveness of collaborative governance approaches (cf. Klijn and Skelcher, 2007; Newig and Fritsch, 2009; Bodin, 2017). Hence, it is ultimately not certain whether or not governance and collaboration-centered solutions are of the proclaimed importance and offer greater leverage for change than technocratic approaches. Notwithstanding, based on the arguments and claims outlined above, I assume here that governance and collaboration do have an important role to play in tackling sustainability problems, in general as well as in agriculture.

The possible benefits of collaboration have apparently been recognized also in the context of EU agriculture as networking is explicitly supported within the EU Common Agricultural Policy (CAP) (Marquardt et al., 2011). However, although examples of collaboration for agri-environmental outcomes in the EU exist (e.g. Franks and Mc Gloin, 2007; Steingröver et al., 2010), they remain isolated and are based on voluntary schemes. In other words, collaboration is made possible but collaborative approaches are neither compulsory nor in any other way an integral part of the EU agricultural policy framework. Consequently, there has been a lack of holistic consideration of how collaboration can be systematically integrated and promoted in the governance of EU agriculture (gap 1).

Undoubtedly, changes in the overall governance system to better integrate collaboration are of tremendous importance and have the potential to effect wide-spread change. However, they are also very complex as well as hard and slow to achieve. Thus, an additional way to promote collaboration is supporting existing and emerging small-scale collaborative initiatives for sustainable agriculture. Examples for such initiatives are organic farmer cooperatives (e.g. Antonelli et al., 2004; Schmid et al., 2004), supply chain initiatives for sustainably produced agricultural products (e.g. Brandsma et al., 2005), community-based initiatives for biodiversity conservation on agricultural land (e.g. Peterken, 2010) etc. Albeit having less far reaching effects, such local or regional initiatives can be established comparatively easily and swiftly. What is more, smaller individual initiatives can serve as proof of the feasibility and effectiveness of collaborative approaches and provide important lessons (Koc, 2010). Thus, apart from integrating collaboration in the overall governance system, also supporting a larger number of small-scale initiatives is vital to promoting collaboration for agricultural sustainability (Shi and Gill, 2005; van Latesteijn and Rabbinge, 2012).

Indeed, there has been substantial research into the conditions that influence success of collaborative efforts in areas related to sustainable agriculture, e.g. farmer collaboration for agri-environmental management (Ingram et al., 2008; Prager, 2015) or social networks in agricultural or sustainability contexts (e.g. Newman and Dale, 2007; Isaac, 2012). However, existing literature largely lacks a specific focus on collaboration in the context of sustainable agriculture and mostly investigates only few cases, which poses challenges in terms of the generalizability of the findings of these studies. Thus, there is a lack of specific focus on collaboration for sustainable agriculture as well as of integration of knowledge on conditions for success of collaboration (gap 2).

What further complicates the promotion of collaboration for sustainable agriculture is the fact that the very aim of such collaboration – sustainable agriculture – is ambiguous and contested (Pretty, 1995). However, stakeholders concerned with the promotion and realization of sustainable agriculture need to have a notion of the meaning of this concept in order to be able to put it into practice (Allen et al., 1991) (gap 3).

This dissertation aims to contribute to addressing these three research gaps and therefore has the overall aim of *contributing to a better understanding of how collaboration can be facilitated and designed as a means to govern for and advance sustainable agriculture*. This includes the following sub-aims:

1) *Concept:* Advancing the understanding of the complex concept of 'sustainable agriculture' (addresses gap 3).
2) *Status-quo:* Analyzing the current governance system to identify whether and how it facilitates or hampers collaboration (addresses gap 1).
3) *Ways forward:* Assessing conceptually and empirically how actor collaboration can be facilitated as a means to govern for sustainable agriculture by both
    a. considering how the governance system of EU agriculture can better promote collaboration ('top-down perspective') (addresses gap 1) and
    b. investigating conditions for success of local and regional collaborative initiatives for sustainable agriculture ('bottom-up perspective') (addresses gap 2).

In addressing the sub-aims 2 *Status-quo* and 3 *Ways forward*, I focus on EU agriculture. This focus is motivated on the one hand by the practical relevance of EU agriculture: EU agriculture is of great economic importance as it contributes more than 7% of total exports of the EU (European Commission, 2018b) while claiming almost 38% of EU expenditures (EEA, 2018). At the same time, EU agriculture causes major environmental impacts. It is, for example, one of the main users of land and natural resources (OECD, 2017; EEA, 2018) and plays an inglorious role as the main source of diffuse water pollution (EEB, 2017). On the other hand, EU agriculture presents a unique setting: The numerous countries and regions that are part of the EU provide a great variety of ecological, social, cultural, and economic conditions. Yet, with the Common Agricultural Policy they share a common and unifying agricultural policy framework.

This framework paper proceeds as follows: In the next section, I outline the core concepts of this dissertation. Section 3 describes the research context of this dissertation by providing an overview over the CAP as dominant policy framework shaping EU agriculture. Afterwards, I present the papers included in this dissertation, describe the research design, and the contributions of the single papers to the aims of this dissertation. Section 5 summarizes the findings in relation to the research aims and reflects on the applied methods. Finally, I draw conclusions regarding key insights, their relevance, and future research needs.

2 Conceptual background

The following sections introduce and clarify my understanding of the core concepts on which this dissertation is based: sustainable agriculture, governance, and collaboration.

2.1 Sustainable agriculture

The origins of the idea of sustainable agriculture have been described very differently, some accounts tracing them back to Malthus' idea that population growth would outpace agricultural production (Hyberg and Setia, 1996) and others going back even further to 17th century English philosopher John Locke (Harwood, 1990). The development of the notion of sustainable agriculture was spurred already in the early 20th century through the emergence of approaches like biodynamic agriculture, humus farming, and organic agriculture (Harwood, 1990). However, the concept gained real momentum only in the 1980s, when the environmental impacts of industrial agriculture had become evident (Harwood, 1990; Zhen and Zoebisch, 2006).

The concept of sustainable agriculture is "at once extremely important and practically useless" (Pannell et al., 2006, p. 65) as it has been deemed impossible to be defined absolutely and conclusively (Pretty, 1995; Frantzeskaki et al., 2012). Therefore, it has been described in the most varied ways as a set of goals, a set of strategies, an ideology, a property of agriculture (Hansen, 1996), a vision (Buckland, 2006), a philosophy, a farming system (MacRae et al., 1993) and so on. At first sight, this multiplicity of meanings seems confusing and creates difficulties for the practical application of sustainable agriculture (Pannell et al., 2006). However, there are virtues to the flexible and ambiguous meaning of sustainable agriculture: It allows for a great diversity of options which can be drawn on to adapt to future developments. If sustainable agriculture was understood as prescribing a fixed set of approaches, many of these future options would be foreclosed. This, in turn, would undermine the very nature of the concept of agricultural sustainability (Pretty, 1994). Furthermore, ambiguous concepts allow divergent meanings to co-exist but at the same time create common purpose. With that, they are better able to bridge the divide between different kinds of stakeholders with their different understandings and framings (Wynne, 2002).

Despite the ambiguity of sustainability, there are some basic ideas which are widely acknowledged to characterize it. In line with the definition of sustainable development, it is an agriculture that meets the needs of the present without compromising the ability of future generations to meet their own needs (e.g. Culleton et al., 1994; Horlings, 1994; Ogaji, 2005; Ikerd, 2008). For this purpose, sustainable agriculture must be able, now and in the future, to meet in an integrated way an evolving set of (at least) environmental, social, and economic goals. Thus, rather than providing a fixed selection of pre-defined, readily implementable practices and approaches, sustainable agriculture guides the development of locally and timely appropriate approaches for its implementation.

Notwithstanding, the hermeneutic flexibility of sustainable agriculture has led to the emergence of different paradigms of sustainable agriculture that are often described as competing and mutually exclusive. Although different authors have divided the discourse about sustainable agriculture into varying numbers of paradigms, they can be roughly summarized into two positions. On the one hand, there is the paradigm termed for example "position promoted by economists" (Pierce, 1993), "life sciences integrated paradigm" (Johnson, 2006) or "technocentric approach" (Robinson, 2009), which is mainly characterized by a positivist and reductionist view with a focus and reliance on modern science, technological solutions, and economic efficiency. This paradigm is contrasted with the paradigm named, for instance, "position promoted by ecologists" (Pierce, 1993), "ecologically integrated paradigm" (Johnson, 2006), or "ecocentric approach" (Robinson, 2009). Underlying this paradigm is a more holistic and systemic view as well as reasoning rooted in

ecology. It takes into account aspects and interrelations that lie outside the farm and searches for integrated instead of isolated solutions, drawing on both modern science and traditional knowledge.

As argued above, reductionist and technology-centered solutions are likely to be insufficient to tackle sustainability problems. Therefore, the understanding of sustainable agriculture in the context of this dissertation is closer to the ecological / ecocentric paradigm. It includes technological issues and approaches but goes beyond them and also considers the wider context of agriculture. Most importantly, this includes questioning who gets to decide what in which way – the very subject of governance.

2.2 Governance

The concept of governance emerged in the late 1980s and thus in the same era as the concept of sustainable development. This co-emergence is more than mere coincidence as both concepts are linked to each other: "Better governance is a prerequisite for, and probably also a product of, steps towards sustainability." (Kemp et al., 2005, p. 18).

The rise of these concepts occurred in a situation where accelerating global change started to create ever more complex societal problems that often crossed traditional borders and multiple scales. Both then and now, these characteristics have rendered contemporary sustainability problems impossible to be addressed adequately by any single agent. Thus, also the state, which is traditionally seen responsible for dealing with societal problems, has become ever less capable of addressing sustainability problems adequately and effectively. To compensate for this lack of capacity of the government, different kinds of non-governmental actors have entered the governance process (Lemos and Agrawal, 2006; Bitzer, 2012). This has led to a redistribution of political competences away from the national state. This redistribution occurs vertically (upwards to inter- and transnational organizations and downwards to subnational and regional levels) and horizontally (to non-governmental actors) (van Kersbergen and van Waarden, 2004; Renting and Wiskerke, 2010; Jager, 2016). Consequently, governance decisions are increasingly made in a multitude of different, complicated networks of various actors from different sectors (government, private, civic) and at different levels (local, regional, national, transnational, global) (van Kersbergen and van Waarden, 2004).

The concept of governance captures these complex governance arrangements. However, along with the multitude of different governance arrangements and contexts also comes a variance in the understanding of the concept of governance in different literatures (cf. Rhodes, 1996; van Kersbergen and van Waarden, 2004; Pierre and Peters, 2005). In the context of this dissertation, governance is understood as steering in general. It thus includes formal and informal rules, structures and processes (Folke et al., 2005; Turner et al., 2014; Mitchell et al., 2016) that determine how collectively relevant decisions are made and action is taken (Turner et al., 2014; Emerson and Nabatchi, 2015) in order to solve collectively relevant problems (Biermann and Pattberg, 2008). Thereby, governance extends beyond traditional government and also includes processes where actors that were formerly outside the policy process (private actors, civil society groups, local governmental actors) are involved and engaged in decision-making and implementation

(Bitzer, 2012; Mann et al., 2015). This also comprises processes where formal government is only one among many actors or where it is not involved at all (van Kersbergen and van Waarden, 2004).[1]

This understanding of governance includes both more traditional, hierarchical governance modes and governance modes usually subsumed under the term 'network governance' (cf. Rhodes, 1996; van Kersbergen and van Waarden, 2004). Network governance is seen as an alternative to hierarchical or market-based modes of governance. It portrays governance to occur through networks of interdependent actors from governmental, private, and civic sectors (Rhodes, 1996). These networks operate based on trust, cooperation, and negotiation: The involved actors exchange resources and negotiate their decisions and actions; and even the rules that regulate their interactions are negotiated and agreed by the participants of the network (Frances et al., 1991; Rhodes, 1996).

In such governance networks, the boundaries between the different sectors become blurred (Stoker, 1998). In consequence, in a governance network meant to address an issue of public relevance also aspects of private business management may become relevant. For example, initiatives of regional branding and marketing usually aim at conserving landscapes and improving the socio-economic conditions in that landscape. These are aims of predominantly public interest. For this purpose, public, private, and civic actors come together. They develop brands for products and services from the concerned landscape and devise a marketing strategy. Consequently, these activities, which are usually associated with the private sector, also become important for a good performance of this governance arrangement.

Also two of the more specific forms of network governance are relevant for this dissertation: multi-level governance (MLG) and self-organization (van Kersbergen and van Waarden, 2004). The MLG perspective is especially relevant for the top-down approach of this dissertation, which considers the governance system of EU agriculture. Partially originating in European Union studies (Hooghe and Marks, 2003; van Kersbergen and van Waarden, 2004; Pierre and Peters, 2005), MLG considers networks not only across different types of actors but also across the different levels at which these actors operate (EU, national, regional/local) (van Kersbergen and van Waarden, 2004). Different from traditional intergovernmental relationships, the involved actors are linked to each other in multiple ways with little or no hierarchy among them. For instance, regional actors from one EU-country can interact directly with EU level institutions without having to go through the national level. What is more, rather than being defined and pre-determined by constitutions and legal frameworks, decision-making in MLG "appear[s] indeterminate and negotiable among the parties." (Pierre and Peters, 2005, p. 72) While there are views that see MLG as an alternative to formal government, I conceive it here to be nested within the existing institutional structures (cf. Hooghe and Marks, 2003; Pierre and Peters, 2005) One important issue in MLG is the question how authority is supposed to be organized. A prominent approach to this question is a concept of two MLG types (Frey and

[1] The advantages of such governance approaches are considered to be more emancipation and greater legitimacy of decisions (Newig et al., 2018). Moreover, they are supposed to be more flexible and responsive and therefore better able to deal with increasing complexity (Duit et al., 2010). Hence, they are supposed to be better able to address inefficiencies of state action (Bitzer, 2012) and to lead to more effective outcomes (Newig et al., 2018). However, there are also various concerns and challenges such as a lack of transparency (van Kersbergen and van Waarden, 2004) and accountability mechanisms, which is why such governance processes can suffer from legitimacy and accountability deficits (Rhodes, 1996; Stoker, 1998; Folke et al., 2005; Keast et al., 2006). Governance approaches that include a variety of different actors can also pose governability challenges (van Kersbergen and van Waarden, 2004) that stem from difficulties to steer the process and to reach agreements on decisions and actions (Keast et al., 2006).

Eichenberger, 1996; Hooghe and Marks, 2003): In MLG type I, jurisdictions are territorially bound, rather static and show little overlap. In MLG type II, overlapping, task-specific jurisdictions are formed that can change according to current requirements.

The understanding of governance as self-organization, on the other hand, is present primarily in the bottom-up approach of this dissertation, where I focus on local and regional collaborative initiatives for sustainable agriculture. This notion of governance is most prominently advocated by Ostrom (1990), who studied common-pool resources that were managed by communities rather than by the state or single private proprietors. Also in these arrangements, interactions and decision-making in the network of resource users are based on mechanisms such as informal understandings, negotiations, trust, and social control. What distinguishes the notion of self-organization from the more general network governance is its focus on bottom-up governance processes where government is usually not involved at all. Such arrangements are characteristic also of many local or regional collaborative initiatives for sustainable agriculture.

2.3 Collaboration

One basic principle of the different forms of network governance is collaboration. Being a shared trait of all human beings (Schoon and Cox, 2018), collaboration has been (re-)discovered especially in the context of sustainability problems and has been linked also to the sustainability of agri-food systems (Schiller et al., 2015; Hubeau et al., 2017). This is due to the manifold benefits that are attributed to collaborative forms of governance: In general, collaboration is, among other things, considered to be more democratic, inclusive, and transparent (Emerson and Nabatchi, 2015; Ulibarri, 2015) as well as more flexible and conducive to innovation and novelty (Folke et al., 2005; Hubeau et al., 2017). It can help overcome long-standing conflicts (Ulibarri, 2015) and address scale-mismatches (Sayles and Baggio, 2017). Overall, collaborative governance modes are assumed to be more environmentally effective, i.e. to lead to better environmental outcomes (Kochskämper et al., 2016; Newig et al., 2018). Specific benefits of collaboration in the context of agriculture can be, for example, a reduction of habitat fragmentation in farming landscapes, the enhancement of the feeling of belonging within a community, and increased economic efficiency through the minimization and sharing of costs (Uetake, 2014; Prager, 2015).

Yet, collaboration is not a panacea (Koontz and Thomas, 2006; Emerson and Nabatchi, 2015) and thus also poses many challenges. One severe challenge in the context of agriculture are the high transaction costs related to collaboration (Uetake, 2014; Prager, 2015). They can occur in form of costs for preparing an application for funding; the time needed for meetings and negotiations; the time and effort necessary for the establishment of relations and trust among the involved actors etc. Furthermore, collaboration may even lead to detrimental outcomes. For instance, bringing together many different parties may increase conflict (Brody, 2003) or the need to balance the many competing interests may lead to agreements that represent nothing more than the lowest common denominator (Brody, 2003; Kochskämper et al., 2016; Newig et al., 2018). Thus, whether or not collaboration leads to sustainable outcomes ultimately depends on the quality and configuration of a collaborative initiative (Sayles and Baggio, 2017).

Just like in the case of governance, also the concept of collaboration is understood and described in different ways. On the one hand, there is considerable overlap between the terms ‘collaboration’ and ‘participa-

tion'. The terms 'participation' and 'participatory governance' are more prominent in Europe and refer to the involvement of actors without formal decision-making power. 'Collaboration' and 'collaborative governance' are more common in North America and describe the process of working together. These terms overlap as they both entail the respective other: "From the perspective of participatory governance, collaboration is one form of interaction (out of many); from the perspective of collaborative governance, participation is one element (out of many)." (Newig et al., 2018, p. 273) On the other hand, 'collaboration' is often used as a synonym for 'coordination' while in fact these terms "refer to different degrees of joint working" (Prager, 2015, p. 59): 'Coordination' describes a situation, where actors take action in an isolated way but inform each other about their actions. 'Collaboration' refers to genuine joint working as a collective entity, where both decisions and (at least part of the) actions are carried out together (Prager, 2015; Schoon and Cox, 2018).

Within this dissertation, different understandings of collaboration prevail as well. The top-down perspective of this dissertation (on the whole governance system of EU agriculture) questions mainly whether and how actors who are usually outside the policy process can be involved in order to govern for sustainable agriculture and facilitate farmer collaboration for agri-environmental management in practice. Thus, the focus here is on participation. Furthermore, in the top-down perspective collaboration can refer to both coordination and genuine collaboration because there are many situations in agriculture where "'co-ordination' is sufficient for the delivery of the desired [sustainable] outcomes and genuine 'collaboration' is not required." (Boulton et al., 2013, p. 14) In contrast, in the bottom-up perspective (on small-scale collaborative initiatives for sustainable agriculture) I examine how actors can successfully work together to make agriculture more sustainable. Therefore, this perspective refers to collaboration in the sense it is used in the North American context and refers only to genuine collaboration.

3 Research context: The Common Agricultural Policy (CAP)

Despite its ecological, economic, social, and cultural diversity, agriculture in the different EU countries and regions is unified and fundamentally shaped by the Common Agricultural Policy. The CAP came into existence with the foundation of the European Economic Community (EEC) through the Treaty of Rome in 1957. Its original objectives were to guarantee basic food self-sufficiency and provide for a better quality of life for those involved in agriculture (Donald et al., 2002; Renting and Wiskerke, 2010; Laschi, 2018). It was assumed that this could be achieved through an increase in production, which would then also lead to an increase of wealth of the food producers. The main instruments to achieve this intensification were the introduction of guaranteed minimum prices as well as tariffs for international trade that penalized cheap imports and incentivized exports (Donald et al., 2002).

While the CAP was more than successful at meeting its requirement for food self-sufficiency, it performed very poorly regarding the aim of improving the situation of the farmers. Moreover, by the late 1980s it entered into a multi-dimensional crisis consisting of environmental issues (pollution and biodiversity loss), financial pressures (growing criticism regarding the high share of EU budget dedicated to the CAP), and political opposition from international fora (which demanded the reduction of the trade distorting price support and trade tariffs) (Renting and Wiskerke, 2010). This situation gave rise to the MacSharry reforms in 1992, where price support was cut and farmers were compensated with direct payments tied to their agricultural

area. Importantly, this reform introduced measures for environmental conservation and thus introduced environmental protection as a new goal of the CAP (Donald et al., 2002; Laschi, 2018). Several other reforms have followed since.

The current CAP 2014-2020 continues the two-pillar structure introduced at the Agenda 2000 reforms in 1999 (BMEL, 2014, 2015). Pillar 1 consists of direct payments, which are meant to support agriculture per se. Pillar 2 is dedicated to rural development and provides the funds for the implementation of national and regional Rural Development Plans, which include the often-cited agri-environment measures. The greatest novelty of the current CAP is the so-called 'greening', which ties a part of the pillar 1 direct payments to environmental requirements (BMEL, 2015; OECD, 2017).

Although the current CAP is praised as the greenest CAP yet, there are considerable doubts regarding its effectiveness to deliver significant environmental benefits (Pe'er et al., 2014; OECD, 2017; Pe'er et al., 2017; Pe'er et al., 2018). Also, negotiations for the CAP 2021-27 are already underway and legislative proposals have been presented in mid-2018. The future CAP will be based on a balanced set of nine economic, environmental, and social objectives. Key aspects of the proposals include, among others, higher support per hectare for small and medium-sized farms, the requirement that only genuine farmers (rather than corporations) receive support, and realization of crop rotation instead of the currently promoted mere crop diversification (European Commission, 2018a). The promotion or integration of collaborative approaches is, however, not to be found among these proposals[2].

In sum, since its beginnings the CAP has become more inclusive of goals other than productivity and profitability. Yet, it has been little effective in generating significant improvements. The proposals for the new CAP are promising but it is not clear whether they represent the drastic change of direction needed to brake with the CAP's unsustainable trajectory (Laschi, 2018). In any case, there seems to be lack of potential for collaboration.

4 Research design and methodology

This dissertation is cumulative and thus consists of the following articles and this synthesizing framework paper:

1) *'Sustainable agriculture':* **Velten, S.**, Leventon, J., Jager, N.W., Newig, J., 2015. What is sustainable agriculture? - A systematic review. Sustainability 7 (6), 7833–7865.
2) *'Fragmentation':* Leventon, J., Schaal, T., **Velten, S.**, Dänhardt, J., Fischer, J., Abson, D.J., Newig, J., 2017. Collaboration or fragmentation? Biodiversity management through the common agricultural policy. Land Use Policy 64, 1–12.
3) *'Scenarios':* Leventon, J., Schaal, T., **Velten, S.**, Fischer, J., Newig, J., 2019. Landscape Scale Biodiversity Governance: Scenarios for reshaping spaces of governance. Environmental Policy and Governance 46 (1), 1-15.

[2] Only continued support of collaboration in terms of knowledge exchange for innovation is mentioned once in the proposals (European Commission (2018c)).

4) *'Acceptability of alternatives'*: **Velten, S.**, Schaal, T., Leventon, J., Hanspach, J., Fischer, J., Newig, J., 2018. Rethinking biodiversity governance in European agricultural landscapes: Acceptability of alternative governance scenarios. Land Use Policy 77, 84-93.
5) *'Success of collaboratives':* **Velten, S.,** Jager, N., Newig, J., forthcoming. Success of Collaboration for sustainable agriculture: a case study meta-analysis. Environment, Development and Sustainability.

In Figure 1 and Table 1, these articles are characterized regarding their research approach and the methods applied. While the included articles draw on the full range of research inputs from empirical data to conceptual considerations, the majority of the articles contribute empirical evidence rather than conceptual clarification (articles 2, 4, 5). Nevertheless, articles 1 'Sustainable agriculture' and 3 'Scenarios' also contribute insights of mainly conceptual nature. However, these are strongly based on empirical evidence or viewed in light of a real-world context, respectively. From a methodological perspective, this dissertation presents a mixed method program, where the mixing of qualitative and quantitative elements "occurs across a closely related set of studies" (Johnson et al., 2016, p. 123): It includes both mixed methods studies, which combine qualitative and quantitative elements within the same study (articles 1 and 4), and articles whose methodology can be characterized as purely qualitative (article 2) or quantitative dominant (article 5) (Johnson et al., 2016). Article 3 'Scenarios' is based on conceptual considerations and did not apply any specific methodology.

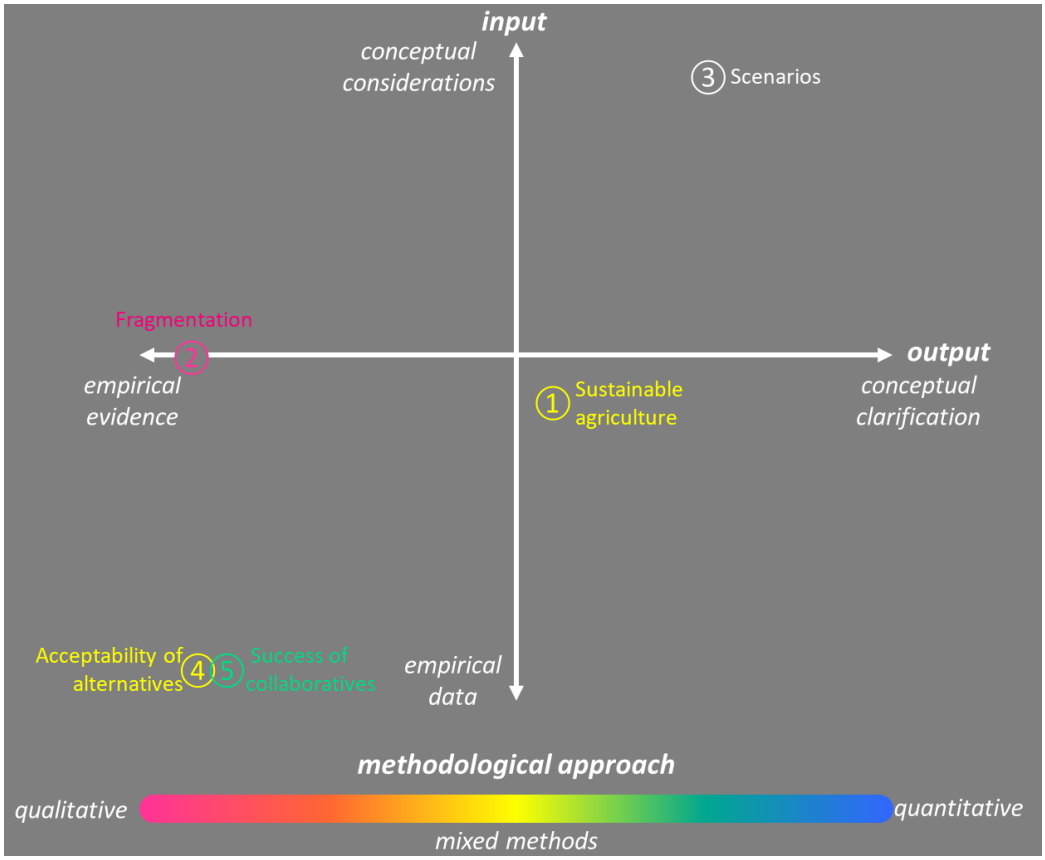

Figure 1: Characterization of the research approaches of the single articles regarding input, output, and methodological approach; numbers in circles represent the different articles, colors show the kind of methodological approach. Article 3 did not apply any specific methods and therefore is not characterized regarding its methodological approach.

Table 1: Research approach and applied methods of the articles constituting this doctoral dissertation.

Article no.	Short title	Research approach			Applied research methods for	
		Input	*Output*	*Methodol. approach*	*…data collection*	*…data analysis*
1	Sustainable agriculture	Empirical data on the use and understanding of a concept	Conceptual clarification based on empirical evidence	Mixed methods	*Systematic literature review:* systematic literature search	Inductive qualitative content analysis, descriptive statistics, cluster analysis
2	Fragmentation	Empirical data and conceptual considerations	Empirical evidence	qualitative	Group discussions	Narrative analysis
3	Scenarios	Conceptual considerations	Theoretical implications of the application of concepts in a real-world context	None	None	None
4	Acceptability of alternatives	Empirical data	Empirical evidence	Mixed methods	Group discussions, questionnaire	Inductive qualitative content analysis, descriptive statistics, cluster analysis
5	Success of collaboratives	Empirical data	Empirical evidence	Quantitative dominant	*Case survey / case meta-analysis:* Coding of case studies	Multiple regression

Figure 2 illustrates how the different articles contribute to the research aims of this dissertation and how they relate to each other. Article 1 'Sustainable agriculture' contributes to a clarification of the ambivalent and contested concept of sustainable agriculture in general and on a global scope. In doing so, this article elucidates what governance and collaboration for sustainable agriculture are supposed to achieve. Thus, it fulfills aim 1 *Concept* and provides the conceptual groundwork and basis for the subsequent studies. Methodologically, article 1 is based on a systematic literature review. First, both academic and non-academic, practitioner-oriented publications that critically discuss the meaning of sustainable agriculture were searched systematically. Then, the obtained literature was analyzed with a mixed methods approach with a concurrent triangulation design, where data collection is carried out by applying both qualitative and quantitative methods during the same research phase (Creswell et al., 2003): General topics related to the concept of sustainable agriculture were identified through inductive qualitative content analysis (Mayring, 2007) with ATLAS.ti. Descriptive statistics of the occurrence of the different topics allowed identifying patterns and

changes of the different understandings of sustainable agriculture. Investigated were the overall importance of the different topics, the perceptions of the concept by different groups (scientists vs. practitioners, scientists from different disciplines), and changes in the debate over time. Furthermore, through a cluster analysis, strands of academic literature with similar understandings of sustainable agriculture were ascertained. In sum, this article draws on empirical data on the use and understanding of a theoretical concept. Therefore, its input is characterized as empirical with a strong tendency towards conceptual considerations. As its output, this article contributes to the clarification of a concept based on empirical evidence. Hence, the output of this article is characterized as mainly conceptual with a strong relation to empirical evidence (see Figure 1).

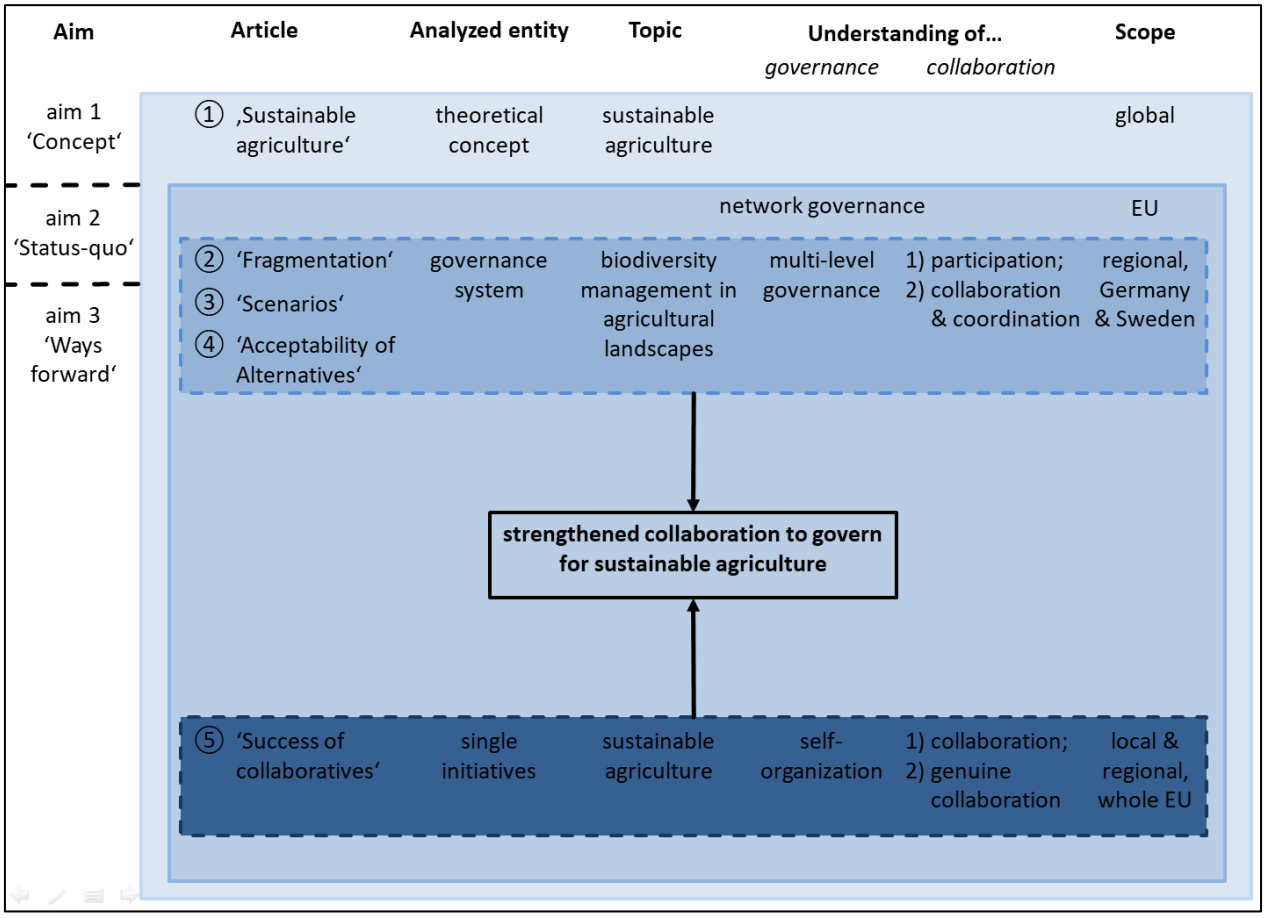

Figure 2: Structure of the doctoral thesis regarding the contribution of the different constituting articles to the overall research aims as well as regarding the unit of analysis, general topic, understanding of the main concepts, and geographical scope of the single articles. The contents of the column 'Understanding of… collaboration' relate to the different understandings of collaboration regarding 1) collaboration vs. participation and 2) genuine collaboration vs coordination (see section 2.3).

Articles 2 to 5 explore how collaboration can be strengthened as a means to govern for sustainable agriculture and narrow down their scope on EU agriculture. This issue is approached both from the top-down, by considering the whole governance system of EU agriculture, and from the bottom up, by examining single small-scale collaborative initiatives for sustainable agriculture.

The top-down perspective is taken in articles 2, 3, and 4, which are the product of work package 5 of the research project MULTAGRI. This project focused on biodiversity management and conservation in agricultural landscapes in synergy with agricultural production as one way towards sustainable agriculture. Work package 5 assessed the current governance system for challenges for biodiversity management and sought to identify viable alternatives. More specifically, this work package focused on the question how meaningful collaboration between farmers and other actors can be facilitated as an important means for improved farmland biodiversity management. For this purpose, case studies in three regions in Germany (in the federal states of Lower Saxony and Saxony) and Sweden (province of Scania) were conducted.

Article 2 'Fragmentation' contributes as its output empirical evidence on whether and how the current governance system of biodiversity management in agricultural landscapes of the EU facilitates or impedes actor collaboration. It thus fulfills research aim 2 *Status-quo*. For this purpose, the article takes a novel approach by considering the entire governance system surrounding CAP as key framework for biodiversity management in agricultural landscapes. It draws on qualitative empirical data collected through group discussions during a series of stakeholder workshops in the three MULTAGRI case study regions. This data was analyzed through a narrative analysis and interpreted in light of theoretical considerations of optimally connected social-ecological systems (Bodin and Tengö, 2012; Kininmonth et al., 2015). Thus, on the side of its research input, this article draws both on empirical data and conceptual considerations and applies qualitative methods for data collection and analysis.

The remaining articles (3, 4 and 5) contribute to research aim 3 *Ways forward*. Article 3 'Scenarios' assesses theoretically the potential of alternative governance approaches to facilitate and strengthen actor collaboration for the management of farmland biodiversity. For this purpose, the paper draws on considerations of multi-level governance arrangements on the one hand (Frey and Eichenberger, 1996; Hooghe and Marks, 2003) and decentralization and devolution of power on the other hand. These considerations are used to develop four archetypal alternative governance scenarios. These scenarios are theoretical constructs that propose different arrangements of actors, their roles and responsibilities across the different levels (from EU to local levels). The article further assesses theoretically the performance of the different scenarios in addressing ecological scale mismatches (Satake et al., 2008; Pelosi et al., 2010; Dallimer and Strange, 2015) and problems of governance complexity. Consequently, this article contributes mainly conceptual and theoretical considerations. Yet, these considerations are tied to a real-world context, which is why the output of this article is characterized as mainly, but not purely conceptual.

The scenarios developed in article 3 'Scenarios' are used in article 4 'Acceptability of alternatives' to explore empirically how acceptable these different governance approaches would be to stakeholders in the three MULTAGRI case study regions. Also this article applied mixed methods with a concurrent triangulation design. The quantitative and qualitative empirical data used as input was collected during a second series of stakeholder workshops in the MULTAGRI case study regions. At these workshops, participants first discussed the advantages and disadvantages of the different scenarios in group discussions. In these discussions, they agreed on up to three main positives and negatives for each scenario. Afterwards, the participants were asked to fill out a questionnaire eliciting the degree of their (dis-)agreement with a series of statements about each scenario. Also in the analysis of this data, a mixed methods approach was taken. Quantitative methods were used to analyze the data obtained through the questionnaires: Through a cluster

analysis, different stakeholder groups were determined. Descriptive statistics allowed evaluating scenario preference of the different kinds of stakeholders as well as the influence of different factors on shaping stakeholder acceptance of the scenarios. Notes from the group discussions were analyzed through qualitative content analysis based on an open, inductive coding process in order to identify additional, emergent factors that shape stakeholder acceptability. Additionally, mentions of these acceptability factors as main positives and negatives were counted as an estimate of their relevance.

Also article 5 'Success of collaboratives' contributes to research aim 3 *Ways forward* but takes a bottom-up perspective. It aims at contributing empirical evidence for a better understanding of conditions that impact on the success of small-scale collaborative initiatives for a more sustainable agriculture (subsequently termed 'collaboratives'). For this purpose, a case survey of 30 such initiatives in different EU countries was conducted: Expert coders used a predefined coding scheme to transform the relevant qualitative data of the case study descriptions into numerical values. For the analysis of this quantitative data, a multi-step exploratory analysis, including multiple regression, was conducted. While this method is strongly focused on quantification and numerical analysis, it initially draws on qualitative data and includes an interpretative element (the coding process). Furthermore, the used coding scheme includes some inductive elements to render it more amenable to the nature of the analyzed cases. Consequently, this approach is predominantly but not purely quantitative.

5 Results and discussion

5.1 Sub-aim 1 – Concept

The sub-aim of contributing to a better understanding of the concept of 'sustainable agriculture' is met by article 1 'Sustainable agriculture'. The findings of this paper underline the complexity of the concept of sustainable agriculture as they identify a great number and variety of aspects that have been used to characterize this concept in the analyzed literature: 66 different aspects summarized in 17 more general themes. These 17 themes are organized in a framework made up by three overarching thematic groups: Goals (5 themes), Strategies (7 themes), and Fields of Action (5 themes).

The evaluation of the occurrence of these different themes shows that the general debate about sustainable agriculture is focused more on anthropocentric than ecocentric Goals and that mostly technology-centered, on-farm solutions are considered and suggested for the realization of sustainable agriculture. Although of lesser importance, also most of the less dominant themes are mentioned in great shares of the analyzed literature and thus have a strong standing in the debate, too. However, the Strategy-theme of 'co-operation' ranks last among the Strategies for sustainable agriculture.

The paper also aims to detect differences in the patterns of use of the concept of sustainable agriculture. By looking at changes in the debate about sustainable agriculture over time, this article asserts that the debate is characterized by a great, heterogeneous variety of topics that are discussed parallel to each other and remain on the agenda almost constantly. This indicates the presence of alternative, competing conceptions of sustainable agriculture. Nevertheless, some changes were detected, notably a narrowing down of the

debate regarding the Strategies for the realization of sustainable agriculture: In the last observed years[3] fewer strategies were widely considered. This is especially pronounced for 'co-operation' and the application of 'ecological principles'. These themes used to be of key importance in the debate but were referred to only very infrequently in later years.

What is more, clear differences in the use of the concept of sustainable agriculture are found in different literature types: In the academic literature, a more utilitarian view prevails than in the practitioner-oriented literature. In scientific journal articles, economic benefits and the conservation of environmental assets as a basis for agricultural production are most considered. In contrast, practitioner-oriented publications tend to focus on social aspects and the protection of the environment for its own sake. Also within the scientific community, the various disciplines use the concept of sustainable agriculture in different ways, which can be located along a continuum: One extreme of this continuum is characterized by a narrower view focused on themes relevant to agricultural production only. This view is predominant in engineering and natural sciences as well as in agricultural sciences. The other extreme features a wider view that considers several aspects and pays greater attention on the context in which agricultural production takes place. On this extreme, the humanities as well as social and political sciences are located. Interdisciplinary sciences (that combine social and natural sciences) and economics present intermediate views that share characteristics with both of these extreme orientations.

Additionally, article 1 'Sustainable agriculture' investigates overall conceptions of sustainable agriculture in the academic discourse. For this purpose, it identifies five clusters representing specific lines of argumentation as to what constitutes sustainable agriculture. The paper compares these five clusters with the two main paradigms of sustainable agriculture proposed in the literature (see section 2.1), which are termed 'techno-economic position' and 'agroecological-ruralist position' in article 1. As a result, the article argues that most conceptualizations of sustainable agriculture represented by the five identified clusters combine elements of both the techno-economic and the agroecological-ruralist positions.

Article 1 'Sustainable agriculture' does not only provide a comprehensive framework that captures and structures all aspects found to form the debate about sustainable agriculture and disentangles the different conceptions of sustainable agriculture. It also highlights ways to deal with this complexity in order to move towards sustainable agriculture in practice. Particularly, the results of this article reveal that the two supposedly opposing paradigms of sustainable agriculture are not as contradictory and mutually exclusive as they have often been portrayed. Much to the contrary, these findings give reason to support the idea that it is possible and even necessary to integrate approaches in ways that are appropriate to context and scale. This standing has also been supported by other recent literature reviews in related fields: Glamann et al. (2015) reviewed academic literature on the food–biodiversity nexus; Kettenburg et al. (2018) assessed the scientific discourse around genetically modified "Golden Rice" regarding its positions on sustainability. In both of these discourses, patterns of two contrasting strands of literature are identified, ("biophysical-technical" and "socio-political" (Glamann et al., 2015); "biotechnological" and "socio-systemic" (Kettenburg et al., 2018)), which bear similarities to the way the debate on sustainable agriculture has been described. For these two discourses, the authors also come to the conclusion that the respective positions are complementary rather than mutually exclusive.

[3] The study analyzed publications published until 2012.

In practice, such cross-fertilizing integration of different approaches to sustainable agriculture requires inter- and transdisciplinary collaboration across scientific disciplines and between scientists and practitioners, respectively (cf. Balsiger, 2004; Russell et al., 2008). Interdisciplinary research allows integrating the focus of engineering, natural, and agricultural sciences on rather technical issues related (primarily) to agricultural production practices with contributions of the more socially-focused disciplines on the human-made context in which agricultural production is embedded. What is more, the results of article 1 indicate a need for increased mutual awareness of scientists and practitioners about their respective needs and contributions. This need can be addressed through transdisciplinary collaboration. Admittedly, the promises and benefits of inter- and transdisciplinary collaboration can only be fulfilled if the several accompanying challenges of such collaboration are adequately addressed (Harris et al., 2009). Nevertheless, in light of the observation of the drastically reduced weight of co-operative strategies in the debate around sustainable agriculture, the importance of inter- and transdisciplinary collaboration cannot be emphasized enough.

In its conclusions, paper 1 'Sustainable agriculture' encourages embracing the complexity of the concept of sustainable agriculture with its varied and seemingly contradictory meanings. This is argued to be important because such a flexible notion may be more useful to engaging with the wicked sustainability problems of agriculture than precisely definable and assumedly unambiguous concepts. Broadening the notions of sustainable agriculture requires finding links, complementarities, and synergies between its different conceptions. This in turn calls on stakeholders to insist less on supposedly insurmountable differences and to engage more with each other.

5.2 Sub-aim 2 – Status-quo

Just like sub-aim 1 *Concept*, also sub-aim 2 *Status-quo* is met by a single article, which is article 2 'Fragmentation'. This article aims to identify whether and how CAP facilitates or hampers collaboration for sustainable agriculture. As a first step, the article identifies actor-resource motifs that are typical for the three MULTAGRI case study regions. Actor-resource motifs are schematic representations of the connections in social-ecological systems. Hence, they demonstrate whether and how different nodes, which stand for social actors and ecological resources, are linked to each other. The optimal motif of landscape-scale social-ecological systems for the management of farmland biodiversity takes the shape of a house (see Figure 1 in article 2) and shows a high degree of connectedness, i.e. all possible linkages between social and ecological nodes are established.

Article 2 'Fragmentation' identifies in all three MULTAGRI case study regions the same actor-resource motif that clearly contrasts with the ideal motif: It is bucket-shaped (see Figure 2 in article 2) and characterized by a low connectivity among the nodes. This motif represents the finding that no collaboration between farmers for biodiversity management was reported. Additionally, also the connections of farmers to their own ecological resources (their fields, meadows etc.) were found to be rather weak. This means that farmers rarely go beyond compulsory biodiversity measures and land management actions are usually not carried out with the intention of conserving or enhancing biodiversity. Coordination-type actors (e.g. consultancies) could help overcome this situation by promoting and facilitating farmer collaboration. Although several kinds of

actors that could take the role of a coordinating actor are present in the case study regions, none of these actors actually coordinates actions for biodiversity conservation under CAP.

Following, the article argues that CAP actively reinforces this lack of coordination and collaboration for biodiversity management in agricultural landscapes. This reinforcement takes three forms: 1) CAP targets only individual farms and while it allows for collaboration, it does neither promote nor facilitate it. Thus, under CAP, farmers do not have any reason to collaborate and much less are they compelled to do so. 2) CAP stimulates the proliferation of coordination-type actors and therefore actively creates barriers to collaboration. Due to the increased complexity of CAP, among other things, consultancy services have proliferated. Consequently, there is greater competition between the consultancies and each consultancy attends a smaller number of farmers. As a result, farmers lack information, advice, and someone with the necessary overview to coordinate collaboration for biodiversity management. 3) CAP fails to address existing barriers and disincentives to collaboration, such as insecure land tenure: Due to quickly rising land prices, tenure agreements are often shorter than the length of time required for an agri-environment scheme under CAP. Thus, farmers have insufficient time to establish collaborative networks and it is unlikely that neighboring farmers' fields coincide on length and expiration of their tenure agreements. Therefore, collaborative planning becomes extremely difficult. Nevertheless, there is also evidence which indicates that farmers are motivated to manage biodiversity and are willing to collaborate for this purpose if this is easy to realize and requires only limited effort.

In a nutshell, the findings presented in this article establish that there exists a severe lack of collaboration for biodiversity management and other sustainability issues in agricultural landscapes and that the CAP entrenches this situation instead of addressing the underlying causes. Article 2 therefore concludes by calling for research that considers change more systemically. This includes scrutinizing barriers and opportunities for actors to collaborate as well as assessing stakeholder acceptance of alternative governance approaches.

5.3 Sub-aim 3 – Ways forward

As described in section 4, the question of how actor collaboration for sustainable agriculture can be facilitated is addressed by three articles (articles 3, 4, and 5). Two of these articles take a top-down perspective (articles 3 'Scenarios' and 4 'Acceptability of alternatives') and one article takes a bottom-up perspective (article 5 'Success of collaboratives').

5.3.1 Top-down perspective: Governance systems that facilitate collaboration for sustainable agriculture

Building on the findings of article 2 'Fragmentation', article 3 'Scenarios' considers on a theoretical level wholesale change of the governance of biodiversity management in agricultural landscapes. For this purpose, it develops four archetypal governance scenarios, which result from the combination of two variations of decision-making units (administrative units (MLG Type I) vs. ecological boundaries (MLG Type II)) with two extremes of a continuum of (de-)centralization and devolution of power (centralized and top-down vs. decentralized and bottom-up). The resulting scenarios are 'administrative hierarchy' (top-down, centralized,

administrative units), 'autonomous farmers' (bottom-up, decentralized, administrative units), 'ecological scale hierarchy' (top-down, centralized, ecological boundaries), and 'collaborating actors' (bottom-up, decentralized, ecological boundaries). Article 4 'Acceptability of alternatives' uses these theoretical scenarios to assess acceptable governance alternatives for the management of farmland biodiversity. For this purpose, it draws on empirical data obtained at a second series of workshops in the three MULTAGRI case study regions.

The findings of article 4 indicate that stakeholders support fundamentally different governance approaches for biodiversity management in agricultural landscapes: Workshop participants showed the highest overall preference for the scenario 'collaborative actors', which of all scenarios is most different to the current governance approach. At the same time, they displayed the greatest aversion towards the scenario most similar to the current situation, i.e. 'administrative hierarchy'.

Furthermore, the results show that stakeholder acceptability of alternative governance arrangements is shaped by a large array of diverse factors. The most prominent factors are costs and efforts related to administering an alternative governance system, procedural fairness of decision-making processes in an alternative governance arrangement, as well as the effectiveness of an alternative governance system to bring about improved biodiversity outcomes. Thus, stakeholder acceptability would need to be evaluated and addressed holistically if the governance system for the management of farmland biodiversity was to be reshaped.

What is more, article 4 identified substantial heterogeneity in the views of different stakeholder groups regarding stakeholder acceptance and perception of the different scenarios. Stakeholder acceptance of the scenarios varied as civil society actors mainly preferred the scenarios organized around ecological borders while private actors had a clear preference for scenarios with bottom-up and decentralized decision-making power. Differences in the perception of the scenarios can be detected for instance for the scenario 'autonomous farmers'. Governmental actors expected this scenario to lead to fair decision-making processes and outcomes. In contrast, civil society actors displayed great concerns regarding the fairness of decision-making in this scenario.

The findings of article 4 'Acceptability of alternatives' as well as the considerations of article 3 'Scenarios' regarding the administrative complexity of the different scenarios and their potential to address ecological scale mismatches suggest both that a viable and acceptable alternative governance system would have to combine elements of the different scenarios. For such a hybrid governance approach, article 3 'Scenarios' proposes a scenario where biodiversity management in agricultural landscapes is centered on collaborative landscape-scale planning. Despite the landscape-scale approach, administrative units continue to exist. However, they devise together landscape biodiversity management plans in a landscape-level decision-making forum. In these landscape-level fora, all stakeholders are involved in agenda-setting and decision-making. There also remains an element of hierarchy: The landscape scale plans can be enforced and higher administrative levels have the power to influence the goals and outcomes of biodiversity management through higher level legislation such as the EU biodiversity strategy.

Article 4 'Acceptability of alternatives' develops a slightly different hybrid approach: Decisions on the objectives for biodiversity conservation are taken for ecological units in a top-down, centralized way. In contrast,

decisions on specific measures and schemes to achieve these objectives are decided upon within administrative units in a bottom-up, decentralized way, requiring the collaboration of a broad range of actors at the local level. Nevertheless, some degree of coordination between different local administrative units is possible and desirable to increase coherence of conservation measures.

Such mixing of governance modes is not an entirely new idea and has already been advocated in earlier work (Keast et al., 2006; Lemos and Agrawal, 2006). However, articles 3 and 4 provide more concrete and more specific ideas for such a governance mode mix as they focus on a specific issue (management of farmland biodiversity). What is more, the approaches presented here are not only based on considerations of specific strengths and weaknesses of the different governance modes but also consider their acceptability to stakeholders.

Both presented approaches have potential to overcome actor and issue fragmentation and to bring about positive environmental and social outcomes beyond the topic of biodiversity conservation. Yet, reshaping the governance system holds several challenges (e.g. establishing constructive collaboration processes). Additionally, these proposed governance approaches provide only guiding principles and are by no means to be understood as blueprints for implementation. Thus, reshaping the governance of biodiversity management in agricultural landscapes in practice would require the detailed elaboration of an alternative governance approach that carefully considers all aspects relevant in shaping stakeholder acceptability and ensures democratic legitimacy.

5.3.2 Bottom-up perspective: Success of local and regional collaboratives for a more sustainable agriculture

Article 5 'Success of collaboratives' provides prospects for *Ways forward* towards sustainable agriculture from a bottom-up perspective. It presents the findings of a case survey that assessed which factors influenced the success of collaboratives for a more sustainable agriculture in the EU in terms of 1) the achievement of the environmental, social, and economic goals of the collaboratives; 2) the durability of the achievements of the collaboratives; 3) the general acceptance of the collaboratives themselves.

As a result, the article identifies a range of different factors that are decisive for different success criteria. Among these are factors that are external to and uncontrollable by the collaborative as well as factors internal to and changeable by the collaborative. The crucial external factors include:

- characteristics of the issue(s) addressed by a collaborative (e.g. the degree to which the issue is a public good problem),
- conditions of the market in which a collaborative operates (especially the general demand for the kinds of offered products or services).

The crucial internal factors include:

- characteristics of the individual involved actors (their devotion to the collaborative),
- characteristics of the whole group of involved actors (e.g. level of trust among the involved actors),
- structure and organization of the collaborative (e.g. the sufficiency of available financial resources),
- business performance of those collaboratives that involve commercial activities (e.g. the quality of the offered products).

Overall, the results of this case survey show that there are no 'silver bullet factors' that would ensure good performance of a collaborative regarding all success criteria. Rather, for each success criterion a different set of factors is relevant. However, while a trade-off between the pursuit of economic objectives and the realization of social objectives was identified, no trade-off between environmental and the remaining goals was found. Moreover, the analysis revealed that several aspects related to finances and business management contribute to almost all success criteria. In sum, while there is no simple way to achieve overall success and some priorities have to be set, it is possible to pursue different success criteria simultaneously and thus render a collaborative successful in many respects.

Furthermore, the results of this article give reason to be optimistic about the performance of collaboratives for a more sustainable agriculture: Internal factors, i.e. the way collaboratives are composed and managed, are likely to have at least as much influence on the performance of a collaborative as uncontrollable external conditions. Additionally, with the exception of extremely adverse initial preconditions, conditions encountered at the outset of a collaborative seem to matter less than the way the conditions develop towards later stages.

Admittedly, the results of this article can be seen only as a first hint due to the small number and heterogeneity of the analyzed cases. Nevertheless, they highlight that the fate of collaboratives for a more sustainable agriculture depends less on hardly changeable external and pre-existing conditions but rather on the agency within a collaborative. Thus, this article argues that there is much potential for small initiatives at the local and regional level to contribute to bottom-up change towards more collaboration for sustainable agriculture.

5.4 Methodological reflection

This cumulative dissertation aims at investigating a variety of different aspects related to governance and collaboration for sustainable agriculture. Additionally, it is mainly concerned with socio-political phenomena, which are characterized by great complexity. In such a situation, where various aspects of complex research subjects need to be illuminated, the use of a mix of qualitative and quantitative methods is especially appropriate (Creswell et al., 2003; Molina Azorín et al., 2012). Therefore, the overall design of this dissertation as a mixed methods program seems suitable. Subsequently, I reflect on the strengths and weaknesses of the designs of the single studies included in this dissertation.

Article 1 'Sustainable agriculture' and article 4 'Acceptability of alternatives' both apply a mix of qualitative and quantitative methods within the same study. These studies are, on the one hand, of explorative character: They aim at assessing how the concept of sustainable agriculture is understood and which aspects influence stakeholder acceptability of governance approaches, respectively. For elucidating such interpretations, qualitative methods are especially appropriate (Maxwell, 2004). On the other hand, these studies intend to provide additional, deeper insights into overall patterns, such as the overall importance of the different identified aspects and differences of understanding and opinion between stakeholder groups. Such tasks lend themselves especially to quantitative methods (Castro et al., 2010). Thus, only by using a combination of qualitative and quantitative methods, these questions could be addressed all at once. Hence, the mixed methods approaches of articles 1 and 4 allow for more complete pictures of the research subjects

than would be possible with mono-method approaches. The main challenges of these mixed method approaches are of practical character: The application of different methods does not only require substantially more time and effort. It also demands more knowledge and skills to adequately conduct all types of data collection and analysis (cf. Creswell et al., 2003; Molina Azorín et al., 2012). In case of this dissertation, providing all the necessary skills was only possible by joining forces with other researchers with complementary skill sets.

Article 2 'Fragmentation' aims at uncovering patterns of actor collaboration as well as mechanisms through which CAP facilitates or hampers such collaboration. For this task, a qualitative research approach with a small number of case studies is taken. This approach allows for a direct and in-depth exploration and analysis of the causal mechanisms of interest with high internal validity of the results (Maxwell, 2004; Gerring, 2007; Castro et al., 2010). Admittedly, this purely qualitative approach does not provide any estimation of the relative importance of the different mechanisms. However, providing such information is not within the scope of article 2. What is more, due to the small sample of this study the external validity of the results is questionable. Yet, the fact that the same patterns and mechanisms were identified in all three case studies at least indicates a certain generalizability of the findings.

Finally, article 5 'Success of collaboratives" applies with the case survey a predominantly quantitative research approach. This approach takes advantage of already existing small-N and in-depth case study research. Through the transformation of the qualitative data from the case studies into quantitative data and analysis with quantitative methods, this approach allows integrating the existing knowledge to identify general patterns of which factors are decisive for the success of collaboratives. However, the approach taken is only predominantly, not purely quantitative because it includes several inductive elements. Therefore, also the main shortcoming of quantitative approaches, which is the decontextualization from the real-world context (Castro et al., 2010), can partially be overcome.

The approach of article 5 presents to some extend also a methodological novelty: On the one hand, it offers another example of the application of the case survey method. Thus, it contributes to promoting this method, which has great potential but is rarely used in the sustainability sciences. On the other hand, the research presented in this article was met by the challenge of having a large number of potential influencing factors and therefore many (i.e. several hundreds) independent variables combined with a comparatively small sample (30). This challenge was dealt with through an innovative, theory-supported stepwise and exploratory statistical analysis. What this approach does not deliver is information on the exact mechanisms of why and how the different identified crucial factors affect the performance of collaboratives. These mechanisms would have to be explored in subsequent and more qualitative research.

6 Conclusions

This dissertation aimed at contributing to a better understanding of how collaboration can be facilitated and designed as a means to govern for and advance sustainable agriculture. For this purpose, this dissertation focused on EU agriculture and pursued three sub-aims (*Concept, Status-quo, Ways forward*). These sub-aims were approached through the application of a mix of research approaches. This included a mixed methods systematic review of the *Concept* of sustainable agriculture with its different meanings and under-

standings. The *Status-quo* of the current governance system was evaluated regarding its potential to facilitate or hamper collaboration by means of a qualitative investigation. *Ways forward* to facilitate collaboration were sought both from a top-down and a bottom-up perspective. The top-down perspective considers conceptually and empirically how the governance system of the EU could better promote collaboration. The bottom-up perspective investigates conditions for success of small-scale collaboratives for sustainable agriculture through a predominantly quantitative case survey.

The findings of this dissertation regarding the *Concept* of sustainable agriculture and the *Status-quo* of the current governance system underline that collaboration for sustainable agriculture has been underappreciated and even hampered. The underappreciation of collaboration is evident both in the theoretical debate about sustainable agriculture and in practice: The debate about sustainable agriculture is dominated by reductionist and technology-centered views. What is more, the theme of co-operation has experienced a dramatic loss of importance in this debate and is overall the least considered strategy for sustainable agriculture. In practice, in three exemplary case study regions in the EU a severe lack of farmer collaboration has been identified. Obstacles to collaboration were also found both in research and in practice: In research, a division into supposedly opposing and contradictory paradigms of sustainable agriculture has been promoted instead of seeking complementarity and synergy of the different approaches. Regarding obstacles to collaboration in practice, the findings on the *Status-quo* outline multiple ways in which the governance system promotes the existing lack of farmer collaboration.

In contrast, this dissertation establishes as its central argument that promoting and realizing sustainable agriculture can be facilitated through collaboration and requires different ways of integration: First, this dissertation argues from its outset that collaboration needs to be promoted both top-down, by considering changes to the whole governance system, and bottom-up, by supporting small-scale collaboratives for sustainable agriculture. Second, the findings on the *Concept* of sustainable agriculture show that the different conceptions of sustainable agriculture are not as opposing and mutually exclusive as they have been portrayed. Based on these findings, this dissertation argues that moving towards sustainable agriculture requires the integration of different kinds of knowledge and building on the complementarities of different conceptions instead of relying on one or few supposedly superior approaches. Third, the findings regarding *Ways forward* from a top-down perspective suggest that a meaningful and potentially widely acceptable governance approach would have to integrate different governance modes. Fourth, also the bottom-up perspective on *Ways forward* shows that it is not sufficient to focus on few related factors to bring local and regional collaboratives for sustainable agriculture to success. Rather an array of different factors has to be considered in an integrated way.

These findings are relevant both for scientists and practitioners as they encourage and justify more research, discussion, and action around collaboration in the context of sustainable agriculture. Especially approaches that think and move beyond the current governance system would be important ventures for future research. What is more, this dissertation provides first tangible insights on principles for the design of systemic change of the governance of farmland biodiversity management and sustainable agriculture. It also provides first concrete insights on factors that are crucial for the successful establishment and management of collaboratives for sustainable agriculture. However, more research is required to address the various challenges that are associated to wholesale change of a governance system. Also, more detailed

and differentiated insights would be required into the ways the identified factors influence the success of different kinds of collaboratives for sustainable agriculture.

Most importantly, however, this dissertation highlights that progressing towards sustainable agriculture is not a matter of choosing any approach over another. The question that should rather be asked is which approach is most appropriate for which task, in which place, at which level and at which time (cf. Fraser et al., 2016). Such an 'integrative attitude', which considers a variety of different approaches to be of equal importance, could contribute to more mutual appreciation of each other's work and experience among and between scientists and practitioners. Not least, it could contribute to more collegial, collaborative and hopefully more constructive research, discussion and action for sustainable agriculture.

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Annex

Article 1 'Sustainable agriculture'

What is sustainable agriculture? - A systematic review

Abstract

The idea of a sustainable agriculture has gained prominence since the publication of the Brundtland Report in 1987. Yet, the concept of sustainable agriculture is very vague and ambiguous in its meaning, which renders its use and implementation extremely difficult. In this systematic review paper, we aim to advance understandings of sustainable agriculture from a social science and governance perspective by identifying areas of complementarity and concern between emerging definitions of sustainable agriculture. For this purpose, we conducted a structured literature review in combination with a cluster analysis in order to (1) identify the overall ideas and aspects associated with sustainable agriculture; (2) detect patterns and differences in how these ideas and aspects are adopted or applied; (3) evaluate how the different ideas and aspects of sustainable agriculture are combined in the scientific debate, and assess whether these different conceptions match with those that have been claimed to exist in the debate. There are two valuable outcomes from this research. The first is a framework for understanding the components of sustainable agriculture. The second outcome is in highlighting ways for actors involved with sustainable agriculture to deal with the complexity and multiplicity of this concept in a constructive manner.

Keywords

Sustainable agriculture; definitions; qualitative content analysis; cluster analysis; journal articles; grey literature; goals; strategies; fields of action.

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Review

What Is Sustainable Agriculture? A Systematic Review

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Abstract: The idea of a sustainable agriculture has gained prominence since the publication of the Brundtland Report in 1987. Yet, the concept of sustainable agriculture is very vague and ambiguous in its meaning, which renders its use and implementation extremely difficult. In this systematic review paper, we aim to advance understandings of sustainable agriculture from a social science and governance perspective by identifying areas of complementarity and concern between emerging definitions of sustainable agriculture. For this purpose, we conducted a structured literature review in combination with a cluster analysis in order to (1) identify the overall ideas and aspects associated with sustainable agriculture; (2) detect patterns and differences in how these ideas and aspects are adopted or applied; (3) evaluate how the different ideas and aspects of sustainable agriculture are combined in the scientific debate, and assess whether these different conceptions match with those that have been claimed to exist in the debate. There are two valuable outcomes from this research. The first is a framework for understanding the components of sustainable agriculture. The second outcome is in highlighting ways for actors involved with sustainable agriculture to deal with the complexity and multiplicity of this concept in a constructive manner.

Keywords: sustainable agriculture; definitions; qualitative content analysis; cluster analysis; journal articles; grey literature; goals; strategies; fields of action

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1. Introduction

An agriculture able to continually provide food and other resources to a growing world population is of crucial importance for human existence and hence for any human activity. However, there are a great number of problems that threaten this ability of agriculture to fulfill human needs now and in the future, including climate change; a high rate of biodiversity loss; land degradation through soil erosion, compaction, salinization and pollution; depletion and pollution of water resources; rising production costs; an ever decreasing number of farms and, linked with that, poverty and a decrease of the rural population [1–8]. Agriculture not only has to face these problems, but in the form it has been practiced over the last decades it also is a major cause of all of these issues [2,9].

In face of these challenges, the idea of sustainable agriculture has gained prominence since the publication of the Brundtland Report in 1987, alongside the overarching concept of sustainable development [10]. Yet, like the notion of sustainable development itself, the concept of sustainable agriculture is ambiguous in its meaning [11]. This characteristic has led to the emergence of a great variety of different discourses, views or paradigms of sustainable agriculture [10,12–18] and rendered the discussion and implementation of this idea extremely difficult. It also allows for exploitation of the concept by vested interests who use the notion for their own purposes [19]. In the hope of solving this problem and making the concept more tangible, there have been numerous attempts to define sustainable agriculture. Collections of definitions are found in [20] and [21], and include:

> Sustainable agriculture is an "integrated system of plant and animal production practices having a site specific application that will, over the long term: (a) satisfy human food and fiber needs; (b) enhance environmental quality; (c) make efficient use of non-renewable resources and on-farm resources and integrate appropriate natural biological cycles and controls; (d) sustain the economic viability of farm operations; and (e) enhance the quality of life for farmers and society as a whole." 1990 U.S. Farm Bill [22].
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> "For a farm to be sustainable, it must produce adequate amounts of high-quality food, protect its resources and be both environmentally safe and profitable. Instead of depending on purchased materials such as fertilizers, a sustainable farm relies as much as possible on beneficial natural processes and renewable resources drawn from the farm itself." Reganold *et al.* 1990 [23].
>
> Sustainable Agriculture comprises "management procedures that work with natural processes to conserve all resources, minimize waste and environmental impact, prevent problems and promote agroecosystem resilience, self-regulation, evolution and sustained production for the nourishment and fulfillment of all." MacRae *et al.* 1989 [24].

These attempts to try and find a single all-encompassing definition were doomed to failure: Due to the complex and contested nature of the notion of sustainable agriculture, and its adaptation to context, its precise and absolute definition is impossible [25]. The emergence of variable definitions, interpretations and uses of the term could lead to complementarity between definitions, whereby all definitions can co-exist, and potentially aid each other. Alternatively, there could be negative interplay between definitions, whereby the aim of one works against the aim of another. Indeed, it is often claimed that there prevail two [12,14,15,26–28] or more [29–31] different and opposing overarching schools of

thought or paradigms of sustainable agriculture that have made the use of the term even more confusing and obscure.

In this systematic review paper, we aim to advance understandings of sustainable agriculture by identifying areas of complementarity and concern between emerging definitions of sustainable agriculture. Our main interest here is on social processes and the social reification of sustainable agriculture rather than mapping it as a technical paradigm. For this aim, we initially conduct a structured literature review with the objective of identifying the ideas and aspects associated with the concept of sustainable agriculture as well as the central aspects of the debate (objective 1). We therefore focused on papers that engaged critically with the definition of sustainable agriculture. We then seek to identify patterns and differences in how these ideas and aspects are adopted or applied (objective 2). To do so, we look at the differences in the perceptions of sustainable agriculture held by different groups. Thus, we compare the views of scientists and practitioners as well as the perspectives of scientists of different academic disciplines. Framing the different conceptions of sustainable agriculture of these different groups can improve their mutual understanding. This in turn might benefit future work as all of them are involved in the attempt to realize a sustainable agriculture, and for this purpose, their collaboration is indispensable [31–35]. We also compare how ideas have evolved over time. Finally, in objective 3, we apply a cluster analysis methodology to identify how the different ideas and aspects of sustainable agriculture are combined in the scientific debate, and explore whether these different conceptions match with those that have been claimed to exist. We explored these overlaps and differences to examine the extent to which emerging concepts are complementary. In putting these objectives together, we are able to highlight strategies for progressing our understanding and implementation of sustainable agriculture.

There are two valuable outcomes from this research. The first is a framework for understanding the components of sustainable agriculture. Such an understanding of all aspects associated with sustainable agriculture is especially important as farmers, extension professionals, policy makers and other stakeholders need to have a notion of what is meant by the term in order to put it into practice [36]. The second outcome results from highlighting the complexities and subtleties of varying definitions. We intend that actors involved in sustainable agriculture can use our understandings to consider their own definitions of sustainable agriculture, and identify how to strengthen their actions through collaboration with others. Our discussion section describes these outcomes, and highlights their applicability for future sustainable agriculture research and implementation. Prior to the discussion, the following section outlines our methodology in detail. We then present our results for each objective. Finally, at the end of the paper we sum up and draw conclusions.

2. Methods

In order to collect a sample of definitions of sustainable agriculture, we conducted a search of both academic and practitioner-oriented literature. Academic publications were searched in Scopus, a database of abstracts and citations of peer-reviewed scientific journal articles, with the search string TITLE-ABS-KEY (“sustainable agriculture” OR “agricultural sustainability”). We searched for publications in English, German, French, Spanish and Portuguese published in all years up to and including 2012 in the subject area of social sciences and humanities. This subject area was chosen

because of our focus on social science and governance aspects of sustainable agriculture. We wanted to engage with publications that critically discuss the concept of sustainable agriculture itself. In order to avoid technical research that is justified by the objective of contributing to sustainable agriculture, but does not make explicit what the researchers mean by the term, we did not actively search the physical science and engineering literature.

For the evaluation of the practitioner view on sustainable agriculture, we searched for non-peer reviewed literature, mainly those kinds of publications without ISBN or ISSN such as websites, reports or brochures. Such publications may or may not be authored by scientists but mostly they are directed less towards the scientific community and more to practitioners, decision-makers *etc*. This type of literature is referred to as "grey literature" in the remainder of this article. Grey literature publications were searched in Google with the search terms "sustainable agriculture" and "agricultural sustainability" in English, German, French, Spanish and Portuguese. The results of each query were checked until a point where no new usable publications were found. Additionally, we searched websites of organizations known to be related to agriculture or sustainability including BUND (Friends of the Earth Germany), FAO, German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Greenpeace, Monsanto, Syngenta, UNEP, Unilever, U.S. Department of Agriculture, WHO, WWF, *etc*.

Search results were narrowed down to include only those publications that were available, and that gave at least a minimal definition or explanation of what was meant by sustainable agriculture. With this search, we found 129 journal articles and 26 grey literature publications (see Table S1 in the Supplementary Information for the full list of these publications). This selection is not a complete compilation of all publications that have ever defined sustainable agriculture. Particularly, it does not contain any book chapters or conference papers. Nevertheless, it provides a broad overview of the conceptions of sustainable agriculture in use.

Objective 1 was fulfilled by subjecting the publications to content analysis supported by ATLAS.ti. We employed an inductive qualitative content analysis [37] in order to identify different topics and aspects that are related to sustainable agriculture in the examined literature. In the remainder of this article, we refer to the single aspects of sustainable agriculture as "categories" and to the overall topics as "themes" (see Tables 2–4). These categories and themes were organized into a framework which summarizes descriptions of sustainable agriculture. This framework includes both technical and non-technical issues of sustainable agriculture. However, as we focused on governance and social issues in this research, technical aspects were strongly summarized into few categories and themes while the issues of greater interest to this research are represented in more detail and in a greater number of categories and themes. In order to assess which topics are more central in the debate about sustainable agriculture, we assessed the number of examined publications—both journal articles and grey literature publications—the different themes occurred in.

Our framework served as an analytical framework for the quantitative analysis of the investigated literature in objective two. One part of this quantitative analysis consisted of the assessment of the occurrence of the different themes in journal articles and grey literature publications. Furthermore, for the journal articles we assessed differences in the occurrences of the themes and categories between different disciplines. Additionally, we assessed changes in the debate over time by focusing on the level of categories. All categories were classified according to their persistence and relevance. The persistence

is measured as the percentage of the years in which a category appears in the journal articles. To determine the relevance, the mean percentage of journal articles mentioning a category for those years in which the category appeared was calculated. The categories were classified as persistent or occasional, and as being of low, medium or high relevance. By combining both parameters, a typology of six category-types with different combinations of persistence and relevance was developed (Table 1).

Table 1. Category types according to their persistence and relevance in the debate.

Category-Type	Persistence	Relevance	Interpretation
Famous topics	*persistent*: appear 51%–100% of years	*high*: appear in 50%–100% (mean) of papers in years of appearance	form mainstream debate
Key topics	*persistent*: appear 51%–100% of years	*medium*: appear in 25%–49% (mean) of papers in years of appearance	form mainstream debate
Wall-flower topics	*persistent*: appear 51%–100% of years	*low*: appear in 1%–24% (mean) of papers in years of appearance	niche topics
Buzz topics	*occasional*: appear 0%–50% of years	*high*: appear in 50%–100% (mean) of papers in years of appearance	complement mainstream
Visiting topics	*occasional*: appear 0%–50% of years	*medium*: appear in 25%–49% (mean) of papers in years of appearance	complement mainstream
Outsider topics	*occasional*: appear 0%–50% of years	*low*: appear in 1%–24% (mean) of papers in years of appearance	niche topics

For objective three, we conducted a cluster analysis of only the journal papers in order to identify overall conceptions of sustainable agriculture in the academic discourse. For this cluster analysis, we assessed which themes of our framework (Tables 2–4) were mentioned in each publication. Thus, we obtained a binary dataset containing the information of which themes of sustainable agriculture are brought up in which journal article. As it was our aim to obtain clusters of different positions regarding sustainable agriculture, a special approach had to be taken for those papers that juxtapose two or more positions regarding sustainable agriculture [10,14,16,17,38]: In order to separate these positions, these articles were divided into several sub-articles with each sub-article containing the coding data pertaining to only one of the presented positions. Those aspects which were mentioned in these articles and for which it was not clear to which of the positions they related were coded in all of the sub-articles. Each of the sub-articles was regarded as an own instance for the cluster analysis, leading to a total number of 136 instances whereas each instance contains one position regarding sustainable agriculture.

The cluster analysis was carried out in a two-step approach. In the first step, all instances were included in the analysis. We used different algorithms to calculate the clusters, but for all of them, clusters were mainly determined by the number of themes mentioned in the instances rather than by different orientations with regard to contents. To counteract this effect, in a second step we excluded all those instances that mention less than four or more than fifteen of the seventeen themes (see Table A1 in the Appendix). With that, the number of instances analyzed was reduced to 119. For the cluster analysis of these 119 instances, we specifically conducted an agglomerative hierarchical cluster analysis using Euclidean distance measures and Ward's method of agglomeration. With this method we aimed to

minimize within-group variance while simultaneously maximizing dissimilarity between groups. Based on all variables, the analysis proceeds in a bottom-up way, starting from the single units (*i.e.*, instances). It then aggregates successively the two most similar units (or aggregates of units) until only one all-encompassing cluster remains [39]. We employed Ward's method of agglomeration because it resonates well with our goal of arriving at homogenous groups and tends to produce readily interpretable and widely understood results [40].

Table 2. Themes and categories making up the goals of sustainable agriculture.

Goal Themes	**Goal Categories**	
	General	***Specific***
Overarching Goals		• ethics • multifunctionality • safety • stability & resilience
Environmental Goals: Production-Specific	*ecological soundness*	• ecosystem function conservation • natural resource conservation • productive capacity
Environmental Goals: Non-Production-Specific		• animal well-being • environment conservation & improvement • harmony with nature
Social Goals	*social responsibility*	• acceptability • cultural preservation • equity, justice, fairness • fulfillment of human needs • good working conditions • human health • nourishment • quality of life • strong communities
Economic Goals	*economic viability*	• development • livelihood • provision of products • thriving economy

Table 3. Themes and categories making up the strategies for sustainable agriculture.

Strategy Themes	Strategy Categories
Adaptive Management	• adaptation • learning & experimentation • management, integration & redesign • prevention • substitution
Co-operation	• collaboration & communication • participation
Ecology-based Strategy	• diversification • ecological principles
Economics-based Strategy	• capital asset maintenance • demand-orientation • efficiency • quality-orientation
Holistic & Complex Systems Thinking	• long-term perspective • scale-sensitivity • systemic thinking
Knowledge & Science	• innovation • modern • traditional
Subsidiarity	• decentralization • independence • local/regional

Table 4. Themes and categories making up the fields of action for sustainable agriculture.

Fields of Action Themes	Fields of Action Categories
Agrifood System	• consumption • production • supply Chain
Management & Technological Solutions	• crops & livestock • management tools • resource use • technology & practices
Social & Environmental Challenges	• emission-reduction • global trends
Social & Human Capital	• organization • knowledge, education, skills • research & development
Social, Political & Economic Environment	• accessibility • economic system • infrastructure • investment • policy & institutions • society

3. Results

3.1. Objective 1: Categories and Themes that Contribute to Sustainable Agriculture

The inductive content analysis revealed a great variety of different categories that are associated with sustainable agriculture, which can be organized into three general groups. Sustainable agriculture is often described as a set of ideal objectives which it is supposed to achieve (*Goals*). In order to achieve these goals, authors suggest or criticize different approaches and principles (*Strategies*), which should or should not be applied in different areas (*Fields of Action*). We identified altogether 17 themes that specify which are the concrete Goals, Strategies and Fields of Action of and for sustainable agriculture from a social science and governance perspective, thus forming a framework of sustainable agriculture (Figure 1). These 17 themes summarize the overall 66 more detailed categories (or aspects) of sustainable agriculture that were identified through the qualitative content analysis (Tables 2–4).

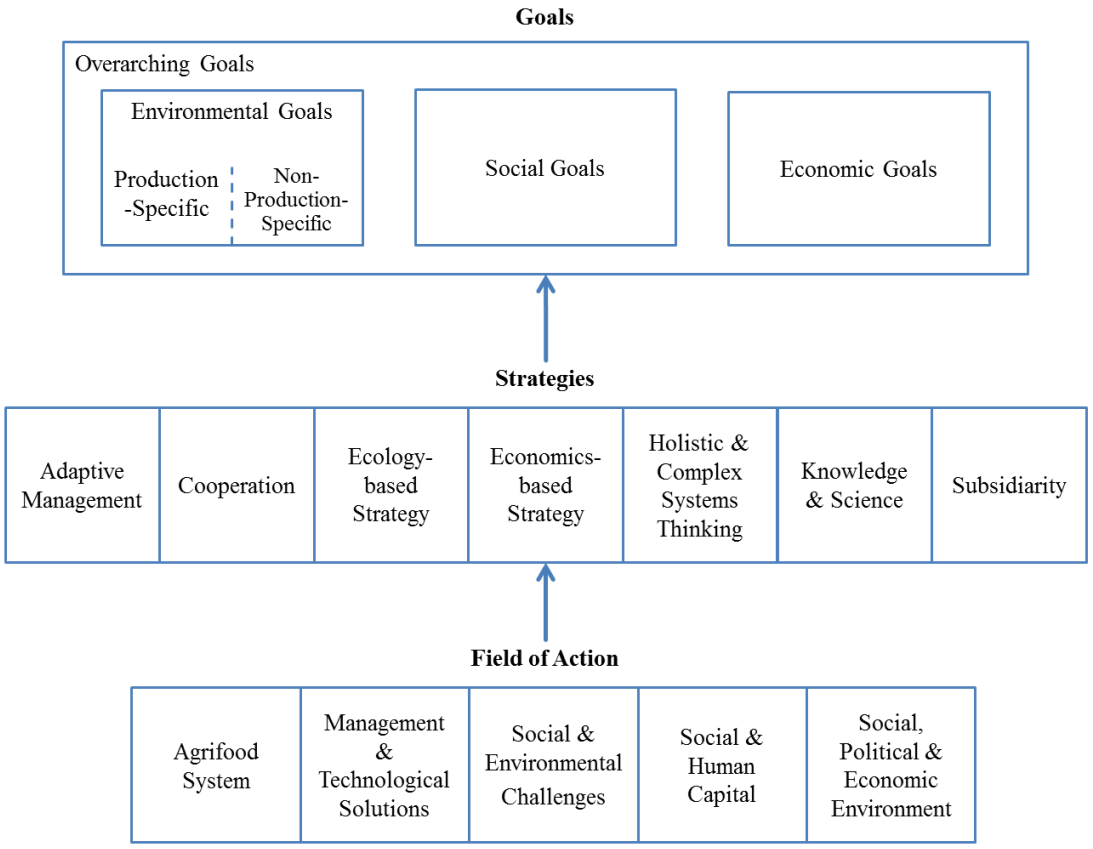

Figure 1. Groups and themes of the sustainable agriculture framework.

While the division of the groups of Strategies and Fields of Action into single themes is quite straightforward, the structure of the group of Goals is more complex: The Environmental Goals theme is subdivided into two sub-themes. Whereas the theme of Production-Specific Environmental Goals summarizes those categories that demand the protection of the environment as a basis for agricultural production, the theme of Non-Production-Specific Environmental Goals contains categories that imply environmental protection rather for its own sake and for the greater good [41,42]. Another specialty are the categories "ecological soundness", "social responsibility" and "economic viability", which represent

the general goals of sustainable agriculture in the environmental, social and economic pillars respectively. The remaining categories in each of these themes give a more detailed and concrete account of these goals and therefore operationalize the general goal categories of ecological soundness, social responsibility and economic viability. In addition to the classical sustainability triad of environment, social sphere, and economy, our framework contains Overarching Goals as a further theme. This theme comprises categories which represent goals that are not specific to any of the three areas of sustainability but rather are valid for all areas, such as "stability & resilience". Descriptions and explanations of all of the themes and categories in this framework can be found in Table S2 in the Supplementary Information of this article along with some exemplary citations for each category.

Our analysis of central (*i.e.*, most frequently used) topics highlights that the debate about sustainable agriculture seems to be focused more on anthropocentric than ecocentric values: The most mentioned and therefore most considered goals are the Production-Specific Environmental Goals, Economic Goals, and Social Goals (Figure 2). There is almost complete balance among these three dominating goals as they all appear in very similar shares of approximately 80% of the publications.

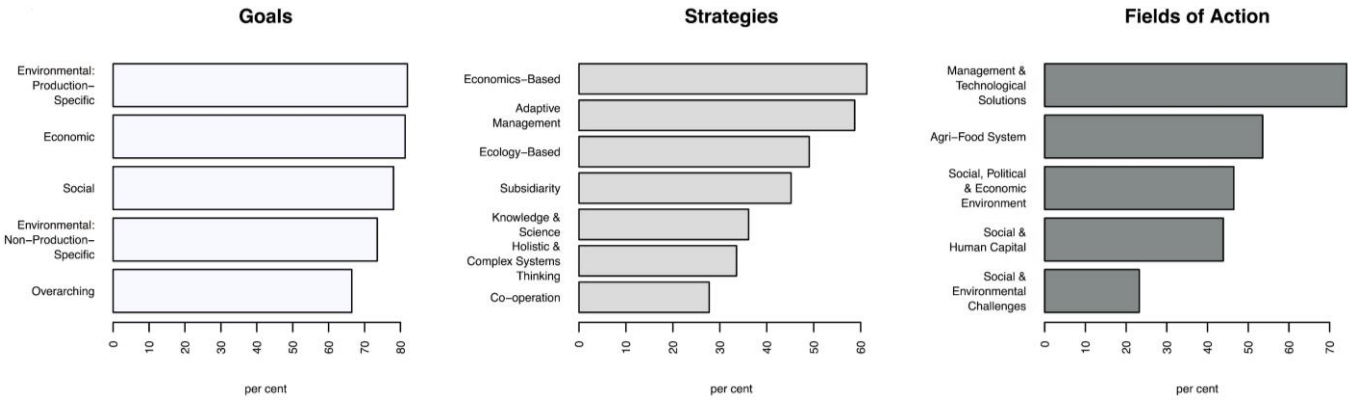

Figure 2. Total share of publications mentioning the different themes in the group of Goals, the group of Strategies, and the group of Fields of Action.

Furthermore, from the occurrences of the Strategy and Fields of Action-themes, we find that the main focus for the realization of sustainable agriculture has so far been on rather technology-centered, on-farm solutions: The most mentioned Strategies are the Economics-Based Strategy and Adaptive Management and the most suggested Field of Action is the one of the Management & Technological Solutions. Thus, there is a strategic emphasis on economic efficiency and adaptation of practices. At the same time, most action-related statements make recommendations or prescriptions about which technologies, management practices, kinds of resources, crop varieties, and livestock breeds are supposed to be used in which way if one wants to practice sustainable agriculture. The focus on measures at the farm level is also highlighted by the fact that roughly two thirds of the scientific publications only consider the level of agricultural production when writing about sustainable agriculture whereas only one third of the publications follow demands to look beyond the farm gate to solve sustainability problems in agriculture [28,43,44] (Figure 3).

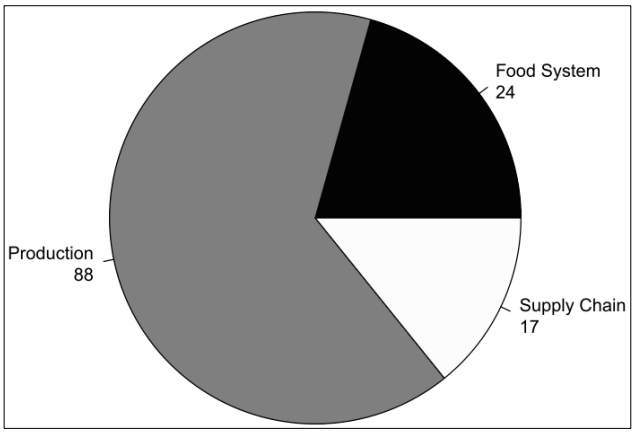

Figure 3. Breadth of focus of the journal articles. Journal articles attributed to "production" consider only the stage of agricultural production; publications with a supply chain focus take into account both production of agricultural goods and the subsequent marketing and distribution; articles considering the food system look at production, distribution and also consumption of agricultural produce.

The debate about sustainable agriculture is not solely characterized by these themes; alternative conceptions have a strong standing in the discourse. This becomes evident, on the one hand, by looking at the two remaining goal themes—Environmental Goals which are not directly related to agricultural production and Overarching Goals. They are of lesser concern in the debate than the three anthropocentric goal themes but have an occurrence in two thirds or more of the publications and are thus widely considered. Also, in the groups of Strategies and Fields of Action, there are themes that appear significantly less often than the dominant Strategies and Fields of Action, but still they are mentioned in more than one third of the publications and therefore are of relevance, too. These are all remaining Strategies except for Co-operation, and all of the remaining Fields of Action, with the exception of Social & Environmental Challenges. We evaluate the remaining themes of Co-operation and Social & Environmental Challenges, which appear in less than one third of the publications, to be niche themes: They have been relevant only to few authors and/or during some time periods.

3.2. Objective 2: Use Patterns of Ideas and Aspects of Sustainable Agriculture

3.2.1. Use Patterns of Ideas and Aspects of Sustainable Agriculture over Time

Over time, the sustainable agriculture debate has been shaped by a large number of Famous and Key topics. As described in the methodology section (Section 2, Table 1), the single categories of sustainable agriculture were classified as belonging to one of six category-types according to the persistence with which they occurred in the debate and the relevance attributed to them (see Table 5). The fact that there are no Buzz topics as well as the overall low number of categories with a low persistence and the high number of categories classified as Key topics suggest that the overall discourse about sustainable agriculture is not one which homogenously favors few topics for a short time period before it turns its attention towards other topics. Rather, it is characterized by a great, heterogeneous variety of topics that are discussed parallel to each other and remain on the agenda almost constantly, which indicates the presence of alternative, competing conceptions of sustainable agriculture.

Table 5. Classification of the categories of sustainably agriculture according to their relevance and persistence.

Persistence	**Group**	**Relevance**			
		0%–24%	***25%–49%***		***50%–100%***
51%–100%	*Goals*	**Wallflower topics** cultural preservation	**Key topics** development livelihood thriving economy ecological soundness ecosystem function conservation productive capacity ethics multifunctionality safety	Acceptability equity, justice, fairness fulfillment of human needs nourishment quality of Life social responsibility strong communities	**Famous topics** economic viability provision of products environment conservation & improvement natural resource conservation stability & resilience
	Strategies	long-term perspective systemic thinking	Adaptation management, Integration & redesign participation diversification ecological principles	demand-orientation quality-orientation innovation decentralization independence local/regional	efficiency
	Fields of Action	emission-reduction	Production supply chain crops & livestock knowledge, education, skills	economic system policy & institutions society	resource use technology & practices

Table 5. *Cont.*

Persistence	Group	Relevance		
		0%–24%	***25%–49%***	***50%–100%***
0%–50%	*Goals*	**Outsider topics** animal well-being good working conditions	**Visiting topics** harmony with nature human health	**Buzz topics**
	Strategies	learning & experimentation prevention substitution capital asset maintenance scale-sensitivity	collaboration & communication modern traditional	
	Fields of Action	Consumption organization infrastructure investment	management tools global trends research & development accessibility	

However, evaluating the significance of the categories only based on frequency and relevance measured over the whole observed time period might obscure changes in the persistence or the relevance of a category during this time. Thus, a category could be an Outsider topic in the first years and become a Key topic in later years. Overall, the category could be classified as a Visiting topic but this classification would not reflect changes in the debate in a sufficient way. Therefore, we also checked the time lines of the individual categories for such trend changes (Table 6). Only 18 of the overall 66 categories (27%) experienced such a trend change.

These findings further underline the overall constancy of the presence of manifold aspects of sustainable agriculture at the same time. Yet, some developments can be detected: After the turn of the millennium, both the Environmental Goal to conserve ecosystem functions or ecosystem services and the Overarching Goal of having agriculture fulfill a variety of different functions rather than just producing food and other products ("multifunctionality") started to be discussed in more papers and have therefore gained relevance. Therefore, the commodity-centered view that considers agriculture and the environment as providers of certain resources has been complemented by a function-centered view. In this view, the functions of the environment and of agriculture are recognized as valuable in addition to material goods because they underpin the provision of such goods and offer additional benefits to society.

Another development is the narrowing down of the debate regarding the Strategies for a sustainable agriculture, *i.e.*, fewer Strategies are now widely considered than before. This trend is most pronounced for Co-operation and the Ecology-Based Strategy. In the first half of the 2000s, both categories of the Strategy of Co-operation ("collaboration & communication" and "participation") turned from Key into almost completely neglected Outsider topics. A few years later, the Ecology-Based Strategy also started to lose weight in the debate as "ecological principles" turned from a Famous to a Key topic and "diversification" from Key to Wallflower topic. Thus, in earlier years the Ecology-Based Strategy belonged to the dominant Strategies, just like the Economics-Based Strategy and Adaptive Management (see Section 3.1), and for just a few years it has been an alternative strategy.

Table 6. Categories that experienced trend changes.

Group	Theme	Category	Year																					
			89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12
Goals	Environmental: Non-Production-Specific	*harmony with nature*	Outsider								Key															
	Environmental: Production-Specific	*ecosystem function conservation*	Key													Key (with higher relevance)										
	Overarching	*multifunctionality*	Wallflower																				Key			
	Social	*acceptability*	Visiting													Key						Wallflower				
		equity, justice, fairness	Key													Famous							Wallflower			
		good working conditions	Outsider																	Wallflower						
		human health	Visiting																	Key						
Strategies	Adaptive Management	*learning & experimentation*	Outsider (not mentioned)						Key											Outsider						
		prevention	Outsider												Outsider (not mentioned)					Wallflower						
	Co-operation	*collaboration & communication*	Key																	Outsider						
		participation	Key																	Outsider						
	Ecology-based	*ecological principles*	Famous																	Key						
		diversification	Visiting											Key								Wallflower				
	Holistic & Complex Systems Thinking	*long-term perspective*	Key												Outsider							Wallflower				
	Knowledge & Science	*modern*	Visiting												Outsider							Wallflower				
Fields of Action	Social & Environmental Challenges	*emission-reduction*	Wallflower													Wallflower (with higher relevance)										
	Social & Human Capital	*research & development*	Outsider								Key									Outsider						
	Social, Political & Economic Environment	*economic system*	Key													Key (with higher relevance)						Wallflower				

3.2.2. Differences in the Use of Ideas and Aspects of Sustainable Agriculture between Scientists and Practitioners

Differences in the perceptions of sustainable agriculture held by scientists and practitioners indicate that in academia a more utilitarian view is dominant than in the practitioner-oriented literature. We compared the ranking of the themes for each publication type (academic and grey literature) [45] according to the frequency of mentions in the publications (Table 7). Whereas economic benefits of sustainable agriculture and the conservation of environmental assets as a basis for agricultural production are the most considered goals in journal articles, grey literature publications focus on social aspects and attribute more importance to the protection of the environment for its own sake. This can be seen by the fact that for practitioners, Social Goals and Non-Production-Specific Environmental Goals are apparently more relevant than for scientists, whereas the opposite is true for Production-Specific Environmental Goals. Also, the Fields of Action theme Human & Social Capital ranks significantly higher for grey literature publications than for journal articles.

Table 7. Shares and ranks (based on the frequency of mentions) of the different themes of the sustainable agriculture framework in journal articles and grey literature publications.

	Themes	Share		Rank	
		Journal	**Grey**	**Journal**	**Grey**
Goals	Environmental: Production-Specific	80%	92%	1	4
	Economic	78%	96%	2	2
	Social	74%	100%	3	1
	Environmental: Non-Production-Specific	69%	96%	4	2
	Overarching	64%	77%	5	5
Strategies	Economics-based	60%	69%	1	2
	Adaptive Management	56%	73%	2	1
	Ecology-based	47%	58%	3	3
	Subsidiarity	43%	54%	4	4
	Knowledge & Science	32%	39%	5	6
	Holistic & Complex Systems Thinking	32%	54%	5	4
	Co-operation	26%	35%	7	7
Fields of Action	Management & Technological Solutions	73%	81%	1	1
	Agri-Food System	51%	65%	2	3
	Social, Political & Economic Environment	45%	54%	3	4
	Social & Human Capital	39%	69%	4	2
	Social & Environmental Challenges	21%	35%	5	5

The draw towards a more socially-centered view in the perspective of the practitioners is noticeable also when looking at the categories: The issue of the need for agriculture to provide a livelihood for those working with it gains overwhelmingly more attention in grey literature than in journal articles as in grey literature more heed is paid to categories such as “good working conditions”, “safety”, “accessibility” and “infrastructure”. In return, in grey literature publications, much less attention is paid to the conservation of ecosystem functions than in journal articles.

3.2.3. Differences in the Use of Ideas and Aspects of Sustainable Agriculture between Scientists from Different Disciplines

Views of sustainable agriculture may not only differ between scientists and practitioners but also within academia itself, as evaluated by comparing the occurrence of the different themes in the journal articles from the different disciplines. The journal articles in our sample originate from six academic disciplines (Figure 4). Although the search for journal articles had been limited to social sciences and humanities, roughly one third of the articles were written either by authors with an engineering and natural sciences background or by agricultural scientists. Thus, also the more "technical" view of sustainable agriculture is represented in the sample.

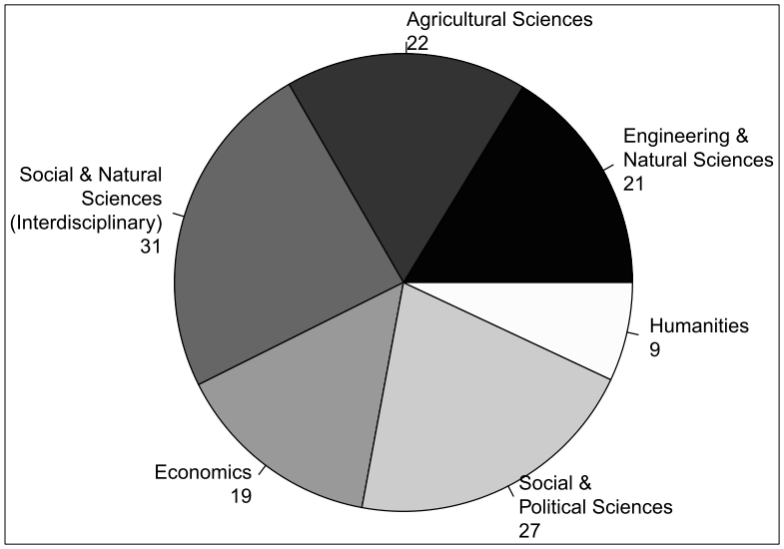

Figure 4. Distribution of the journal articles regarding the discipline they originate from. Journal articles were attributed to a discipline according to the discipline/affiliation of the first author.

Overall, among the views of sustainable agriculture in the different disciplines, we find a spectrum of perspectives ranging from more production-centered views with a concentration on fewer aspects on the one end and a consideration of a great variety of aspects accompanied by a greater regard for social and societal questions on the other end. We consider disciplines to have a more production-centered view if they put their main focus on the Production-Specific Environmental Goals together with an emphasis on the Economics-Based Strategy and Adaptive Management and an almost exclusive interest in the Field of Action of Management & Technological Solutions. At this end of the spectrum, with a focus on agricultural production and concentration on a smaller set of aspects, we find the disciplines of engineering and natural sciences as well as the agricultural sciences. However, these characteristics are more pronounced for engineering and natural sciences than for agricultural sciences (for a more detailed view of our findings, see Table A2 in the Appendix).

At the opposite end of the spectrum, we locate disciplines that consider a greater variety of aspects and attribute greater importance to aspects which are not directly related to agricultural production: In these disciplines, objectives other than the conservation of the natural production base, such as Social, Economic, and Non-Production-Specific Environmental Goals, receive more attention. Also in

these disciplines, production-oriented themes (Economics-Based Strategy, Adaptive Management, and Management & Technological Solutions) play a crucial role. However, different from the production-centered disciplines, authors from the socially-focused disciplines discuss also those Strategies and Fields of Action that point at changes in the social and societal environment in which agricultural production takes place (Strategies of Co-operation, Knowledge & Science, and Subsidiarity, Field of Action Social, Political & Economic Environment). The disciplines at this end of the spectrum are the humanities and the social and political sciences.

The two remaining groups of disciplines—interdisciplinary sciences, which work at the intersection of natural and social sciences like geography or environmental sciences, and economics—build the middle ground of the spectrum as they combine characteristics of both orientations. When writing and researching about sustainable agriculture, interdisciplinary scientists are in general interested in a maintained and improved productivity of the natural production base of agriculture—just like the production-centered disciplines. Yet, regarding Strategies and Fields of Action to achieve this goal, they do not only seek to improve agricultural production but also look at issues of societal organization. For economics, the opposite is the case: They consider a wider range of goals and the conservation of the natural production base is not their primary concern. Also, economists rather build on alternative strategies. In these respects, publications from economics are similar to the socially-focused disciplines. However, when it comes to concrete action, economists mainly focus on agricultural technologies and management practices in the same way as the production-centered disciplines.

Despite the emphases on different themes in the different disciplines, there is one area on whose importance all disciplines seem to agree: Management & Technological Solutions is the most frequent Field of Action in all disciplines.

3.3. Objective 3: Different Conceptions of Sustainable Agriculture in the Scientific Debate

Our cluster analysis revealed five specific lines of argumentation as to what constitutes sustainable agriculture. We identified six clusters based on how they reflected the themes and categories identified in objective one: cluster (1) anthropocentric goals; cluster (2) production and overarching goals-centered; cluster (3) collecting pond; cluster (4) systems thinking; cluster (5) comprehensive; and cluster (6) knowledge and science (Table 8; see Figure A1 in the annex to see which instances are contained in which clusters). Cluster 3 does not represent a specific line of argumentation or orientation but, as its name already suggests, just captures all instances that do not fit with the patterns of the other clusters. This is shown by there being no particularly strong presence of any theme in the cluster.

The other five clusters emerge as groups with themes that are strongly present within them. They can be grouped into outcome-centered, process-centered, as well as outcome and process-considering clusters. Cluster 1, the "anthropocentric goals cluster", presents an outcome-centered view of sustainable agriculture, claiming that agriculture is sustainable if defined objectives are achieved. These objectives are particularly strong in the themes of Social, Economic and Production-Specific Environmental Goals. Yet, it leaves open the question of how these objectives are supposed to be achieved. In contrast, the instances of the "systems thinking cluster" (Cluster 4) and of the "knowledge and science cluster" (Cluster 6) have a process-centered view of sustainable agriculture, claiming that agriculture becomes sustainable if specific approaches are applied and action is taken in certain areas. Here, the "systems

thinking" cluster strongly promotes Holistic & Complex Systems Thinking and also the Subsidiarity principle and focuses on action related to Management & Technological Solutions. In contrast, the instances in the "knowledge and science cluster" concentrate on the use of Knowledge & Science in combination with some other Strategies and recommend to take action in all Fields of Action but especially regarding Social & Human Capital and the Social, Political & Economic Environment. At the same time, these process-centered clusters tell little about what is supposed to be accomplished by using their recommended approaches. Only the "production and overarching goals-centered cluster" (Cluster 2) and the "comprehensive cluster" (Cluster 5) refer to both outcomes and processes and provide explanations of what means of sustainable agriculture are supposed to be applied for which ends of sustainable agriculture. However, whereas the "production and overarching goals-centered cluster" (Cluster 2) focuses on certain Goals, Strategies, and Fields of Action, the instances of the "comprehensive cluster" (Cluster 5) discuss almost all themes, yet with a special emphasis on the rather alternative Ecology-Based Strategy and Subsidiarity.

Table 8. Strength of the presence of each theme in the different clusters based on the indicator values (measure the statistical alliance of the themes to the different clusters): + stands for indicator values of 0.10 to 0.14, ++ for values of 0.15 to 0.29, and +++ for values of 0.30 and higher. A table with the individual indicator values can be found in Table S3 in the Supplementary Information.

Group	Theme	Indicator Value					
		cl. 1	**cl. 2**	**cl. 3**	**cl. 4**	**cl. 5**	**cl. 6**
Goals	Economic	++	++		+	++	+
	Environmental: Non-Production-Specific	+	+	+		++	
	Environmental: Production-Specific	++	++			++	+
	Overarching	+	++		+	++	
	Social	++	++			++	
+Strategies	Adaptive Management		++			++	++
	Co-operation					++	+
	Ecology-based		+			+++	
	Economics-based		++			++	++
	Holistic & Complex Systems Thinking				+++		
	Knowledge & Science					+	+++
	Subsidiarity				++	+++	
Fields of Action	Agri-Food System		++			++	++
	Management & Technological Solutions		+	+	++	++	++
	Social & Environmental Challenges					+	++
	Social & Human Capital				+	++	+++
	Social, Political & Economic Environment					++	+++

Table 9. Different characterizations of the positions in the debate about sustainable agriculture (all of these characterizations were proposed or made reference to in journal articles of our sample).

References	Techno-Economic Position	Agroecological-Ruralist Position
Pierce 1993 [12]	• position promoted by economists	• position promoted by ecologists
Farell & Hart 1998 [26], Tait & Morris 2000 [10]	• competing objectives	• critical limits
Johnson 2006 [27]	• life sciences integrated paradigm	• ecologically integrated paradigm
Rezaei-Moghaddam & Karami 2008 [14]	• ecological modernization	• de-modernization
Thompson & Scoones 2009 [15]	• paradigm of molecular biology and genetic engineering	• holistic stream
Robinson 2009 [28]	• technocentric approach	• Ecocentric approach
O'Riordan 1993 [46], Cobb *et al.* 1999 [47]	• very weak sustainability	• very strong sustainability • Strong sustainability
Frouws 1998 [30], Hermans *et al.* 2010 [16], Hermans *et al.* 2012 [17]	• utilitarian discourse	• agri-ruralist discourse • hedonist discourse
Marsden 2003 [29], Hermans *et al.* 2010 [16]	• agro-industrial model • post-productivist model	• rural development model
Pretty 1997 [31]	• business-as-usual optimists • industrialized world to the rescue • new modernists	• environmental pessimists • sustainable intensification

Our identification of five clear clusters contrasts with the frequently cited idea that there are two contrasting positions as to what constitutes sustainable agriculture. Many existing analyses of what constitutes sustainable agriculture claim that the debate is framed by two contrasting positions, which have been termed in different ways [12,14,15,26–28]; we term these two positions the techno-economic and the agroecological-ruralist positions. There have been arguments that the debate can be divided into three or more different positions on sustainable agriculture [16,17,29,31]. However, we argue that these additional positions result from emphasizing different aspects of the same paradigm, such that they can be organized as different framings or characteristics of the same position (Tables 9 and 10). However, our cluster analysis of positions on sustainable agriculture demonstrates that most conceptualizations of sustainable agriculture actually combine elements of both positions. Only one of the identified clusters, the "anthropocentric goals cluster" (Cluster 1), can be clearly matched with one of the two positions proposed in the literature, namely with the techno-economic position. The remaining four clusters are hybrids of the two positions as they contain elements of both the techno-economic and the agroecological-ruralist position (Table 11). Most notably, the "comprehensive cluster" (Cluster 5) integrates (almost) all themes and therefore greatly combines the aspects of both positions suggested in the literature.

Table 10. Stances of the techno-economic and the agroecological-ruralist position on different components [9,10,12,14–16,26–29,31,46].

Topic	Techno-Economic Position	Agroecological-Ruralist Position
underlying mindset	economics, belief in the effectiveness of market mechanisms	ecology
role of science and technology	belief in modern science and technologies	belief in traditional knowledge, skepticism/rejection of modernity and technology
approach to solving problems	problems can be approached and solved separately modification	problems require integrated and interdisciplinary solutions transformation/fundamental change
guiding principles of economic action and organization	competitiveness, productivity, efficiency	respect for the limited carrying capacity of ecosystems, no or minimal growth
orientation of agricultural production and the supply chain towards	globalization and export agribusiness	local autonomy/autarky regional development
management style	entrepreneurship, individual action	collective action, participation
role of the farmer	entrepreneur	custodian of nature and countryside
most reasonable form of agriculture	intensive agriculture with high use of external inputs production of standardized products in monoculture production in large scales	Organic agriculture, low use of external inputs diversified production, multifunctional agriculture Production in small scales, small/family farms
main strategy to satisfy the needs of all humans	compromise (especially with nature conservation targets) to ensure the satisfaction of all consumption needs	change of life and consumption styles
value of nature	consumption good	intrinsic value of nature
to be conserved	material capital	natural environment

Table 11. Similarities of the five clusters with clear orientations regarding sustainable agriculture to the techno-economic and the agroecological-ruralist positions.

Cluster	Similarities to the Techno-Economic Position	Similarities to the Agroecological-Ruralist Position
Cluster 1: the anthropocentric goals cluster	• strong focus on Economic Goals • higher relevance of Production-Specific Environmental Goals than of Non-Production-Specific Environmental Goals aiming • low focus on Overarching Goals	
Cluster 2: the production and overarching goals-centered cluster	• high occurrence of the anthropocentric Goals • emphasis on Economics-based Strategy • concentration on agricultural production: o strong presence of the Field of Action Agri-Food System (with "production" being the by far most mentioned category) o slight presence of Management & Technological Solutions	• Overarching Goals (include e.g., "multifunctionality") are the most present theme • Adaptive Management is often suggested • Slight presence of the Ecology-based Strategy
Cluster 4: the systems thinking cluster	• concentration on agricultural production: main Field of Action: Management & Technological Solutions	• strategic focus on Holistic & Complex Systems Thinking and Subsidiarity
Cluster 5: the comprehensive cluster	• high presence of the anthropocentric Goals • high consideration of the Economics-based Strategy • high consideration of agricultural production: o Management & Technological Solutions is the most mentioned Field of Action o strong presence of the Field of Action Agri-Food System (with "production" being the by far most mentioned category)	• high presence of Non-Production-Specific Environmental Goals and Overarching Goals • main strategic focus on Ecology-based Strategy and Subsidiarity • high presence of Adaptive Management and Co-operation • high presence of the Fields of Action Social & Human Capital and Social, Political & Economic Environment
Cluster 6: the knowledge and science cluster	• very pronounced presence of the Strategy of Knowledge & Science with a high occurrence of the categories "innovation" and "modern" • strong presence of the Economics-based Strategy • strong presence of the Field of Action Management & Technological Solutions	• very pronounced presence of the Strategy of Knowledge & Science with a high occurrence of the category "traditional" • high presence of the Strategy of Adaptive Management • very strong emphasis of the Fields of Action Social & Human Capital and Social, Political & Economic Environment • comparatively high occurrence of the categories "supply chain" and "consumption" in the Field of Action Agri-Food System

4. Discussion

The analysis of scientific and practitioner-oriented literature on the characteristics of sustainable agriculture has shown that the debate about sustainable agriculture is marked by various different conceptions of sustainable agriculture. By analyzing the way in which sustainable agriculture is defined or used in a range of publications, we identified a number of themes and categories that characterize framings of the concept. Our review structures these categories and themes into Goals, Strategies and Fields of Action. We see that there is a selection of themes that are dominant in the debate. These are anthropocentric Goals and those Strategies and Fields of Action that recommend the application of specific technologies on the level of the farms. However, there is also a strong alternative discourse which considers ecocentric and overarching values, proposes the application of alternative, less technology-oriented approaches and promotes action in arenas beyond the farm gate, *i.e.*, in the whole agri-food system and in society at large. Our cluster analysis shows that authors tend to combine Goals, Strategies and Fields of Action into specific groups, such that there are five distinct framings of sustainable agriculture.

We propose our structure of Goals, Strategies and Fields of Action (and the categories contained therein) as a framework for understanding the real difference between such conceptions; the areas of complementarity and clash with other conceptions; and therefore the implications for governance and actions towards realizing sustainable agriculture. Using our framework, we have shown that over time, different conceptions of sustainable agriculture are discussed in parallel to each other; there are a number of categories that are considered by significant numbers of publications on an almost constant basis with little overall change in the debate. However, we can see greater variation amongst disciplines and uses. Whereas in the scientific literature a more utilitarian view of sustainable agriculture is prevalent, authors of practitioner-oriented literature emphasize non-production-related issues and especially social issues concerning individuals working in and living with agriculture. Within the scientific debate itself, we identified a spectrum of views ranging from production-centered and focusing on few aspects at a time to social-centered and considering a greater number of aspects.

Our framework also helps to understand the substantive differences between the identified clusters, highlighting that most divergence in concepts happens in terms of strategies. We can see that the outcome-centered cluster (cluster 1) focuses on anthropocentric goals of sustainable agriculture. The two clusters that characterize sustainable agriculture both in terms of its desired outcomes and processes to achieve these outcomes offer complete overviews of both goals and strategies. However, these do not clash with each other–both include the same goals as that of the "anthropocentric goals cluster", and both include a focus on economics approaches. Cluster 5 (the "comprehensive cluster") only opens up the range of options by integrating non-anthropocentric Goals and adding further Strategies, having its main emphasis on an ecology-based and subsidiary approach. The two process-centered clusters focus mainly on strategies, and thus both could fit with the "anthropocentric goals cluster". However, one of these clusters (Cluster 4) has a strong focus on Complex & Holistic Systems Thinking and Subsidiarity. The theme of Complex & Holistic Systems Thinking is not well represented in other clusters and therefore presents a divergence from the debate. Yet, despite its demand for holism, this cluster concentrates only on agricultural practices for concrete action. Our framework

and analysis have clarified that there is actually a high degree of complementarity or fit between different conceptions of sustainable agriculture.

It has often been argued that these different conceptions of sustainable agriculture have been competing [10,14] or even opposing [15,16,28] and rivaling [38] and the very presence of such a multitude of interpretations has made the debate about sustainable agriculture confusing [1,48,49]. Yet, we argue that the existence of different conceptions of sustainable agriculture does not necessarily cause conflict. Rather, the diverse views of sustainable agriculture may complement each other and a diversity of interpretations might be what is necessary to realize sustainable agriculture. In fact, different paradigms of sustainable agriculture have already been integrated. This is shown through our cluster analysis, where we found elements of both the techno-economic and the agroecological-ruralist paradigms in all but one cluster. Additionally, there are explicit demands in the literature that both approaches be combined for the sake of sustainable agriculture. For instance, there is a number of publications that suggest that modern and innovative knowledge and approaches (which are promoted in the techno-economic position) be combined with local and traditional knowledge and practices (which are promoted in the agroecological-ruralist position) [23,33,50–53].

Our findings lead us to support ideas that integrate approaches in ways that are appropriate to context and scale, rather than to propose a single one-size-fits-all definition. For example, Firbank *et al.* [54] suggest that in some cases an approach that focuses on increased yields alone may be appropriate, in others a low-input approach seeking to enhance ecosystem services would be more sustainable. Therefore, both approaches are necessary and contribute to a more sustainable agriculture if applied in appropriate situations. In a similar vein, Fischer *et al.* [55] conclude that an integrated farming approach that includes both land sparing (techno-economic) and wildlife-friendly (agroecology-ruralist) farming offers complementary benefits for biodiversity conservation, which in turn contributes to a more sustainable agriculture. Indeed the globalization of agricultural supply chains, (as advocated by the techno-economic position), and the localization of agricultural production, distribution, and consumption (favored by the agroecological-ruralist position) are not necessarily mutually exclusive. Sustainable food strategies should have a balance between the localization and globalization of food chains [56]. This translates into local production and consumption of (seasonal) foods and raw materials while maintaining fair supra-regional trade relations, thus ensuring sufficient supply with food and raw materials in times of bad harvests. Trade with other regions and countries also enables the provision of those foods and raw materials that are necessary for a wholesome nutrition and required economic activities that can be neither produced in the region nor substituted by regionally available products.

There already are practical examples which show that the techno-economic and the agroecological-ruralist paradigms can be combined to offer approaches for a more sustainable agriculture. For example, in farmer cooperatives, actual agricultural production happens on smaller farms with the associated benefits of small-scale production such as increased biodiversity, higher productivity in terms of total farm output, more vivid rural and even national economies [57,58]. At the same time, by acting collectively also small farmers can take advantage of economies of scale and economize on transaction costs [59,60], which are important arguments in favor of large-scale agricultural production [61–63]. Consequently, farmer organization in cooperatives is one way to integrate both the demand for production on smaller units of the agroecological-ruralist position and the demands for large-scale agriculture of the techno-economic position.

The need to integrate paradigms and conceptualizations of sustainable agriculture demands that knowledge is integrated between scientific disciplines. Indeed, such integral solutions address a range of different challenges all at once instead of seeking different isolated solutions for single aspects [64]. For the design of integral solutions, it is necessary to combine the knowledge and expertise from different scientific disciplines because each discipline delivers answers to only some of the relevant aspects. Our analysis highlights that appropriate agricultural production practices, the specialty of engineering and natural sciences as well as agricultural sciences, are at the core of a sustainable agriculture. However, "a technocratic approach to sustainable agriculture is not necessarily any more responsive to rural and urban stakeholder groups, or even to environmental concerns, than was traditional agricultural research" [65] (p. 341). For this reason, it has often been argued that looking at agricultural production alone is not sufficient [43,64,66]; that the realization of sustainable agriculture also requires looking beyond the farm gate [28]. Thus, research looking at the human-made context in which agricultural production takes place, as is conducted by the more socially-focused disciplines, is necessary and important.

However, our recommendations actually extend beyond that of interdisciplinary collaboration and into transdisciplinary research that engages with stakeholders in order to "look beyond the farm gate". The need for more exchange and cooperation between scientists and practitioners is emphasized by our findings. Social and non-production-related environmental issues are of great relevance to practitioners but do not find equivalent consideration in the scientific debate. This very clearly expresses what has already been expressed by other researchers [67–69]: Social issues of sustainable agriculture have been neglected in the scientific debate about sustainable agriculture. At the same time, these issues are of high relevance in practice and therefore research should pay greater attention to these aspects. On the other hand, the conservation of ecosystem functions is little mentioned in the practitioner-oriented literature but has been a topic of increasing importance in the scientific publications (as we have seen in Section 3.2.1). Thus, the rather new insight on the relevance of what we call the function-centered view has not found its way into the discourse of practitioners, yet. Consequently, enhanced exchange between scientists, practitioners, and other stakeholders could be fruitful to inform scientific research about real-life challenges and relevancies and to have a faster diffusion of new findings into practice of and the societal debate about sustainable agriculture.

With these findings in mind, we argue that proliferation in strategies proposed, and therefore in definitions of sustainable agriculture is beneficial to realizing the aim of achieving sustainability in agriculture. Integral solutions require the combination of different insights, kinds of expertise and strategies. For the design of integral solutions, a variety of different options needs to be at hand [25,70]. Therefore, it would be of little value to point out certain approaches and strategies to be adopted for the realization of a sustainable agriculture and neglect others as all approaches identified in our analysis have their value and merit in different situations. What is more, our observed reduction in the variety of frequently discussed strategies in recent years is worrying. With only a limited selection of strategies, the solutions designed might not be integral and comprehensive enough to foster sustainable agriculture over the variety of scales and locations discussed here. Therefore, although this might make the concept of sustainable agriculture seem confusing and fuzzy, we encourage the consideration of a broad range of approaches and possibilities for their integration when designing solutions for sustainable agriculture.

We only caution that academics and practitioners have regard for how such solutions fit together, and what goals they are working towards. For this, our framework should provide clarity.

5. Conclusions

In this review article, we aimed to advance the understanding of the concept of sustainable agriculture, especially from a social sciences and governance point of view. We pursued this aim by identifying the ideas and aspects that are associated with sustainable agriculture. We summarized these ideas and aspects in a framework of Goals, Strategies and Fields of Action of sustainable agriculture, which gives an overview of the debate. We highlighted the use of this framework in understanding differences and fit between different views on sustainable agriculture. Additionally, we pointed out the central and important alternative aspects that are frequently discussed in the debate. We evaluated different patterns in which the term sustainable agriculture has been conceived. Here, we investigated changes that occurred in the scientific debate over time, and assessed differences between scientific and practitioner-oriented publications as well as differences in the conception of sustainable agriculture between different academic disciplines. Through a cluster analysis, we identified how the different ideas and aspects of sustainable agriculture are combined in the scientific debate, and assessed whether these different conceptions match with those that have been claimed to exist in the debate.

Our findings highlight strategies to progress understanding and implementation of sustainable agriculture. Since the beginnings of the debate about sustainable agriculture, there has been a great variety of conceptions of the term. It has been claimed that this multitude of different and partially opposing definitions has made the realization of sustainable agriculture a fuzzy affair, and caused confusion by exacerbating differences in the views of different stakeholder groups. However, there is no way to streamline the concept. Thus, we recommend embracing the complexity of sustainable agriculture with its varied and seemingly contradictory aspects. For complex problems of the modern world such as sustainability challenges in agriculture, ambiguous terms may indeed be more useful than precise and supposedly unambiguous concepts. This is due to their multivalent and flexible meanings, which are better able to "[represent] the objects of interest to, and [create] bridges of common purpose and meaning across otherwise differentiated social worlds" [71] (p. 461). Furthermore, we found the different conceptions of sustainable agriculture to be not as contradicting and mutually exclusive as they have often been portrayed. There are many examples where the integration of the different paradigms has been proposed and even been practiced. Indeed, the different views of and approaches to sustainable agriculture of the different academic disciplines complement each other. Thus, their integration allows a more comprehensive picture of the situation and approach to resolving the existing issues.

Nevertheless, there remains the challenge of bringing together the different viewpoints on sustainable agriculture in practice when working on solutions for concrete problems. An important way to approach this challenge is something that has actually already been proposed in the literature on sustainable agriculture before but has been paid rather little heed: co-operation, interdisciplinary and transdisciplinary research and work. Through interdisciplinary collaboration, the different kinds of expertise and insights can be combined; through transdisciplinary cooperation, practical relevancies, theoretical considerations and technical requirements can inform each other. In general, this suggests more engagement with each other and finding links between the different conceptions in order to advance the development towards a

sustainable agriculture rather than giving up due to the supposedly unsurmountable differences, even if this might be at times a very difficult process. We highlight that our framework can help to find such links by showing similarities between ideas and concepts. Future research could further help the integration of the different approaches and paradigms by detecting and understanding the motivations that have led the different groups to conceive sustainable agriculture in the way they do. This understanding would help to discover more complementarities between the different conceptions where motivations are similar or where differences are rather superficial because they merely stem from practical requirements (such as different working focuses of the different disciplines). Where the differences are more deeply rooted and originate from diverging belief systems, an understanding of the underlying motivations could be the basis to evaluate whether these differences can be overcome without necessarily having to challenge the different belief systems.

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Author Contributions

This research was designed, carried out and written mainly by Sarah Velten. Julia Leventon contributed conceptual thoughts and also was involved in structuring the results and findings as well as in writing the article. Nicolas Jager executed the cluster analysis and wrote the concerning part of the methods section. He also provided the figures in this article. Jens Newig contributed methodological and conceptual ideas. All authors were involved in the finalization of the submitted manuscript and in adapting the manuscript according to the reviewers' comments. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

Appendix

Table A1. Instances excluded from the cluster analysis.

Excluded Instances Mentioning Three or Less Different Themes	Excluded Instances Mentioning Sixteen or More Different Themes
Aikanathan *et al.* 2011	Beus, Dunlap 1990
Christianson, Tyndall 2011	Bowler 2002
Dubey *et al.* 2010	Chiappe, Butler Flora 1998
Erenstein *et al.* 2012	Dillon *et al.* 2010
Goodland 1997	Koohafkan *et al.* 2012
Goodwin 1991	Pierce 1993
López-Aguilar *et al.* 2012	
Manuel-Navarrete, Gallopín 2012	
Paoletti, Pimentel 1995	
Ramakrishnan 2007	
Tilak *et al.* 2005	

Table A2. Ranks of the themes that are mentioned frequently in the publications of the different disciplines (rankings are based on the frequency of mentions of the themes). Goal themes are considered to occur frequently if they are mentioned in at least 70% of the publications of a discipline. Strategy and Field of Action themes have to be mentioned in at least 45% of the publications of a discipline to be considered as frequently occurring. Different thresholds are applied because the Goal themes are generally mentioned more frequently than Strategy and Field of Action themes.

	Themes	Ranks of the Frequently Occurring Themes					
		Engineering & Natural Sciences	***Agricultural Sciences***	***Interdisciplinary Sciences***	***Economics***	***Humanities***	***Social & Political Sciences***
Goals	Environmental: Production-Specific	1	1	1	2	2	-
	Economic	-	2	2	1	2	1
	Social	-	2	-	3	1	2
	Environmental: Non-Production-Specific	-	4	-	3	2	3
	Overarching	-	-	-	-	-	-
Strategies	Economics-based	1	1	1	-	1	2
	Adaptive Management	2	2	2	2	-	1
	Holistic & Complex Systems Thinking	-	3	-	3	-	-
	Subsidiarity	-	-	3	-	2	3
	Ecology-based	-	-	4	1	2	-
	Knowledge & Science	-	-	-	-	-	4
	Co-operation	-	-	-	-	-	5
Fields of Action	Management & Technological Solutions	1	1	1	1	1	1
	Agri-Food System	-	2	2	-	-	2
	Social, Political & Economic Environment	-	-	3	-	2	3
	Social & Human Capital	-	-	4	-	-	4
	Social & Environmental Challenges	-	-	-	-	-	-
	Ø occurrence of all themes	42%	52%	53%	51%	57%	60%

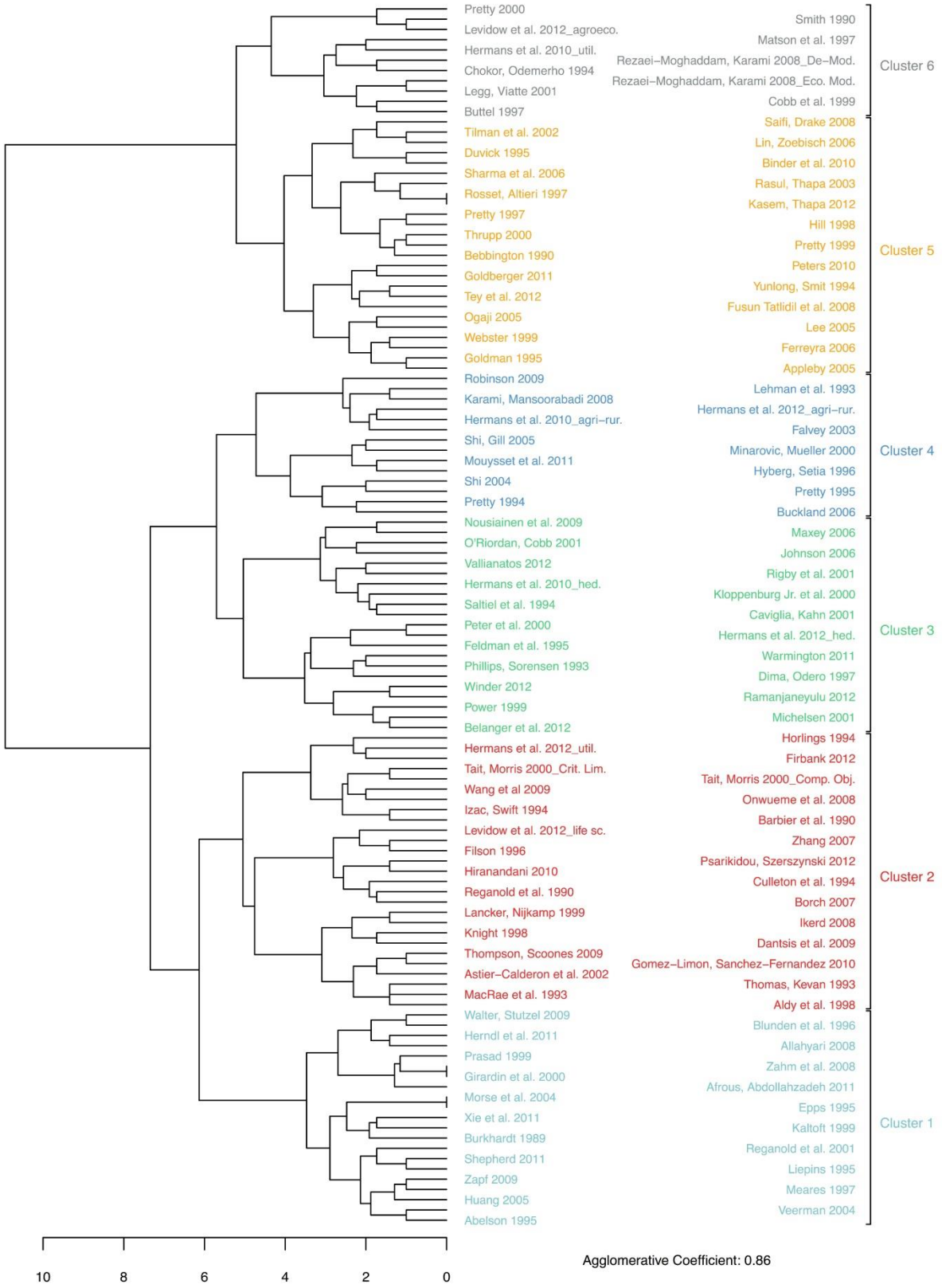

Figure A1. Dendrogram showing the six clusters and the instances belonging to each cluster.

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Supplementary Information

What Is Sustainable Agriculture? A Systematic Review. *Sustainability* 2015, *7*, 7833-7865

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Table S1. List of analyzed publications.

Reference	Focus	Discipline
Journal Articles		
Abelson, P.H. Sustainable Agriculture and the 1995 Farm Bill. *Science* **1995**, *267*, 943.	food system	eng. & nat. sc.
Afrous, A.; Abdollahzadeh, G. Assessing factors affecting on sustainability of agriculture a case of Dezful County, southwest Iran. *Aust. J. Basic Appl. Sci.* **2011**, *5*, 1444–1449.	production	eng. & nat. sc.
Aikanathan, S.; Chenayah, S.; Sasekumar, A. Sustainable agriculture: A case study on the palm oil industry. *Malays. J. Sci.* **2011**, *30*, 66–75.	supply chain	econ.
Aldy, J.E.; Hrubovcak, J.; Vasavada, U. The role of technology in sustaining agriculture and the environment. *Ecol. Econ.* **1998**, *26*, 81–96.	production	econ.
Allahyari, M. Extensionists' Attitude Toward Sustainable Agriculture in Iran. *J. Appl. Sci.* **2008**, *8*, 3761–3763.	production	agric. sc.
Appleby, M.C. Sustainable Agriculture is Humane, Humane Agriculture is Sustainable. *J. Agric. Environ. Ethics* **2005**, *18*, 293–303.	food system	human.
Astier-Calderón, M.; Maass-Moreno, M.; Etchevers-Barra, J. Derivación de indicadores de calidad de suelos en el contexto de la agricultura sustentable. *Agrociencia* **2002**, *36*, 605–620.	production	eng.& nat. sc.
Barbier, E.B.; Markandya, A.; Pearce, D.W. Sustainable agricultural development and project appraisal. *Eur. Rev. Agric. Econ.* **1990**, *17*, 181–196.	production	econ.
Bebbington, A.J. Farmer knowledge, institutional resources and sustainable agricultural strategies: a case study from the eastern slopes of the Peruvian Andes. *Bull. Latin Am. Res.* **1990**, *9*, 203–228.	production	human.

Table S1. *Cont.*

Reference	Focus	Discipline
Journal Articles		
Bélanger, V.; Vanasse, A.; Parent, D.; Allard, G.; Pellerin, D. Development of agri-environmental indicators to assess dairy farm sustainability in Quebec, Eastern Canada. *Ecol. Indic.* **2012**, *23*, 421–430.	production	agric. sc.
Beus, C.E.; Dunlap, R.E. Conventional Versus Alternative Agriculture: the Paradigmatic Roots of the Debate. *Rural Socioogyl* **1990**, *55*, 590–616.	food system	soc. & pol. sc.
Binder, C.R.; Feola, G.; Steinberger, J.K. Considering the normative, systemic and procedural dimensions in indicator-based sustainability assessments in agriculture. *Environ. Impact Assess. Rev.* **2010**, *30*, 71–81.	production	interdisc.
Blunden, G.; Cocklin, C.; Smith, W.; Moran, W. Sustainability: A view from the paddock. *N. Zeal. Geogr.* **1996**, *52*, 24–34.	production	interdisc.
Borch, K. Emerging technologies in favour of sustainable agriculture. *Futures* **2007**, *39*, 1045–1066.	production	interdisc.
Bowler, I. Developing sustainable agriculture. *Geography* **2002**, *87*, 205–212.	food system	interdisc.
Buckland, J. International obstacles to rural development: How neoliberal policies constrain competitive markets and sustainable agriculture. *Can. J. Dev. Stud.* **2006**, *27*, 9–24.	production	econ.
Burkhardt, J. The morality behind sustainability. *J. Agric. Ethics* **1989**, *2*, 113–128.	production	human.
Buttel, F.H. The politics and policies of sustainable agriculture: Some concluding remarks. *Soc. Nat. Resour.* **1997**, *10*, 341–344.	food system	soc. & pol. sc.
Caviglia, J.L.; Kahn, J.R. Diffusion of Sustainable Agriculture in the Brazilian Tropical Rain Forest: A Discrete Choice Analysis. *Econ. Dev. Cult. Chang.* **2001**, *49*, 311–333.	production	econ.
Chiappe, M.B.; Butler Flora, C. Gendered Elements of the Alternative Agriculture Paradigm. *Rural Sociol.* **1998**, *63*, 372–393.	food system	soc. & pol. sc.
Chokor, B.A.; Odemerho, F.O. Land degradation assessment by small scale traditional African farmers and implications for sustainable conservation management. *Geoforum* **1994**, *25*, 145–154.	production	interdisc.
Christianson, L.; Tyndall, J. Seeking a dialogue: a targeted technology for sustainable agricultural systems in the American Corn Belt. *Sustain. Sci. Pract. Policy* **2011**, *7*, 70–77.	production	eng. & nat. sc.
Cobb, D.; Dolman, P.; O'Riordan, T. Interpretations of sustainable agriculture in the UK. *Progress in Human Geography* **1999**, *23*, 209–235.	food system	interdisc.
Culleton, N.; Tunney, H.; Coulter, B. Sustainability in Irish agriculture. *Irish Geography* **1994**, *27*, 36–47.	production	agric. sc.
Dantsis, T.; Loumou, A.; Giourga, C. Organic Agriculture's Approach towards Sustainability; Its Relationship with the Agro-Industrial Complex, A Case Study in Central Macedonia, Greece. *J. Agric. Environ. Ethics* **2009**, *22*, 197–216.	supply chain	interdisc.
Dillon, E.J.; Hennessy, T.; Hynes, S. Assessing the sustainability of Irish agriculture. *Int. J. Agric. Sustain.* **2010**, *8*, 131–147.	production	econ.
Dima, S.J.; Odero, A.N. Organic Farming for Sustainable Agricultural Production: A Brief Theoretical Review and Preliminary Empirical Evidence. *Environ. Resour. Econ.* **1997**, *10*, 177–188.	production	econ.
Dubey, N.K.; Shukla, R.; Kumar, A.; Singh, P.; Prakas, B. Prospects of botanical pesticides in sustainable agriculture. *Curr. Sci.* **2010**, *98*, 479–480.	production	eng. & nat. sc.

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Reference	Focus	Discipline
Journal Articles		
Duvick, D.N. Biotechnology is compatible with sustainable agriculture. *J. Agric. Environ. Ethics* **1995**, *8*, 112–125.	production	agric. sc.
Epps, R. The sustainability of Australian agricultural production systems: a realistic objective or simply a desirable aim? *Aust. Geogr.* **1995**, *26*, 173–179.	production	interdisc.
Erenstein, O.; Sayre, K.; Wall, P.; Hellin, J.; Dixon, J. Conservation Agriculture in Maize- and Wheat-Based Systems in the (Sub)tropics: Lessons from Adaptation Initiatives in South Asia, Mexico, and Southern Africa. *J. Sustain. Agric.* **2012**, *36*, 180–206.	production	agric. sc.
Falvey, L. Agri-history and sustainable agriculture: A consideration of technology and ancient wisdom. *Asian Agri-Hist.* **2003**, *7*, 279–294.	production	agric. sc.
Feldman, S.; Welsh, Rick. Feminist Knowledge Claims, Local Knowledge, and Gender Divisions of Agricultural Labor: Constructing a Successor Science1. *Rural Sociol.* **1995**, *60*, 23–43.	production	soc. & pol. sc.
Ferreyra, C. Emergy analysis of one century of agricultural production in the Rolling Pampas of Argentina. *Int. J. Agric. Resour. Gov. Ecol.* **2006**, *5*, 185–205.	production	interdisc.
Filson, G.C. Demographic and farm characteristic differences in ontario farmers' views about sustainability policies. *J. Agric. Environ. Ethics* **1996**, *9*, 165–180.	production	soc. & pol. sc.
Firbank, L.G. Commentary: Pathways to global sustainable agriculture. *Int. J. Agric. Sustain.* **2012**, *10*, 1–4.	production	eng. & nat. sc.
Füsun Tatlıdil, F.; Boz, İ.; Tatlidil, H. Farmers' perception of sustainable agriculture and its determinants: a case study in Kahramanmaras province of Turkey. *Environ. Dev. Sustain.* **2009**, *11*, 1091–1106.	supply chain	agric. sc.
Girardin, P.; Bockstaller, C.; van der Werf, H. Assessment of potential impacts of agricultural practices on the environment. *Environmental Impact Assessment Review* **2000**, *20*, 227–239.	production	agric. sc.
Goldberger, J.R. Conventionalization, civic engagement, and the sustainability of organic agriculture. *J. Rural Stud.* **2011**, *27*, 288–296.	food system	agric. sc.
Goldman, A. Threats to sustainability in African agriculture: Searching for appropriate paradigms. *Hum. Ecol.* **1995**, *23*, 291–334.	production	interdisc.
Gómez-Limón, J.A.; Sanchez-Fernandez, G. Empirical evaluation of agricultural sustainability using composite indicators. *Ecol. Econ.* **2010**, *69*, 1062–1075.	production	econ.
Goodland, R. Environmental sustainability in agriculture: diet matters. *Ecol. Econ.* **1997**, *23*, 189–200.	food system	interdisc.
Goodwin, N.R. Lessons for the world from US agriculture: Unbundling technology. *World Dev.* **1991**, *19*, 85–102.	production	interdisc.
Hermans, F.; Horlings, I.; Beers, P.J.; Mommaas, H. The Contested Redefinition of a Sustainable Countryside: Revisiting Frouws' Rurality Discourses. *Sociol. Ruralis* **2010**, *50*, 46–63.	food system	soc. & pol. sc.
Hermans, F.; Kok, K.; Beers, P.J.; Veldkamp, T. Assessing Sustainability Perspectives in Rural Innovation Projects Using Q-Methodology. *Sociol. Ruralis* **2012**, *52*, 70–91.	food system	soc. & pol. sc.
Herndl, C.G.; Goodwin, J.; Honeycutt, L.; Wilson, G.; Graham, S.S.; Niedergeses, D. Talking Sustainability: Identification and Division in an Iowa Community. *J. Sustain. Agric.* **2011**, *35*, 436–461.	production	human.

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Reference	Focus	Discipline
Journal Articles		
Hill, S.B. Redesigning agroecosystems for environmental sustainability: a deep systems approach. *Syst. Res. Behav. Sci.* **1998**, *15*, 391–402.	production	soc. & pol. sc.
Hiranandani, V. Sustainable agriculture in Canada and Cuba: a comparison. *Environ. Dev. Sustain.* **2010**, *12*, 763–775.	supply chain	soc. & pol. sc.
Horlings, I. Policy conditions for sustainable agriculture in the Netherlands. *Environmentalist* **1994**, *14*, 193–199.	supply chain	soc. & pol. sc.
Huang, S.-M. The articulation of culture, agriculture, and the environment of Chinese in northern Thailand. *Ethnology* **2005**, *44*, 1–11.	production	human.
Hyberg, B.; Setia, P. Economic and environmental tradeoffs in agricultural sustainability: A Perspective. *Int. Adv. Econ. Res.* **1996**, *2*, 41–46.	production	econ.
Ikerd, J. Sustainable Capitalism: A Matter of Ethics and Morality. *Probl. Ekorozw.* **2008**, *3*, 13–22.	food system	econ.
Izac, A.-M.N.; Swift, M.J. On agricultural sustainability and its measurement in small-scale farming in sub-Saharan Africa. *Ecol. Econ.* **1994**, *11*, 105–125.	production	agric. sc.
Johnson, R.B. Sustainable agriculture: Competing visions and policy avenue. *Int. J. Sustain. Dev. World Ecol.* **2006**, *13*, 469–480.	food system	interdisc.
Kaltoft, P. Values about Nature in Organic Farming Practice and Knowledge. *Sociol. Ruralis* **1999**, *39*, 39–53.	production	econ.
Karami, E.; Mansoorabadi, A. Sustainable agricultural attitudes and behaviors: a gender analysis of Iranian farmers. *Environ. Dev. Sustain.* **2008**, *10*, 883–898.	production	soc. & pol. sc.
Kasem, S.; Thapa, G.B. Sustainable development policies and achievements in the context of the agriculture sector in Thailand. *Sustain. Dev.* **2012**, *20*, 98–114.	food system	eng.& nat. sc.
Kloppenburg Jr., J.; Lezberg, S.; De Master, K.; Stevenson, G.W.; Hendrickson, J. Tasting food, tasting sustainability: Defining the attributes of an alternative food system with competent, ordinary people. *Hum. Org.* **2000**, *59*, 177–186.	food system	soc. & pol. sc.
Knight, C. Sustainable cocoa program. *Plant. Rech. Dev.* **1998**, *5*, 387–392.	supply chain	agric. sc.
Koohafkan, P.; Altieri, M.A.; Gimenez, E.H. Green Agriculture: foundations for biodiverse, resilient and productive agricultural systems. *Int. J. Agric. Sustain.* **2012**, *10*, 61–75.	food system	agric. sc.
Lancker, E.; Nijkamp, P. A policy scenario analysis of sustainable agricultural development options: A case study for Nepal. *Impact Assess. Proj. Apprais.* **2000**, *18*, 111–124.	production	econ.
Lee, D.R. Agricultural Sustainability and Technology Adoption: Issues and Policies for Developing Countries. *Am. J. Agric. Econ.* **2005**, *87*, 1325–1334.	production	econ.
Legg, W.; Viatte, G. Farming systems for sustainable agriculture. Available online: http://www.oecdobserver.org/news/archivestory.php/aid/508/Farming_systems_for_sustainable_agriculture.html (accessed on 15 June 2015)	supply chain	soc. & pol. sc.
Lehman, H.; Clark, E.A.; Weise, S.F. Clarifying the definition of Sustainable agriculture. *J. Agric. Environ. Ethics* **1993**, *6*, 127–143.	production	human.
Levidow, L.; Birch, K.; Papaioannou, T. EU agri-innovation policy: two contending visions of the bio-economy. *Crit. Policy Stud.* **2012**, *6*, 40–65.	food system	soc. & pol. sc.
Liepins, R. Women in agriculture: advocates for a gendered sustainable agriculture. *Aust. Geogr.* **1995**, *26*, 118–126.	production	interdisc.

Table S1. *Cont.*

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Lin, Z.; Zoebisch, M.A. Resource use and agricultural sustainability: Risks and consequences of intensive cropping in China. *J. Agric. Rural Dev. Trop. Subtrop. Suppl.* **2006**, *86*, 1–204.	production	agric. sc.
López-Aguilar, R.; Rodríguez-Quezada, G.; Naranjo-Murillo, A.; Beltrán Morales, L.F.; Troyo-Diéguez, E.E.; Casanova-Cruz, A.; Peralta-Patrón, O.; Troyo-Diéguez, E.E. Uso de yeso para una agricultura orgánica sustentable en zonas áridas y semiáridas. *Indian J. Dryland Agric. Res.* **2012**, *37*, 594–601.	production	eng.& nat. sc.
MacRae, R.J.; Henning, J.; Hill, S.B. Strategies to overcome barriers to the development of sustainable agriculture in Canada: The role of agribusiness. *J. Agric. Environ. Ethics* **1993**, *6*, 21–51.	production	econ.
Manuel-Navarrete, D.; Gallopín, G.C. Feeding the world sustainably: knowledge governance and sustainable agriculture in the Argentine Pampas. *Environ. Dev. Sustain.* **2012**, *14*, 321–333.	production	interdisc.
Matson, P.A.; Parton, W.J.; Power, A.G.; Swift, M.J. Agricultural Intensification and Ecosystem Properties. *Science* **1997**, *277*, 504–509.	production	eng. & nat. sc.
Maxey, L. Can we sustain sustainable agriculture? Learning from small-scale producer-suppliers in Canada and the UK. *Geogr. J.* **2006**, *172*, 230–244.	food system	interdisc.
Meares, A.C. Making the Transition from Conventional to Sustainable Agriculture: Gender, Social Movement Participation, and Quality of Life on the Family Farm1. *Rural Sociol.* **1997**, *62*, 21–47.	production	soc. & pol. sc.
Michelsen, J. Organic Farming in a Regulatory Perspective. The Danish Case. *Sociol. Ruralis* **2001**, *41*, 62–84.	food system	soc. & pol. sc.
Minarovic, R.E.; Mueller, J.P. North Carolina Cooperative Extension Service Professionals' Attitudes Toward Sustainable Agriculture. *J. Ext.* **2000**, *38*, Article 1.	production	soc. & pol. sc.
Morse, S.; McNamara, N.; Acholo, M. Soils, souls and agricultural sustainability: The need for connection. *Int. J. Sustain. Dev.* **2004**, *7*, 410–432.	production	interdisc.
Mouysset, L.; Doyen, L.; Jiguet, F.; Allaire, G.; Leger, F. Bio economic modeling for a sustainable management of biodiversity in agricultural lands. *Ecol. Econ.* **2011**, *70*, 617–626.	production	eng. & nat. sc.
Nousiainen, M.; Pylkkänen, P.; Saunders, F.; Seppänen, L.; Vesala, K.M. Are Alternative Food Systems Socially Sustainable? A Case Study from Finland. *J. Sustain. Agric.* **2009**, *33*, 566–594.	food system	soc. & pol. sc.
Ogaji, J. Sustainable Agriculture in the UK. *Environ. Dev. Sustain.* **2005**, *7*, 253–270.	food system	human.
Onwueme, I.C.; Borsari, B.; Leal Filho, W.D.S. An analysis of some paradoxes in alternative agriculture and a vision of sustainability for future food systems. *Int. J. Agric. Resour. Gov. Ecol.* **2008**, *7*, 199–210.	food system	eng. & nat. sc.
O'Riordan, T.; Cobb, D. Assessing the Consequences of Converting to Organic Agriculture. *J. Agric. Econ.* **2001**, *52*, 22–35.	supply chain	interdisc.
Paoletti, M.G.; Pimentel, D. The environmental and economic costs of herbicide resistance and host-plant resistance to plant pathogens and insects. *Technol. Forecast. Soc. Chang.* **1995**, *50*, 9–23.	production	eng. & nat. sc.

Table S1. *Cont.*

Reference	Focus	Discipline
Journal Articles		
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Grey Literature		
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Table S2. Description of the categories of the sustainable agriculture framework.

Category	Description
Goals	
Overarching Goals	
Ethics	Summarizes all statements that point out that those values that are broadly considered to be morally good have to be upheld and followed also in Sustainable Agriculture. Among these, the frequently mentioned values are stewardship, humaneness, solidarity, respecting human rights and priority of needs instead of greed. *"[H]umaneness to animals is an important, positive aspect of sustainable animal and mixed farming."* [1] "*Vorley (2002) defined agricultural sustainability as not only economic sustainability but also environmental, social and ethical sustainable sustainability."* [2]
Multifunctionality	Summarizes all statements that point out that Sustainable Agriculture has to perform a variety of functions from different areas/dimensions simultaneously (see category group "goals" to see which functions it has to perform: production of food, environmental protection, providing income, *etc*.). *Sustainable agriculture is "one that is purposefully multifunctional and highly productive …"* [3] *"[S]ustainability is visualised as the ability of agriculture to fulfil simultaneously a range of desirable objectives"* [4]
Safety	Summarizes all statements that call for Sustainable Agriculture to be of low or no risk to life and health of humans, animals and the environment in general. There should also be no risk to the economic situation of stakeholders. *"An international Working Group (Smyth & Dumanski 1993) has viewed maintenance or enhancement of productivity, reduced risk, … essential condition for sustainable land management"* [5] *"In industrialized country contexts, the challenges relate more to reducing costs, improving food safety, environmental amenities and nutritional values (World Bank 2008)."* [6]
Stability & Resilience	Summarizes all statements that point out that for Sustainable Agriculture agrifood systems or parts of them have to fulfill its functions in a reliable way, by being resistant to or by recovering quickly from shocks and disturbances and continuing for a long time. *"Sustainability in agricultural systems is viewed in terms of resilience (the capacity of systems to buffer shocks and stresses) and persistence (the capacity of systems to carry on)"* [7] *"In the agri-ruralist discourse, sustainability is directly linked to the family farm scale and, more specifically, to the continuity of the farm."* [8]

Table S2. *Cont.*

Category	Description
	Goals
Environmental Goals: Production-Specific	
Ecological Soundness	Summarizes all statements that point out that that Sustainable Agriculture must be environmentally or ecologically friendly in a physical sense. (This category is part of both the group "Environmental Goals: Production-Specific" and "Environmental Goals: Non-Production-Specific") *"Discussions of sustainable agriculture frequently define it as 'ecologically sound, economically viable, and socially just,' or some variant on that phrase."* [1] *"[S]ustainable agricultural systems use 'the best available technology' in a balanced, well-managed, and environmentally responsible manner (Hess 1991)."* [9]
Ecosystem Function Conservation	Summarizes all statements that emphasize that sustainable agriculture has to maintain the biological processes that sustain ecosystems and generate ecosystem services and benefits. Both this category and the category "Natural Resource Conservation" are actually components of the category "Productive Capacity". They are kept as separate categories here, however, because they are mentioned very frequently in the examined literature and thus seem to be of great significance on their own. Having SAID that, it is worthwhile to assess differences in the significance of these categories, which would not be possible if they were incorporated into the overarching category "Productive Capacity". *"As a consequence, a crucial component of sustainability, as defined in terms of the resilience of an agricultural system to external stresses and shocks, is maintaining the environmental resources and ecological functions upon which the system depends."* [10] *"We define sustainable agriculture as practices that meet current and future societal needs for food and fibre, for ecosystem services, …"* [11]
Natural Resource Conservation	Summarizes all statements that point out that Sustainable Agriculture has to conserve the natural resources, which agricultural production depends on. *"sustainable agriculture involves the use of natural resources to satisfy changing human needs while maintaining or enhancing the natural resource base and avoiding environmental degradation (Firebaugh, 1990)."* [12] *"The main goals in sustainable agriculture are natural resources protection and improvement …"* [13]
Productive Capacity	Summarizes statements that emphasize that Sustainable Agriculture has to maintain the ability of agricultural systems to produce. *"sustainable agriculture is defined as any collection of agricultural practices which leaves the productive potential of the resource base at least as great as it was when those practices were initiated."* [14] *"Altieri (1989) defines sustainable agriculture as a system which should aim to maintain production in the long run…"* [15]

Table S2. *Cont.*

Category	Description
	Goals
Environmental Goals: Non-Production-Specific	
Ecological Soundness	Summarizes all statements that point out that that Sustainable Agriculture must be environmentally or ecologically friendly in a physical sense. (This category is part of both the group "Environmental Goals: Production-Specific" and "Environmental Goals: Non-Production-Specific") *"[A] sustainable agriculture must be ecologically sound, economically viable, and socially just (Ikerd 1992)"* [16] *"WWF is concerned with promoting sustainable agriculture, which is defined as ensuring the production of safe, affordable and healthy food and fibre in ways that are ecologically responsible, economically viable and socially equitable."* [17]
Animal Well-Being	Summarizes all statements that point out that Sustainable Agriculture has to ensure the general health and happiness of animals, especially of farm animals. This includes, for example, living conditions and diet appropriate to the needs of the animals or a treatment that does not cause harm or suffering to the animals. *"Sustainable agriculture is a way of raising food that is healthy for consumers and animals…"* [18] *"To be sustainable in the short term, cattle production systems must fulfil the requirements of … minimum divergence from the welfare needs of the cattle."* [19]
Env Conservation and Improvement	Summary of all statements that call for the improvement or protection of the physical components of the space in which people, animals and plants live from (further) deterioration. Here, "environmental conservation" refers to the environment at large, in its importance for society as a whole. *"Sustainable agriculture is defined as successful management of the resources of agriculture to satisfy changing human needs, to conserve the environment and increase biological resources (Karami and Mansoorabadi, 2008)."* [20] *"Nature and biodiversity are protected and enhanced."* [21]
Harmony with Nature	Summarizes all statements that argue that Sustainable Agriculture has to be based on an attitude of care for and peaceful existence with and within nature. Also contains those statements that even claim that nature should be placed at the center of all considerations for sustainable agriculture (ecocentrism). *"[M]otives to work within the natural order appear to allow the concept of sustainable agriculture to exist."* [22] *"Alternative ideologies, such as those of organic agriculture, focus on the values underlying a vision of sustainability based on the preservation of an idyllic agrarian way of life: harmony with nature…"* [4]
Social Goals	
Social Responsibility	Summarizes all statements that emphasize that Sustainable Agriculture has to be carried out in a way that it benefits society at large and statements pointing out that sustainable agriculture has to be possible and livable for people working and living with it. *"Sustainable agriculture seeks to achieve three main goals: economic efficiency, environmental quality and social responsibility."* [23] *"A desirable end-point for both modern and pre-modern agricultural systems is clearly some design that enhances … the public benefits through other functions."* [24]

Table S2. *Cont.*

Category	Description
	Goals
Acceptability	Summarizes statements arguing that Sustainable Agriculture has to be socially acceptable. *"A major pre-requisite for attaining sustainable agricultural development … is the formulation of appropriate renewable resource management policies which are supported by the farming communities and to which they are willing and able to respond (World Bank 1988, Odemerho 1992)"* [25] *"[E]nsure that the resulting farm practice is acceptable to the balance of aesthetic tastes."* [26]
Cultural Preservation	Summarizes all statements that emphasize that Sustainable Agriculture has to contribute to the preservation and enhancement of customs and beliefs, arts and aesthetics, way of life and forms of social organization in the rural space. *"At the local level, agricultural sustainability is associated with … promotion of local institutions, culture and farming communities."* [7] *"[T]he three corner stones of sustainable agriculture … rest upon a foundation of inter-generational equity which in turn has its foundation in human spirituality."* [15]
Equity, Justice, Fairness	Summarizes all statements that point out that in and for Sustainable Agriculture, everybody has to be treated in a morally right way that does not favor one person over another. *"Cai and Smith (1994) have also suggested that agricultural sustainability should be assessed from the perspectives of ecological soundness, social acceptability and economic viability. […]'[S]ocial acceptability' refers to self-reliance, equality and improved quality of life"* [27] *"[T]he three corner stones of sustainable agriculture … rest upon a foundation of inter-generational equity"* [15]
Fulfillment of Human Needs	Summarizes all statements that contend that it is one goal of Sustainable Agriculture to fulfill human needs in the present and the future. *"Sustainable agriculture is defined as successful management of the resources of agriculture to satisfy changing human needs"* [20] *"Sustainable agriculture … must be capable of meeting the needs of the present without compromising the future."* [28]
Good Working Conditions	Summarizes all statements that claim that Sustainable Agriculture has to provide such work conditions that those who are occupied with it can continue working in agriculture for a long time. *"Policies and programs are needed to address this problem, working toward socially just and safe employment that provides adequate wages, working conditions …"* [29] "*Workers are treated fairly and paid competitive wages and benefits. They work in a safe environment and are offered proper living conditions and food."* [18]
Human Health	Summarizes statements that point out that Sustainable Agriculture has to ensure the protection and enhancement of the physical well-being of all people that get into contact with agriculture and its products. *"ensure the health of workers, rural populations and consumers"* [30] *"Agriculture policy and investment will be smarter to focus on improved human health and access to nutrition, and not only on increasing food supply."* [31]

Table S2. *Cont.*

Category	Description
	Goals
Nourishment	Summarizes all statements arguing that Sustainable Agriculture has to provide sufficient amounts of food that supports human health at all times and to all people. *"this paradigm has the backing of industry, and according to its advocates, no other form of agriculture could possibly feed the world—unarguably a vital prerequisite for an agricultural system claiming to be sustainable."* [32] *"Sustainable agriculture is fundamentally necessitated by the need to satisfying human food needs, which is to responsibly produce sufficient nutritious food to ensure food security."* [33]
Quality of Life	Contains all statements that call for Sustainable Agriculture to provide self-fulfillment and a good quality of life, especially for those individuals involved in agriculture but also for society in general. More exactly, sustainable agriculture should contribute to "a good, happy human life […] a life well lived, a life that is deeply satisfying, fruitful, and worthwhile" [34]. *"We also identified two other elements as critical parts of these women's alternative agriculture paradigm: quality family life and spirituality."* [35] *"[U]rban gardens allow residents of inner areas to experience the joy and satisfaction of producing nutritious food in their own neighborhoods."* [36]
Strong Communities	Summarizes all statements that argue that Sustainable Agriculture has to strengthen rural communities in their social relations and organization. *"The main goals in sustainable agriculture are … empowering of socioeconomic structure of rural communities (Shepherd, A. 1998)."* [13] *"Sustainable agriculture is contrasted with market-driven economic growth in that it is explicitly concerned with "normative" values such as … cohesive rural communities (Pretty 1995, 1)."* [37]
Economic Goals	
Economic Viability	Summarizes all statements that point out that Sustainable Agriculture also has to be able to be carried out and continued from an economic point of view. This implies that Sustainable Agriculture should be, among other things productive, competitive and profitable. *"Another perspective on economic sustainability in agriculture focuses on the economic performance and viability of farming."* [38] *"[A]griculture is not sustainable unless it is profitable."* [39]
Development	Summarizes all statements that point out that a Sustainable Agriculture has to contribute to the improvement of economic and living conditions of people, especially in the rural areas. *"Rao and Rogers (2006) defined sustainable agriculture as a practice that meets current and long-term needs … of society while maximizing net benefits through the conservation of resources to maintain … long-term human development."* [2] *"[I]ntegrate the concept of agricultural sustainability into poverty reduction"* [7]
Livelihood	Summarizes all statements that argue that Sustainable Agriculture has to provide the basis of sustentation for farmers, rural workers and their respective families. *"The Food and Agricultural Organisation (FAO) of the United Nations has tried to offer a more specific description of sustainable agricultural as a development path in which resource use and environmental management are combined with … secure livelihoods"* [40] *"But no matter how elegant the system or how accomplished the farmer, no agriculture is sustainable if it's not also … able to provide a healthy family income"* [41]

Table S2. *Cont.*

Category	Description
	Goals
Provision of Products	Summarizes all statements that state that sustainable agriculture has to produce different material and immaterial outputs (food, fibers, fuels, medicine, services...). Although a great amount of the statements summarized in this category calls for the production of food, this category is different from the category of nutrition. The production of food is a necessary but not a sufficient condition for guaranteeing the nutrition of all people and some authors alert that more attention should be paid to better nutrition (*i.e.*, better quality, diversity and distribution of the food) rather than to merely increasing absolute food production (e.g., [31]). *"[A] cropping system is sustainable if it has an acceptable level of production of harvestable yield"* [42] *"A 'dark green' approach to sustainability suggests priorities for agricultural systems that help to build important natural and social assets whilst producing more food."* [7]
Thriving Economy	Summarizes all statements emphasizing that Sustainable Agriculture has to support a thriving economy in the rural space, *i.e.*, an economy that generates for example employment, growth and well-going rural businesses. *"Economic development policies are needed that encourage more diversified agricultural production on family farms as a foundation for healthy economies in rural communities."* [29] *"This argument is also supported by Pretty et al. (2008), where the authors indicate that the best approach to analysing agricultural sustainability is to assess it through the lens of economic growth, environmental protection and social progress."* [2]
	Strategies
Adaptive Management	
Adaptation	Summarizes all statements that indicate that all strategies and practices for Sustainable Agriculture have to be able to exist and be used in the context of the specific natural, social, economic, political, cultural etc. conditions of a specific spatial and temporal situation without causing problems. *"[F]or agriculture to be sustainable it must be compatible with the socio- political environment within which it operates."* [38] *"[P]romoting agricultural sustainability may demand strengthened coevolutionary processes on the local level"* [43]
Learning	Summarizes all statements that emphasize that Sustainable Agriculture requires learning by agricultural stakeholders, especially joint/social learning. *"A central principle about sustainable agriculture is that it must enshrine some of these new ways of learning about the world."* [44] *"The transition to sustainable agriculture, therefore, needs networks of farmers who can jointly engage in learning and experimentation."* [45]
Management, Integration & Redesign	Summarizes all statements that emphasize that Sustainable Agriculture has to be based on complex management, *i.e.*, handling production and other agriculture-related activities rather by finding alternative ways of organizing the systems (redesign) as well as using a variety of techniques and approaches (integration) than by applying solutions that appear simple but lead to problems themselves (e.g., to control pests, rather apply a complex and diversified crop rotation system than pesticides). *"Sustainable agriculture … emphasizes design and management procedures that work with natural processes"* [46] *"Sustainable agriculture requires integrated, but not unitary, policy measures."* [26]

Table S2. *Cont.*

Category	Description
	Strategies
Prevention	Summarizes all statements that emphasize that for Sustainable Agriculture, problems have to be anticipated and their occurrence avoided, which also requires accounting for uncertainties. *"Thereafter, we define … two characteristics of sustainable agricultural systems: 'prevention' and 'direct marketing"* [47] *"[A]ppropriate resource use in sustainable agriculture should be rationalised in a manner which considers … unanticipated problems."* [33]
Substitution	Summarizes all statements that argue that for Sustainable Agriculture, the use of unsustainable technologies, resources, approaches etc. has to be replaced by the application of more sustainable ones. *"In sustainable agricultural systems, there is … a substitution of renewable sources or labor to the extent that is economically feasible."* [29] *"Shallow sustainability focuses on efficiency and substitution strategies"* [48]
Cooperation	
Collaboration & Communication	Summarizes all statements that call for enhanced and improved social interaction among and between the different agricultural stakeholder groups in the sense of exchange, coordination and joint action in order to realize Sustainable Agriculture. *"The cultural basis of sustainability means accommodating to the interests of all relevant stakeholders in such a way that neighbouring farms co-ordinate management practices"* [26] *"Second, we need to put in place a supportive policy and governance environment, which enhances social capital and knowledge exchange (Pretty et at. 2011)."* [49]
Participation	Summarizes all statements which point out that Sustainable Agriculture requires that agricultural stakeholders have a greater say in relevant decisions. *"Local efforts to enhance political participation must therefore be part of sustainable agricultural strategies"* [50] *"It is important from a democratic point of view that farmers have a voice in formulating the long-term development of the agricultural sector, and in the process of political decision making."* [51]
Ecology-based Strategy	
Diversification	Statements that call for the maintenance and enhancement of variety in many different aspects of Sustainable Agriculture such as species, varieties and breeds of domesticated plants and animals; products and production activities; sources of income; technologies; etc. *"Diversification in this context should therefore imply not only a diversification of crops … but also a diversification of other farm management skills and socio-institutional resources"* [50] *"Farmers and ranchers can boost their financial sustainability by using a greater diversity of marketing techniques"* [52]
Ecological Principles	Summarizes all statements that claim that Sustainable Agriculture has to respect and apply principles of ecosystem functioning. *"In practice this means, that the ecological farmer in order to design sustainable systems is an imitator of nature."* [47] *"They attempt to develop a sustainable system for food production and consumption, based on the idea of the farm as a … self-regulating … whole"* [53]

Table S2. *Cont.*

Category	Description
	Strategies
Economics-based Strategy	
Capital Asset Maintenance	Summarizes all statements that point out that sustainable agriculture has to strive for such a use of all kinds of capital assets (natural, social, human, *etc*.) that allows their conservation or even enhancement instead of their (mere) consumption. *"This suggests that maintaining 'environmental capital' is at least a condition of sustainability."* [10] *"Most attention tends to be given to the* environmental *dimension, including the reproduction of natural capital."* [54]
Demand-Orientation	Summarizes all statements emphasizing that production and resource use have to be according to actual demand in Sustainable Agriculture. *"In a soil fertility context, sustainable agriculture seeks to maintain the balance between nutrients being removed by crops or animal produce and inputs from fertilisers and nutrient recycling."* [39] *"Sustainable Agriculture has to … produce adequate quantities of good quality, safe food"* [55]
Efficiency	Summarizes all statements that emphasize that Sustainable Agriculture - and especially its production - has to be carried out well without wasting any kind of resources. *"This goal requires an efficient use of technology in a manner conducive to sustainability."* [15] *"Sustainable agriculture in the utilitarian discourse is defined well within the limits of the market. The foremost concerns are cost-price efficiency"* [8]
Quality-Orientation	Summarizes all statements that emphasize that Sustainable Agriculture has to be quality-oriented, especially regarding its products. *"Sustainable agriculture produces diverse forms of high quality foods, fibers and medicines."* [48] *"To be sustainable, a farm must produce adequate yields of high quality"* [56]
Holistic & Complex Systems Thinking	
Long-Term Perspective	Summarizes all statements emphasizing that a long-term perspective needs to be taken in considerations for Sustainable Agriculture. *"With a view to the emphasis on the need for long term planning under the rubric of sustainability"* [57] *"In the agricultural context this view seeks to balance long term agricultural sustainability with economic viability, reduction of environmental harm, and fulfilling public demands for food and landscape benefits derived from agriculture."* [58]
Scale-Sensitivity	Summarizes all statements that draw attention to the necessity of considering causes and effects on all relevant scales and choosing an appropriate scale for analysis and action for Sustainable Agriculture. *"Technology matters most if it is affordable and if it is appropriate to scale and conditions."* [31] *"Landscape-scale management holds significant potential for reducing off-site consequences of agriculture."* [11]
Systemic Thinking	Summarizes all statements that emphasize that Sustainable Agriculture needs systemic approaches and thinking, *i.e*., being holistic and considering the various interdependencies, dynamics and interactions between the components of agricultural or agrifood systems. *"The essentials are seeing the land a living system"* [59] *"Hilistic [sic!] thinking in planning and execution of all aspects of sustainable agriculture; i.e., a systems approach."* [60]

Table S2. *Cont.*

Category	Description
	Strategies
Knowledge & Science	
Innovation	Summarizes all statements that express that Sustainable Agriculture has to build on new, alternative and improved approaches and statements calling for (technological, political...) change. *"Sustainability needs perpetual novelty and adaptive performance."* [45] *"Successful sustainable farming futures are seen to be dependent on … significant changes in the wider economic, social and institutional environment (Pierce, 1996: 228)."* [26]
Modern	Summarizes all statements that argue in favor of the application of knowledge, methods and achievements of modern times and science for Sustainable Agriculture. *"Sustainable agriculture … calls for a cautious blending of traditional and modern farm practices"* [37] *"Sustainable intensification via smart inputs from lab knowledge"* [61]
Traditional	Statements arguing that Sustainable Agriculture requires the application of traditional and indigenous knowledge, methods and practices. *"Sustainable agriculture … calls for a cautious blending of traditional and modern farm practices"* [37] *"Maximum use of internal resources, including indigenous knowledge and practices"* [27]
Subsidiarity	
Decentralization	Summarizes all statements that claim that Sustainable Agriculture has to be organized in a less centralized and concentrated way, which also implies smaller units. *"[I]t is also consistent with one of the core philosophical principles of sustainable agriculture, namely, the need for dispersed production"* [62] *"[A]lternative agriculturalists advocate smaller farm units and technology"* [63]
Independence	Summarizes all statements that argue that systems of Sustainable Agriculture should be (more) independent, self-reliant, self-sufficient, autonomous etc. from various external economic factors. *"greater self-reliance for farmers and rural populations"* [2] *"Urban agriculture provides food security for urban residents by promoting self-sufficiency."* [36]
Local/Regional	Summarizes all statements that argue that Sustainable Agriculture requires a greater focus on and strengthening of the local and regional level. *"Off the farm, consumers and grassroots activists are working to create local markets and farm policies that support sustainable practices."* [41] *"From a sustainability framework, the optimum policy is to consume food that is produced as locally as possible' (Lang and Rayner 2002: 36)."* [32]
Fields of Action	
Agrifood System	
Consumption	Summarizes all statements that point out that patterns of leading our lives and consuming need to be adapted in order to achieve a Sustainable Agriculture. Also includes suggestions in which ways these patterns would have to be changed. *"On one hand. sustainable agriculture draws vitality from its being an expression of some strongly held values and concerns: … preferences for high-quality and healthy food"* [64] *"This view presupposes that future farming systems must accept these ecosystem-imposed limits on the number of people in the world and the lifestyle they can enjoy."* [58]

Table S2. *Cont.*

Category	Description
	Strategies
Production	Summarizes suggestions for ways in which agricultural production should be carried out in a Sustainable Agriculture, especially relating to the quantities that agriculture should produce to be sustainable. *"The products that are produced with sustainable agriculture are more diverse"* [65] *"A growing world population makes it necessary to increase food production"* [8]
Supply Chain	Summarizes all suggestions for improving and rearranging the supply chain (here used for all parts of the supply chain excluding agricultural production and consumption, which are treated in own categories as they gain special attention in the literature) in order to facilitate sustainable agriculture. "*Significantly reduce waste along the entire food chain."* [31] *"Sustainable farming … employs marketing practices that reduce the distance between production and consumption locations (Ritchie 1994)."* [66]
Management & Technological Solutions	
Crops & Livestock	Summarizes all statements that suggest that new types of crops and livestock as well as improved varieties and breeds of already used crops and animals are needed for Sustainable Agriculture. *"Crop varieties with enhanced resistance or tolerance to insect pests and crop pathogens."* [60] *"Use of local and improved crop varieties and livestock breeds"* [67]
Management Tools	Summarizes all statements that suggest the application of certain general management tools in decision making at all levels in order to achieve Sustainable Agriculture, e.g., indicators, monitoring, planning, decision-support tools etc. *"These decision-support tools are essential in guiding agriculture towards sustainability (Hansen. 1996)."* [68] *"A key element for any policy document aiming to ensure the transition towards sustainable agriculture is the setting of suitable goals, with clear targets and indicators to measure the progress towards sustainable agriculture (Bell and Morse 1999; Stevenson and Lee 2001)."* [32]
Resource Use	Summarizes all statements that suggest which kind of resources should be used in which way for Sustainable Agriculture. *"Self-sufficiency through preferred use of on-farm or locally available "internal" resources to purchased "external" resources"* [69] *"The upper end of the sustainability scale sees a sustainable approach to wool production as one that: … does not rely on oil or oil-derived chemicals (such as pesticides and artificial fertilisers); recycles and reuses resources, uses renewable energy sources"* [70]
Technology & Practices	Summarizes all statements that suggest which agricultural techniques and technologies should be used in which way in order to achieve Sustainable Agriculture. *"[T]here is no need for any Luddite abandonment of technology as part of sustainable agriculture."* [22] *"Avoid the unnecessary use of agrochemical and other technologies that adversely impact on the environment and on human health"* [67]
Social & Environmental Challenges	
Emission-Reduction	Summarizes statements that suggest that Sustainable Agriculture needs to reduce harmful emissions. *"Reduce the ecological footprint of production, distribution and consumption practices. Thereby minimizing GHG emissions and soil and water pollution."* [67] *"These approaches … are also less energy intensive and less polluting"* [71]

Table S2. *Cont.*

Category	Description
	Strategies
Global Trends	Summarizes all statements pointing out that realizing Sustainable Agriculture requires addressing and adapting to global development trends (such as population growth or climate change). *"While measures and policies need to be put in place to reduce gas emissions from the agricultural sector (e.g., more efficient farming practices, reduced input use), mitigation alone is not sufficient. There is a need to work on adaptation measures to reduce the vulnerability of the agricultural sector to climate change, as well as promote opportunities associated with climate change."* [17] *"A sustainable food production system must keep pace with increasing demands (domestic or global) for food, which are due to continued population increases and improvement in per capita income in less developed countries (Grigg, 1986; Crosson, 1992)"* [38]
Social & Human Capital	
Knowledge, Education, Skills	Summarizes all statements about use and improvement of knowledge, education and skills of farmers but also of consumers, policy makers, extension professionals etc. for Sustainable Agriculture. *"provide technical assistance and capacity-building for ministries of agriculture and natural resource management"* [7] *"ln other words, human capital on the farm (and knowing how to stimulate that capital) is of primary importance."* [23]
Organization	Summarizes all statements that call for better organization of agricultural stakeholders for cooperation and representation of their interests. *"Integral to this participation is strong organisation of the local peasantry."* [50] *"Since sustainable agriculture research and education is not 'business as usual,' research and Extension activities should include the following methodologies: … (c) networking, coalition building"* [72]
Research & Development	Summarizes all statements about the kind of research and development that is needed for Sustainable Agriculture. *"Reinforcing such analyses and examining forms of farming allowing for the joint sustainability of biodiversity and agricultural production require interdisciplinary research."* [73] *"We remain convinced that the question of the high labour cost for organic production can best be addressed in the long term through research."* [62]
Social, Political & Economic Environment	
Accessibility	Summarizes all statements that point out that it is necessary to provide access for everybody to means of production, marketing and distribution and to "life support" (especially food and water) in order to achieve the goals of Sustainable Agriculture. *"Conway and Barbier (1990) opined that farmers' access to appropriate knowledge, production inputs and commodity markets play influential roles in agricultural development."* [12] *"Clear tenure rights are necessary to promote equitable access to resources as well as sustainable management."* [6]
Economic System	Summarizes all suggestions for improving and rearranging the way economic activities are carried out and goods and services are valued. *"Sustainable agricultural development must be seen from a holistic perspective and more ecological economics principles need to be integrated into its practice."* [74] *"And it [sustainability] must be reinforced by market processes, such as pricing which reflects social and ecological costs of production and environmental values (Fairtrade Foundation, 2010)."* [59]

Table S2. *Cont.*

Category	Description
	Strategies
Infrastructure	Summarizes all statements that point out that Sustainable Agriculture needs an improved infrastructure (of various kinds) in rural spaces. *"Invest public resources in essential public goods, including innovation and infrastructure"* [6] *"Farmers in developing countries need … better agricultural infrastructure"* [75]
Investment	Summarizes statements about investments needed for the realization of Sustainable Agriculture from both private and public sources. *"[M]ore sustainable systems will call for much greater public investment at global, regional and national levels aimed at expanding research and extension to underpin the shift to more sustainable systems."* [6] *"These goals might be realised through farm structure expansions or technological investments."* [33]
Policy & Institutions	Summarizes all suggestions for kinds of policies that should be applied and changes in the policy and institutional environment in order to achieve Sustainable Agriculture. *"Fundamental shifts in institutions, policies and incentives will be required in the search for, and broad adoption of, sustainable agricultural practices"* [11] *"Sustainable agriculture needs … supportive external institutions"* [76]
Society	Summarizes all statements that express that Sustainable Agriculture requires broad support of society, in moral, financial and other ways. Also includes claims for a changed society (regarding its organization, thinking, underlying values and roles of individuals) as such a change is often the precondition for support for Sustainable Agriculture. *"[S]ustainable agriculture requires a commitment to changing public policies, economic institutions, and social values."* [29] *"Even so the successful implementation of alternative models of sustainable agriculture requires the support of a new soci.al contract. between farmers, food processors/retailers, consumers and the state."* [54]

Table S3. Strength of the presence of each theme in the different clusters measured as indicator value (measures the statistical alliance of the themes to the different clusters). The shades of grey indicate the strength of the presence of a theme in each cluster (white: 0.00 to 0.09, light grey: 0.10 to 0.14, dark grey: 0.15 to 0.29, black: 0.30 and higher).

Group	Theme	Indicator value					
		cl. 1	cl. 2	cl. 3	cl. 4	cl. 5	cl. 6
Goals	Economic	0.21	0.17	0.03	0.11	0.21	0.11
	Environmental: Non-Production-Specific	0.14	0.10	0.12	0.06	0.23	0.09
	Environmental: Production-Specific	0.18	0.15	0.04	0.07	0.21	0.12
	Overarching	0.12	0.24	0.01	0.14	0.24	0.01
	Social	0.20	0.15	0.06	0.07	0.21	0.09

Table S3. *Cont.*

Group	Theme	Indicator value					
		cl. 1	**cl. 2**	**cl. 3**	**cl. 4**	**cl. 5**	**cl. 6**
Strategies	Adaptive Management	0.01	0.15	0.05	0.05	0.25	0.16
	Co-operation	0.00	0.02	0.01	0.08	0.15	0.13
	Ecology-based	0.00	0.12	0.07	0.03	0.33	0.05
	Economics-based	0.09	0.16	0.01	0.00	0.22	0.29
	Holistic & Complex Systems Thinking	0.02	0.04	0.00	0.43	0.04	0.04
	Knowledge & Science	0.00	0.02	0.01	0.08	0.12	0.43
	Subsidiarity	0.00	0.02	0.06	0.16	0.30	0.08
Fields of Action	Agri-Food System	0.01	0.20	0.06	0.00	0.19	0.22
	Management & Technological Solutions	0.01	0.12	0.13	0.19	0.21	0.21
	Social & Environmental Challenges	0.00	0.00	0.06	0.02	0.10	0.16
	Social & Human Capital	0.00	0.01	0.01	0.10	0.22	0.38
	Social, Political & Economic Environment	0.01	0.04	0.01	0.08	0.23	0.33

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Article 2 'Fragmentation'

Collaboration or fragmentation? Biodiversity management through the common agricultural policy

Abstract

We argue that the current system of agri-environment management in the European Common Agricultural Policy is ineffective at conserving biodiversity in part because it promotes fragmentation instead of collaboration of actors, thus hindering coordinated biodiversity management. Actor fragmentation is reinforced by the Common Agricultural Policy (CAP) in three ways: (1) through targeting individual farmers; (2) by creating confusion around coordination roles for increasing numbers of actors; and (3) by failing to engage with barriers to collaboration among farmers. Our findings draw on empirical evidence collected through multi-stakeholder workshops in Germany and Sweden. Our argument adds a different dimension to accepted explanations for the ineffectiveness of CAP for biodiversity management. Traditionally, explanations have focussed on low levels of farmer uptake of relevant measures, or the lack of ecological knowledge informing such measures. The level of actor fragmentation identified here suggests that a fundamental rethink of farmland biodiversity management is needed. We propose a new research agenda to identify more effective governance approaches.

Keywords

Agri-environment schemes; conservation; ecosystem services; European Union; social-ecological networks; social network analysis.

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Collaboration or fragmentation? Biodiversity management through the common agricultural policy

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ABSTRACT

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1. Introduction

Agricultural and biodiversity policies in Europe face major challenges in managing farmland biodiversity. Biodiversity is declining across Europe's agricultural areas (Butchart et al., 2010; Kleijn et al., 2006). The EU has set a target of halting biodiversity loss, and restoring 15% of degraded ecosystems by 2020 (European Commission, 2011). However, intensification of agriculture across the EU continues to drive losses of semi-natural habitats and crop diversity (Firbank et al., 2008), resulting in a loss of landscape heterogeneity (Benton et al., 2003), species richness, and abundance of farmland species (Donald et al., 2001).

The Common Agricultural Policy (CAP) is the core policy instrument for agricultural development. Since 2000, the CAP has become a key framework for managing biodiversity in agricultural landscapes in Europe. Reforms in 2003 and 2013 refined biodiversity management measures with the aim of 'greening' the CAP (Hauck et al., 2014). The 2013 reform was widely communicated as seeking to promote environmental conservation, including biodiversity. Conservation outcomes were supposed to be enhanced through three routes: (1) cross compliance, whereby farmers only receive payments if they meet statutory management requirements, and their farm is in good environmental condition (pillar 1); (2) "greening payments" obliging farmers to fulfil three basic requirements (growing at least 2–3 different crops; having 5% of their land holdings as ecological focus areas (EFAs); and maintaining the amount of permanent grassland) (pillar 1); and (3) voluntary participation in agri-environment schemes, whereby farmers receive payments to offset the extra cost of implementing environmentally friendly management actions, e.g. installing hedges (pillar 2). However, the effectiveness of the most recent reform for biodiversity conservation has been questioned (Pe'er et al., 2014). Indeed, earlier conservation measures also had equivocal outcomes (Kleijn et al., 2006), failing to demonstrate increases in biodiversity (Batáry et al., 2015).

Traditionally, responses to the biodiversity failings of the CAP have focussed on issues of uptake of the voluntary measures within pillar 2. Uptake of agri-environment schemes by farmers is higher for the simpler management actions, resulting in limited posi-

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tive biodiversity outcomes (Davey et al., 2010). The more complex or difficult components are less popular, prompting research into motivation factors for uptake (e.g. Morris et al., 2000; Wilson and Hart, 2000). Uptake of agri-environment schemes tends to be geographically skewed towards areas where implementation is less costly for farmers, but where they also are less effective (Rundlöf and Smith, 2006). For example, uptake is lower in intensive areas where such interventions may be most necessary to protect biodiversity (Kleijn and Sutherland, 2003). In response, ideas have been put forward to shift pillar 2 payment schemes to being results-based rather than action-based (Reed et al., 2014).

In this article we explore how CAP facilitates (or impedes) actor collaboration for biodiversity management. Although biodiversity management at the farm scale has positive effects, biodiversity outcomes of agri-environment schemes are widely agreed to be improved when implemented across a landscape scale (e.g. Dallimer et al., 2010; Rundlöf et al., 2010). For example, by coordinating installation of landscape features, gains are made by improving the overall landscape matrix and habitat connectivity (Donald and Evans, 2006), and by increasing landscape complexity (Concepción et al., 2008). Thus landscapes can be managed for more wide-ranging species, or species that need heterogeneity across the landscape (e.g. Dorresteijn et al., 2015). At present, mismatches are common between the spatial scale of management (generally field or farm scale), and the scale of ecological processes that often span entire landscapes (Pelosi et al., 2010). Researchers have therefore advocated for collaboration, whereby farmers actively engage with each other to manage biodiversity (after Prager, 2015). Such collaboration would facilitate communication and negotiation between land managers (Prager et al., 2012). This is not to say that collaboration will automatically lead to better biodiversity outcomes; for example groups of farmers collaborating could conceivably lead to similar land use or land management choices and therefore decreased landscape heterogeneity. But well-managed collaboration offers an opportunity to facilitate more coordinated landscape scale management, thereby improving biodiversity outcomes (Prager et al., 2012; Young et al., 2013).

In this paper, we argue that CAP's effectiveness at delivering biodiversity benefits is limited at least partly because both pillars entrench actor fragmentation, defined here as farmers working in isolation to manage biodiversity at the individual farm scale. It should be noted that we do not argue that CAP initiated patterns of fragmentation; rather that by failing to facilitate collaboration, and by failing to engage with barriers to collaboration, it reinforces actor fragmentation in the system. Some researchers have examined models of collaboration in agricultural landscapes (e.g Prager, 2015), and examples of collaboration certainly exist (e.g. Steingröver et al., 2010). In particular, CAP at the EU level allows for the possibility of collaborative management and good practice examples are emerging, particularly in the Netherlands, demonstrating benefits to farmers and biodiversity (Franks and Mc Gloin, 2007). However, such examples are isolated and relate to voluntary pillar 2 schemes, meaning that there is no compulsion to collaborate. Indeed, whether or not CAP really facilitates collaboration will depend on how it is implemented in member states, and making collaboration possible still falls short of actively facilitating it.

Our paper takes a novel approach to examining collaboration by looking at the entire governance system surrounding CAP. Other authors have researched solutions to actor fragmentation by exploring collective payments as a way to improve biodiversity management. However, these have focussed on determining payment levels and types of 'collective' payment, and may in fact show negative impacts of payments through crowding-out social norms of collective action (Midler et al., 2015; Narloch et al., 2012). We take a different perspective by empirically assessing what collaboration exists in agricultural landscapes, and considering how the CAP (pillars 1 and 2) enhances or impedes collaboration. We draw on empirical findings from Saxony (Middle-Saxon Plateau) and Lower Saxony (Southern Oldenburg) in Germany, and Scania in Sweden. All three regions have relatively intensive agricultural land use and thus represent ideal locations in which to promote collaborative management, but differ in their approaches to implementing the CAP. In Germany, implementation varies between federal states (Prager and Freese, 2009), whereas Sweden implements CAP at the national level. By examining three different implementation contexts we were able to explore if differences in implementation resulted in different impacts of CAP on emerging patterns of collaboration. Our findings highlight three ways in which the CAP promotes actor fragmentation, suggesting an urgent need to radically re-design agri-environment policy.

2. Methods

2.1. Conceptual framework

To examine how CAP facilitates or impedes actor collaboration, we draw on conceptualisations of social and ecological connectivity. Bodin and Tengö (2012) outlined a range of motifs, or structures of social-ecological systems, drawing on social network theories that depict interdependencies between social actors and ecological resources. They consider the theoretical construct of two social actors and two ecological resources, and the different ways in which these four nodes could be linked. Kininmonth et al. (2015) argued for an optimal motif (Fig. 1) – in this, there is maximum connectivity between all nodes, facilitating coherence between social and ecological processes. A fifth node is present as a coordinating actor, who links the social actors managing ecological resources.

Drawing on these motifs, we created a conceptual framework of an idealised, landscape-scale system to manage farmland biodiversity (Fig. 1; Table 1). In this system, the two social nodes are farmers. Each influences (and cares for) the biodiversity (ecological resource) on her or his own farm. However, the biodiversity on one farm is also influenced by the management of the neighbouring farm. For example, the biodiversity management of farmer A to increase pollinators on his/her land is more effective if farmer B has strategically placed flower strips on his/her land. Therefore, greater biodiversity outcomes are possible when both farmers work together and also have influence on each other's biodiversity management. To facilitate this, under the optimal motif, a coordinating actor (such as a farm advisory service) is able to assist the farmers in their collaborative actions. Potentially, all links depicted in Fig. 1 are bi-directional, in that impacts and information flows can flow to a farmer, or from a farmer to a coordinating actor. For example, farmers may be affected by biodiversity changes on their own, or their neighbour's farm, through increased pollination (e.g. Breeze et al., 2014; Cong et al., 2014).

We use this optimal motif as a heuristic to conceptualise the state of collaboration and connectivity in our three case study landscapes. This differs from Kininmonth et al. (2015), who applied such motifs using a quantitative social network approach (e.g. Prell et al., 2009). They examined specific actors and their links to quantify the frequency with which the optimal motif appeared in their study area. They thus provide a numerical indication of how well social and ecological resources are aligned. Rather than 'score' the landscapes in this way, we wanted to examine the role that CAP plays in creating, or blocking, the formation of this optimal motif within a given landscape. This required rich qualitative data on the kinds of relationships between actors and on the factors that facilitate or hinder these relationships. To gather such rich data, we needed the perspectives of farmers, and of those stakeholders engaged in policy formulation and implementation. We were therefore looking at

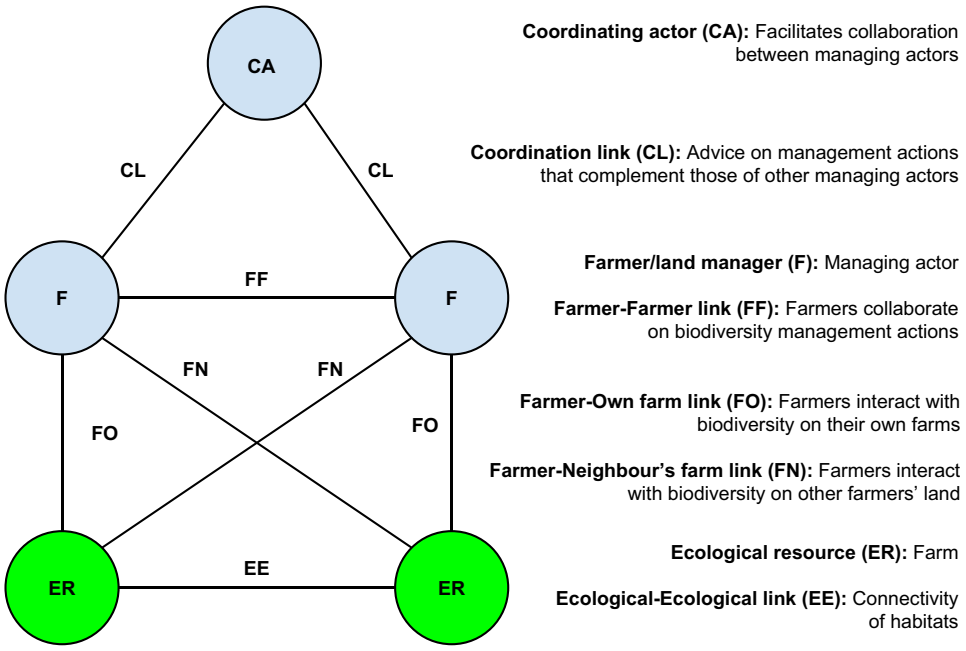

Fig. 1. Optimal landscape-scale social-ecological system for managing biodiversity in agricultural landscapes (adapted from Bodin and Tengö, 2012; Kininmonth et al., 2015). The diagram demonstrates maximum connectivity between social (farmer) and ecological (farm) nodes, with coordination from a coordinating actor.

Table 1
Nodes and links in socio-ecological motifs, as defined for studying biodiversity management in agricultural landscapes.

Type	Label	Description
Node	ER – Ecological resource	The biodiversity on a farm
	F – Farmer	The individual farmer or land manager who makes decisions and/or takes action around biodiversity management
	CA – Coordinating actor	Any actor (organisation or individual) who coordinates biodiversity management between farmers (e.g. negotiating joint targets and facilitating collaboration)
Link	CL – Coordination link	Advice and information or facilitation on collaborative management
	EE – Ecological link	Inherently present – the ecology on one farm is linked to that on another within the same landscape. Can be positive or negative.
	FO – Farmer to own farm link	Each farmer implements management on their own farm.
	FN – Farmer to neighbour farm link	Each farmer influences the biodiversity of other farmers, both intentionally (e.g. through collaboration), and unintentionally (e.g. through using pesticides and other spill over effects).
	FF – Farmer to farmer link	Instances of farmers collaborating to manage biodiversity, for example via planning a fallow area across a farm boundary.

which links were generally supported or inhibited to see if there was a typical motif that represented the state of collaboration for the study areas. Thus, we sought to (1) qualitatively characterise typical social-ecological motifs of our case study landscapes; and (2) examine the influence of CAP on the identified motifs.

In examining the influence of CAP on the identified motifs, we decided to look holistically at the entire governance regime surrounding CAP, and not only at the components that specifically target biodiversity. CAP is the key policy instrument for shaping the agricultural sector in Europe, and embodies within it four sets of regulations (on rural development, 'horizontal issues', direct payments, and market measures), which each incorporate multiple objectives for the agricultural sector. For example, the regulation on rural development has three central objectives: viable food production; sustainable management of natural resources; and rural development (European Parliament & Council of the European Union, 2013). However, these aims for a multifunctional agricultural system are not always well reconciled when implementing various policy initiatives to meet them (Marsden and Sonnino, 2008). Thus potential exists for negative interplay between various components of CAP, whereby the outcomes of one policy instrument can undermine those of another (e.g. Paavola et al., 2009). We therefore deemed it relevant to start with characterising the motif, and then exploring how CAP interacts with it in a bottom-up manner, rather than examine just the biodiversity elements of CAP for the motif they promote.

2.2. Research approach

Our bottom-up approach drew on data collected through a multi-stakeholder workshop in each case study area. We chose a workshop approach because it provided an opportunity to contrast and compare actors' views, and seek consensus around the typical state of collaboration and cooperation in the study areas. Interview or questionnaire data would have provided us with a collection of individuals' opinions and perspectives. In contrast, by bringing stakeholders together, we were able to ask them to collectively consider options, and reach a consensus opinion that they felt represented the overall situation in the region. We recognise that such participatory approaches have their limitations, including that power and social relations can prevent inclusivity of all participants and their views (Fung, 2006), resulting in a dominant opinion

Table 2
Workshop exercises.

Exercise	Purpose	Brief Method	Data Outputs	Further description
Ice-breaker	Understand/verify actors' roles and interests	Participants are asked to take coloured blocks according to their interests (green – biodiversity, etc.). Participants arrange their blocks in order of importance to them.	Photographs of block arrangements.	N/A
Introduction	Provide common understandings. Stimulate discussion on key problems or disagreements.	Presentation on biodiversity challenges in the area, and on CAP measures and implementation.	Notes on key points of discussion.	N/A
Networks	Understand/verify actors' roles. Consider potential for coordinating actors. Stimulate discussion on links between actors.	Participants consider identified actors and arrange them according to who relates to who, and how. Participants add further actors.	Photographs of network diagrams. Notes on points of discussion.	Example protocol for exercise provided in Appendix B.
CAP measures	Elicit actors' opinions about CAP measures and their effectiveness. Explore attitudes to implementation.	Participants discuss their opinion on a list of given methods. Participants consider which of the EFA measures they want to implement on their own land, and why. Participants consider how these measures are implemented, and which other actors they involve.	Completed tables on positives and negatives of measures, and notes on implementation. Notes on accompanying discussion.	Example protocol for exercise provided in Appendix B.
Alternative Implementation	Elicit discussion on weaknesses of CAP. Consider ways to promote biodiversity management.	Participants discuss how they feel biodiversity could be better managed, and how that would be supported.	Mindmap. Notes on discussion.	Example protocol for exercise provided in Appendix B.

rather than a consensus opinion. However, we sought to promote inclusivity, and therefore effective participation, through measures including selecting participants on the basis of their knowledge of the subject matter, using an experienced professional facilitator in the German workshops, and by basing discussions around structured exercises (see Table 2); such measures are thought to facilitate meaningful knowledge exchange (see Newig et al., in press).

In order to identify participants for the workshops, we performed a desk-based, snowball sample of stakeholders within the CAP governance system in each location. To do so, during a background research phase, we performed content analysis on policy documents to understand the actors involved in CAP implementation, their roles, links and networks that policies create in each area (following Leventon et al., 2016). The actors identified included farmers, and also policy and decision makers, food companies, and biodiversity NGO's (see invitee lists in Appendix A). We also gained an understanding of the agri-environment schemes permitted on ecological focus areas under CAP in each case study area, and the pillar 2 measures that could contribute to biodiversity in each study area. This background research is explained in detail in Appendix A. After identifying the actors involved in CAP implementation, we invited them to workshops (one in each study area) in autumn 2014. The workshops in Saxony and Sweden were well attended (n = 26 and n = 22 respectively). In Lower Saxony, due to low attendance (n = 4) at the workshop, we followed up the workshop with interviews with 4 individual farmers in order to get a better understanding of how CAP regulations play out in practice.

2.3. Workshop design and data collection

The workshops were designed to produce qualitative data on actors and their links (objective 1) and on the role of policy in shaping these links (objective 2). During the workshops, participants were asked to discuss their perceptions of EFA measures, and agri-environment schemes permitted in the area, to discuss biodiversity management and agri-environment schemes more generally, and to discuss the networks of actors that are currently engaged in CAP implementation in their area. These discussions were encouraged by first creating a common baseline of understanding on the topic of CAP and our research questions. This was achieved through presentations from the project team, focussing on biodiversity challenges and relevant CAP measures in the workshop area. Following this, the workshop moved into a series of structured exercises and discussions (see Table 2 for a summary of exercises in the order they were executed). These exercises were completed by splitting the larger workshop into smaller groups, and each group had a facilitator from the project team to guide discussions. The workshop thus produced two forms of data: outputs from structured exercises, and transcripts of discussions that were held around producing outputs.

Structured exercises included an ice-breaker exercise, and a network diagramming process. The ice-breaker helped to understand the variety of skills and viewpoints represented by participants. All were asked to select coloured blocks that represented their interests (e.g. green = conservation; blue = agricultural production, etc.). They were then asked to order these blocks according to their priorities. The network diagramming exercise encouraged participants to highlight actors (organisations, people, companies, etc.) that they knew to be involved in CAP formulation and implementation in their area. In small groups, facilitated by a moderator, they were then asked to think about how actors were related to each other. Participants were asked to consider different types of links between actors, including collaboration on projects, memberships of shared associations, and roles and hierarchies in CAP implementation. During the construction of the networks, a note taker took notes on discussions, including key points of disagreement and consensus. The resulting networks were photographed.

Two further exercises were less structured in that they sought primarily to stimulate discussions; these were discussions on the acceptability of CAP measures, and on alternative CAP implemen-

tation approaches. In discussing the acceptability of CAP measures, participants were asked, in small groups, to consider a range of CAP measures, and to discuss those that they most supported. To facilitate this discussion, participants were encouraged to complete a table highlighting the positives, negatives and implementation considerations for each of the discussed measures. Using this discussion as a starting point, participants were then asked to think about ways to improve CAP for biodiversity. While continuing this discussion, the participants were encouraged to summarise their discussions in a mind map diagram. The group's facilitator then used these diagrams to prompt further discussion, for example by asking questions such as "how could this idea be supported by policy?".

2.4. Data analysis and verification

To characterise the typical social-ecological motif in each of our case study landscapes (objective 1), we analysed the data for reference to the links between actors and resources. The network diagrams and discussions were important data because respondents specifically considered links between actors. We examined the network diagrams created to see if any actors were positioned in coordinating roles, and used the discussion notes to see if they were described as such, and what such a role entailed. We examined the broader discussions for references to links between farmers, and between farmers and coordinating actors. We noted how farm actors talked about biodiversity management. In all instances, we sought to understand the links qualitatively and not quantitatively; we considered what links and collaborations were present, and in what form.

To examine the interactions of CAP with the identified typical motifs (objective 2), we performed a narrative analysis. We focussed on discussions that explained or critiqued links, and those that referred to CAP. We highlighted all narratives that were used to explain links. After identifying all explanations for links, we grouped them by looking for common themes and arguments. These emerging categories were around the role CAP plays in facilitating or strengthening links; and in disrupting or blocking links.

Once the results had been created, we sought to verify them by presenting them to the stakeholders and seeking feedback. This verification was done via a second round of workshops in all study areas, held in February and March 2016. The original list of stakeholders was invited to return, though we also invited additional actors that had been named in the first round of workshops. We presented the motifs and the roles of CAP in sustaining them to the workshop attendees, and invited them to critique or comment on our ideas. In all three workshops, no attendee disagreed with our analysis, and instead voiced general agreement with our arguments. While we cannot be certain, we are reasonably confident that this agreement was not down to participants being unwilling to challenge us or our 'expert' positions; there was an engaged discussion around the details of our arguments. For example, participants referred to examples of collaboration in the Netherlands and in other states of Germany. Further, participants in Sweden asked questions around whether the factors that shaped the motif differed between the case studies. In discussing this with the participants, we were able to create a more nuanced analysis about how the CAP interacts differently in different locations.

3. Results

3.1. Objective 1: characterising typical actor-resource motifs

In all case studies, we found that the biodiversity-agriculture system was represented by a bucket-shaped motif (Fig. 2). That is, respondents reported no collaboration between farmers for the purposes of biodiversity conservation. Similarly, in the two German cases, few of the participating farmers went beyond compulsory biodiversity measures under pillar 1. In all our study landscapes, of those pillar 2 agri-environment schemes that were discussed by participants, none were collaborative, neither in the policy nor in the way they were implemented. Also, a clear coordinating actor was missing in the motif in all locations. Instead, several organisations had the potential to coordinate between farmers because they were in positions of providing advice and input to biodiversity conservation. However, in all cases, advice was provided to individual farmers, and did not promote or facilitate collaboration nor coordinated implementation of actions benefiting biodiversity. Consequently, there were no Farmer to Farmer (FF) links, and no Farmer to Neighbouring Farm (FN) links (see Figs. 1, 2).

In addition, many Farmer to Own Farm (FO) links were relatively weak. Such links were present in the form of land management actions in all case studies, but often management actions were not carried out with the specific intention of enhancing or conserving biodiversity. Instead, biodiversity impacts typically arose from broader land management actions (e.g. pesticide use), and from complying with compulsory regulations. Many farmers in Saxony and Sweden felt uncertain about the actual benefits of agri-environmental measures for biodiversity and asked for more information on this. Respondents did, however, note the positive and negative impact of biodiversity to their farm: Participants in Sweden and Saxony argued that fallow areas and hedges tended to increase the presence of pests. In Saxony, respondents felt that having visible indicators of biodiversity, such as flower strips, improved the public perception of farming.

In all study areas, we identified actors filling coordination-type positions, and these could be grouped as consultancies, farmer associations, administrative bodies and food processing and/or retailing companies. Farmer associations (and unions) provided advice and support to their members. For example, Landvolk Niedersachsen provides discussion platforms to develop a common understanding of best practice. Consultancies played a large role in all three cases, often providing a bridge between farmers and administrative actors by advising on farm management plans and assisting farmers with bureaucratic processes. Administrative bodies administered payments and monitored implementation of CAP measures. Some also provided extension or advisory services to farmers, for example through the local branches in Saxony of the LfULG (Saxon State Office for Environment, Agriculture and Geology). In Lower Saxony, the Chamber of Agriculture played a similar role. In Sweden, some food processing companies acted as a slightly different form of administrative actor. Although not directly administering the CAP, they enforced land management conditions on the farmers that they buy from, thus playing a role in shaping biodiversity conservation.

Notably, despite the presence of coordination-type actors, none of these specifically played a true coordination role in terms of biodiversity conservation under CAP. For example, consultancies worked with individual farmers, and were in competition with each other, with many operating in the same landscape. Therefore it is unlikely that they worked with neighbouring farmers who could meaningfully collaborate. Some of the conservation NGOs (e.g. Germany's Local Landcare Associations) came closer to being coordinating actors, in that sometimes they worked with a collection of farmers for the purposes of biodiversity conservation. However, this is generally outside of CAP, and/or is not standard practice throughout the study areas; in the Lower Saxony case study area, there was no active Local Landcare Association. They therefore cannot be said to represent a general coordinating actor for the case study areas.

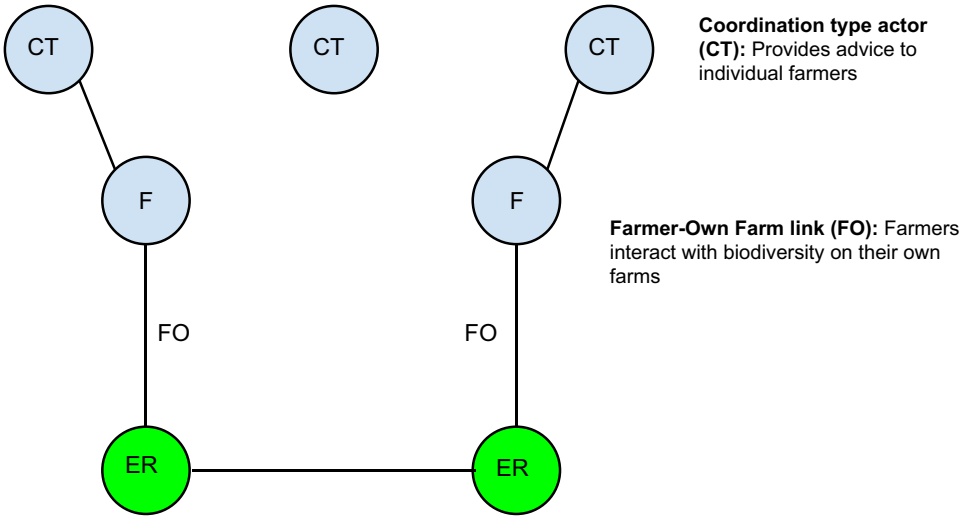

Fig. 2. Bucket-motif characterisation of biodiversity-agricultural systems in case study areas, showing that farmers are only connected to their own farms, and to different coordination-type actors. The increased number of coordination-type actors present, and the lack of links between farmers and each other's farms hinder landscape-scale biodiversity management.

3.2. Objective 2: CAP interactions with typical actor-resource motifs

CAP actively reinforced the lack of coordination across farms in our study areas in three ways. First, through the implementation of CAP in Lower Saxony, Saxony and Sweden, the only links in the stylised actor-resource motifs that are actively reinforced are Farmer to Own Farm (FO) links, while linkages across different actors and farms are not promoted. CAP interacts with actor-resource motifs through compelling individual farmers to act (e.g. through pillar 1 EFA), or providing action-based payments to individual farmers (pillar 2 agri-environment schemes). By targeting individual farmers, agri-environment schemes reinforce individualisation. While collaboration is allowed under the CAP's agri-environment schemes, and was highlighted as a "possibility" in Sweden, these schemes are voluntary and collaboration was not promoted nor actively facilitated in any of our cases. Thus, farmers in our study systems fulfilled their CAP obligations by working to manage biodiversity only on their own farms.

While CAP reinforced FO links, it was not the only driver for them. In some cases in Lower Saxony, farmers chose not to access the payments for measures they voluntarily undertook. This was explained as farmers being motivated by the benefits they derived directly from that action (e.g. better soil quality), rather than payment. Indeed, (non-farming) participants expressed concerns that paying farmers for voluntary actions could undermine their intrinsic motivation to continue the action (crowding-out), particularly if payments were then withdrawn. In addition, farmers were put off accessing CAP payments by their bureaucratic and stringent requirements. Participants in Lower Saxony and Sweden felt accessing CAP payments was complicated and time-consuming. Moreover, they feared facing sanctions if they claimed but implemented something incorrectly. Participants in all locations explained that fully implementing CAP measures was rarely possible; for example, a contractor harvesting a crop might destroy a flower strip.

Second, particularly in the German cases, CAP in its entirety (pillars 1 and 2) actively created barriers to collaborative biodiversity management by stimulating the proliferation of coordination-type actors. Historically, government administrative bodies in all locations provided input and advice to farmers, in the form of extension services. However, our workshop participants considered that such services – due in part to administrative restructuring and government cost-saving – were no longer sufficient to help farmers with CAP's increasing complexity. Indeed in Saxony, there are now very few advisory services provided by state agencies. To fill this service gap, private consultancies have proliferated (see also Hoffmann, 2004). As more consultancies exist within the same landscape, there is an increasing amount of competition between them, and fewer farmers being advised by each service. This makes it less likely that a consultancy will be advising groups of neighbouring farmers, and thus harder for consultancies to support collaboration. In Sweden, actors such as the Swedish Rural Economy and Agricultural Societies (Hushållningssällskapet) fulfil an outreach and extension role on a wide basis, but are still not used by all farmers in a given landscape, and work to an individual basis.

Finally, the CAP (particularly pillar 1) further facilitated a bucket motif of actor-resource interactions by failing to address existing barriers to collaboration. The follow-up interviews in Lower Saxony discussed the impact of high land prices and land ownership in the area. Farmers found it hard to participate in agri-environment schemes because tenure agreements were often shorter than the length of time required for a scheme. Short tenures arose from rising demand for land, meaning that landlords wanted to be able to raise rents and not be locked into lower rents for too long. Such tenure insecurity was seen as a barrier to implementing meaningful biodiversity conservation because farmers do not have sufficient time to foster collaborative networks. Furthermore, the tenures of neighbouring farmers are unlikely to coincide on length and expiration, making it difficult for farmers to plan collaboratively. Our findings do not suggest that CAP creates such barriers, although there is evidence emerging from elsewhere that it does; for example single payment schemes may exacerbate them (see e.g. Swinnen et al., 2008; Acs et al., 2010). However, our findings do show that despite being the core policy that shapes the structure of the agricultural system in the EU, the CAP does not effectively address such challenges.

Despite multiple barriers, farmers recognised the value of collaboration, suggesting there is willingness to develop FF links. Swedish farmers thought it particularly important to implement measures in locations where they would help to connect existing habitats, and form networks beneficial for wildlife dispersal. Lower Saxony interviewees stated that collaboration would allow farms to share responsibilities; for example rather than forcing each

and every farm to produce three crops, the same three crops could be positioned throughout the landscape, according to where it is economically and environmentally desirable to do so. In Saxony, participants argued that some measures were differently applicable to different farmers, and collaboration would therefore allow all measures to be met, but without all farmers doing everything.

4. Discussion

In addition to other well-known reasons for its limited effectiveness, the CAP may be limited in delivering meaningful biodiversity benefits because it entrenches actor fragmentation, thereby reinforcing fragmentation in biodiversity management. CAP may not initiate patterns of fragmentation, but it strengthens such patterns and fails to counter them. Entrenchment initially takes place through a focus on individual farms for implementing agri-environment schemes and for rewards on this basis (type 1). Entrenchment of fragmentation also occurs through the proliferation of coordination-type actors that work to the farm scale (type 2). Finally, CAP reinforces fragmentation by not addressing drivers that provide a disincentive to collaborate (type 3), such as land tenure arrangements. Type 1 actor fragmentation means that farmers are not given reasons to collaborate and are not compelled to. Type 2 means they lack information, advice and someone with the overview to coordinate collaboration. Type 3 means that no actions are taken to reduce disincentives to collaborate. We did, however, find evidence to suggest that farmers are motivated to manage biodiversity, and willing (in principle) to collaborate (in agreement with McKenzie et al., 2013) if facilitated to do so in easy (non-bureaucratic) ways.

Our findings demonstrate the need to think beyond payments to individual farmers – changing payment amounts per se will not overcome any of the types of actor fragmentation that we identified. In contrast, a focus on outcome-based payments for biodiversity (see Bertke et al., 2008) offers more potential because collaboration may be necessary to deliver certain outcomes. Thus agri-environment schemes designed around outcome-based payments could overcome type 1 fragmentation. The impact of outcome-based payments to type 2 actor fragmentation is less clear: Bureaucracy to administer outcome-oriented schemes could increase, and the number of coordinating-type actors may further proliferate. Moreover, facilitating collaboration on voluntary aspects of the CAP is insufficient to restructure the bucket motif when uptake of voluntary schemes is low. Finally, outcome-based payments will fail to foster collaboration unless existing barriers are removed (type 3 actor fragmentation). Types 2 and 3 of actor fragmentation thus may partly explain why examples of collaborative agri-environmental management are uncommon, and why outcome-based payment schemes are not a sufficient modification.

Given the three types of actor fragmentation that are either enhanced or left unaddressed by the CAP, our findings suggest that a more systemic change in the governance of farmland biodiversity is needed. Our findings should be considered in combination with other calls that CAP is not working for biodiversity and indeed, is introducing trade-offs between biodiversity outcomes and social outcomes (Pe'er et al., 2014). Existing alterations to CAP focus on changing pillar 2 for the purpose of improving biodiversity. Such changes include adjusting payment levels or the conservation actions that are funded. These changes take place without targeting deeply embedded drivers for actor fragmentation that are promoted throughout both pillars of CAP. Thus changes to CAP target shallow leverage points for biodiversity, and by not targeting drivers of fragmentation, do not address the deeper system properties and paradigms that shape the scope and effectiveness of such interventions (Meadows, 2008). Instead, policy should consider how biodiversity outcomes could be better achieved in agricultural areas by thinking outside the existing CAP system, and focussing on what is incentivised, how ecologically meaningful actions are facilitated, and how barriers to such actions are removed. Such interventions should engage with the motivation of farmers to manage biodiversity.

Based on these findings, we therefore call for research that explores wholesale governance change in agricultural landscapes, such that biodiversity goals are designed into the agricultural system. Currently we have a core policy (CAP) that was originally designed to deliver viable food production, with other aims (sustainable natural resource use and rural development) retrofitted and limited by path dependencies (Sutherland et al., 2012). Thus, CAP follows a productivist logic that is modified by a project-based approach to delivering public goods, and is therefore limited in meeting non-productivist goals (Marsden and Sonnino, 2008). To effectively manage biodiversity in agricultural landscapes, we would need to change the productivist logic and create a system that was designed to deliver biodiversity (and other conservation/environmental) benefits.

5. Conclusions

Current reforms and modifications to the Common Agricultural Policy can only be of limited benefit to biodiversity conservation. Biodiversity in agricultural landscapes will be best conserved when it is managed at landscape scales, facilitating collaboration between farmers to increase patch size and landscape heterogeneity. Our multi-stakeholder workshop data demonstrates that CAP is currently hindering such collaboration, and instead entrenches actor fragmentation by encouraging farmers to only consider their own farm resources. This entrenchment of fragmentation happens in three ways: 1) by focussing on individual farms for implementing agri-environment schemes and for rewards on this basis; 2) through the proliferation of coordination-type actors that work to the farm scale; and 3) by not addressing drivers that provide a disincentive to collaborate. We argue that such entrenchment is the consequence of adding biodiversity management as an afterthought to a production-focussed agricultural policy. We therefore call for research that proposes more fundamental changes to agricultural policy, such that biodiversity goals are addressed as equal to production goals in the agricultural system of the EU.

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Appendix A. Background Research for Identifying Actors and Understanding Policy Contexts

Scoping research in the case study areas highlighted the key considerations for identifying actors and policies. Initially, academic and practitioner literature was searched to identify the prominent organisations and key issues in the case study areas (Saxony and Lower Saxony, Germany, and Scania, Sweden). Scoping visits were

Table A1
Lower Saxony invite list

Stakeholder (English)	Stakeholder (German)	Location
Administration		
Chamber of Agriculture state level	Landwirtschaftskammer Niedersachsen	Oldenburg
Chamber of Agriculture local level	Landwirtschaftskammer – Bezirksstelle Oldenburg-Süd	Cloppenburg
Lower Saxony State Water Management, Coastal Defence and Nature Protection State level	Nds. Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz (NLWKN)	Norden
Lower Saxony State Water Management, Coastal Defence and Nature Protection local level	Nds. Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz (NLWKN)	Cloppenburg
Ministry of Food, Agriculture and Consumer Protection	Niedersächsisches Ministerium für Ernährung, Landwirtschaft und Verbraucherschutz	Hannover
Ministry of Environment, Energy and Climate Protection	Niedersächsisches Ministerium für Umwelt, Energie und Klimaschutz	Hannover
Nature Conservation office, County Oldenburg	Amt für Naturschutz und Landschaftspflege Landkreis Oldenburg	Wildeshausen (South of Oldenburg)
Nature Conservation office, County Cloppenburg	Amt für Naturschutz und Landschaftspflege Landkreis Cloppenburg	Cloppenburg
Agency for regional rural development in the Weser-Ems area	Amt für regionale Landesentwicklung Weser-Ems	Oldenburg
Consultancy organisations		
Agricultural Management Consulting	Arbeitsgemeinschaft für Landberatung e.V.	Hannover
Consultancy ring 1	Landesverband der Maschinenringe Niedersachsen e.V.	Hannover
Consultancy ring 2	Arbeitsgemeinschaft der Beratungsringe Weser-Ems e.V.	Oldenburg
Others		
Competency centre, Organic farming	Kompetenzzentrum Ökolandbau Niedersachsen e.V.	Visselhövede
Organic farming organisation, Bioland	Bioland Landesverband Niedersachsen/Bremen	Visselhövede
Organic farming organisation, Naturland	Naturland	Visselhövede
Organic farming organisation, Demeter	Demeter im Norden Bäuerliche Gesellschaft e.V.	
LEADER organisation, Wildeshauser Geest	Wildeshauser Geest (LEADER)	Wildeshausen
LEADER organisation, Hasetal	Lokale Aktionsgruppe Hasetal (LEADER)	Löningen
Farmer association, Lower Saxony	Landvolk Niedersachsen	Hannover
Farmer association local branch (Cloppenburg)	Kreislandvolk Cloppenburg	Cloppenburg
Farmer association local branch (Oldenburg)	Niedersächsisches Landvolk – Kreisverband Oldenburg e.V.	Huntlosen
Farmer association local branch (Vechta)	Kreislandvolkverband Vechta e.V.	Vechta
Beekeeper association	Landesverband der Imker Weser-Ems e.V.	Oldenburg
German association for landcare	Deutscher Verband für Landschaftspflege e.V.	
Association for the Environment and Nature Conservation, Lower Saxony	BUND Landesverband Niedersachsen e.V.	Hannover
Association for the Environment and Nature Conservation, Vechta	BUND Kreisgruppe Vechta	Visbek
Association for the Environment and Nature Conservation, Oldenburg	BUND Kreisgruppe Oldenburg (Land)	Prinzhöfte
Nature Protection Association, Lower Saxony	NABU Landesverband Niedersachsen	Hannover
Nature Protection Association, Oldenburg	NABU-Regional- und Bezirksgeschäftsstelle Oldenburg	Oldenburg

Table A2
Saxony invite list.

Stakeholder (English)	Stakeholder (German)	Location
Administration		
State office for environment, agriculture and geology, Nossen	Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie (LfULG)	Nossen
State office for environment, agriculture and geology, Mockrehna	Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie (LfULG)	Mockrehna
State office for environment, agriculture and geology, Köllitsch	Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie (LfULG)	Köllitsch
Consultancy organisations		
Agricultural service provider	EXAgT – Büro für präzise Agronomie	Zschochau
Others		
Farmer association, State level	Sächsischer Landesbauernverband	Dresden
Farmer association regional level	Regionalbauernverband Döbeln-Oschatz e.V.	Döbeln
Syndicate of Traditional Agriculture e.V.	AbL – Arbeitsgemeinschaft bäuerliche Landwirtschaft e.V.	Helbigsdorf
Sächsische Landesstiftung Natur und Umwelt, Academy for environmental education	Sächsische Landesstiftung Natur und Umwelt, Akademie	Tharandt
Non-profit rural association	Sächsische Landsiedlung GmbH	Meißen
Association working in the field of renewable energies	Verein zur Förderung von Biomasse und nachwachsenden Rohstoffen Freiberg e.V.	Freiberg
Nature conservation organisation State level	Grüne Liga Sachsen	Leipzig
Nature conservation organisation local level	Grüne Liga Hirschstein	Hirschstein
Organic agriculture association regional branch	Gäa e.V. Regionalstelle Sachsen	Dresden
Engineering firm	Ingenieurbüro Albrecht und Partner	Klipphausen

Table A2 (*Continued*)

Stakeholder (English)	Stakeholder (German)	Location
Association for conservation tillage/direct sowing	Konservierende Bodenbearbeitung/Direktsaat in Sachsen e.V.	Großrückerswalde
Agricultural holding	Landwirtschaftsbetrieb Kitzscher GmbH	Kitzscher
Producer of food, fodder and seed	Saat-Gut Plaußig Voges KG	Leipzig
Farmers	Landwirte	
ILE group, Mügeln	ILE-Gruppe, Sächsisches Zweistromland	Mügeln
LEADER organisation, Lommatzsch	LEADER Gebiet "Lommatzscher Pflege"	Lommatzsch
Rural area organisation 1	Landesverein Sächsischer Heimatschutz	Dresden
Rural area organisation 2	Sächsisches Landeskuratorium Ländlicher Raum e.V.	Nebelschütz
Beekeeper association State level	Landesverband Sächsischer Imker e.V.	Niederfrohna
Lutheran Church in Saxony	Evangelische Landeskirche Sachsen	Kohren-Sahlis
Association for the Environment and Nature Conservation, working group on agriculture	BUND, Landesarbeitskreis Landwirtschaft	Leipzig
German green political party	BÜNDNIS 90/DIE GRÜNEN	Dresden
Chemical producer	BASF	Limburgerhof

Table A3
Scania, Sweden invite list.

Stakeholder (English)	Stakeholder (Swedish)	Location
Administration		
Region Scania	Region Skåne	Malmö/Kristianstad
Water Body; local branch Höje å and Kävlingeån	Höje å & Kävlingeåns Vattenråd	Lund
National Food Agency, Sweden	Livsmedelsverket	Uppsala
Focus on Nutrients	Greppa näringen	N/A
County Administration Board (division for agriculture and rural development)	Länsstyrelsen i Skåne län (Landsbygdsavdelningen)	Kristianstad
Water Body; local branch Segeå	Segeå Vattenråd	Svedala
Ministry for Rural Affairs	Landsbygdsdepartementet	Stockholm
Water Body; local branch Vegeån	Vegeåns Vattendragsförbund	Ängelholm
Water Body; local branch Hanöbukten	Hanöbuktens Vattenvårdsförbund	Kristianstad
Board of Agriculture	Jordbruksverket	Jönköping/Alnarp
Swedish Forest Agency	Skogsstyrelsen	
Environmental Protection Agency	Naturvårdsverket	Stockholm
Höör Municipality	Höörs kommun	Höör
Tomelilla Municipality	Tomelillas kommun	Tomelilla
County Administration Board (division for environmental protection)	Länsstyrelsen i Skåne län (Miljöavdelningen)	Malmö
Tourist Board; local branch Southwestern Scania	Svenska Turistföreningen	Malmö
Biosphere reserve "Kristianstad Vattenrike"	Kristianstad Vattenrike	Kristianstad
Consultancy organisations		
Swedish Rural Economy and Agricultural Societies; local branch Borgeby	Hushållningssällskapet Borgeby	Borgeby
Others		
KRAV	KRAV	Uppsala
Farmers association; local branch Scania	LRF Skåne	Höör
Farmers	Lantbrukare	
Svenska Foder Group	Svenska Foder	N/A
Yara Sweden	Yara Sverige	Köping
"Lantmännen"	Lantmännen	N/A
Nordic Sugar	Nordic Sugar	Malmö
"Findus"	Findus	Bjuv
"Högestad & Christinehof Förvaltnings AB"	Högestad & Christinehof Förvaltnings AB	Ystad
Swedish Church	Svenska kyrkan	N/A
"Övedskloster"	Övedskloster	Sjöbo
"Häckeberga Säteri"	Häckeberga Säteri	Genarp
"Organic farmers association"	Ekologiska Lantbrukarna	Söderköping
"Landowner Association"; local branch Scania-Blekinge	Skåne-Blekinge Jordägarförbund	N/A
The Swedish Professional Beekeepers	Biodlingsföretagarna	N/A
Agreb AB	Agreb AB	Helsingborg
Ornithological Society in Scania	Skånes Ornitologiska Förening	N/A
Swedish Society for Nature Conservation in Scania	Naturskyddsföreningen i Skåne	Lund
Swedish Outdoor Association; local branch Southern Sweden	Friluftsfrämjandet, Region Syd	Södra Sandby

paid to the areas (April and May, 2014). These visits were planned in collaboration with the local research partners. During the visits, the areas were visited to understand more about what agriculture and biodiversity looked like in the area, and thus to understand the nature of the challenges being faced. In addition, prominent organisations were visited in order to gain further understanding of the context. In particular, these actors were asked to identify further relevant stakeholders, to discuss problems around biodiversity and agriculture that they saw as key challenges, and to highlight the key policies that interact with these challenges.

Using information provided on actors as a starting point, hierarchical and issue actor analyses were conducted. Provan and Kenis (2008) show that governance networks could be understood through both a hierarchical and an issue perspective. Hierarchical networks are those shaped by the connections stimulated by policy and regulation; issue networks are those where actors, not necessarily formally identified by a policy, come together to collaborate around a shared issue of concern. Based on the scoping interviews, we reviewed CAP policy documents relevant to the case study areas and performed internet searches to identify actors engaged in CAP

implementation. In this way, our hierarchical networks were identified. We then performed similar internet searches, but looking for actors engaged in projects or activities related to biodiversity management in the study areas. We specifically searched for projects, and then reviewed project documents to identify actors. In this way we identified issue networks.

Following identification of actors, we sought to characterise them according to their interest and role in managing biodiversity in agricultural landscapes (Reed et al., 2009). To do so, we reviewed the websites of identified actors and documents that they produced. We were thus able to characterise actors according to the type of organisation (public administration, farmers associations, nature conservation, organic farming, research and 'others'). We identified topics or issues that they had engaged in. We sought to better understand their role in managing biodiversity by looking at their activity-type (e.g. networking, campaigning, regulation, etc.) and the projects they had been engaged in.

Based on our analysis of actors, we created invite lists for each workshop that reflected the full breadth of actor interests in each location. We considered the full stakeholder analysis, and discussed which actors were closely involved in CAP decision-making and implementation. These actors were then reviewed to ensure that they represented all interests, roles and levels previously explored. The final invite lists for each workshop are shown in Tables A1–A3 .

Appendix B. Example Protocols for Workshop Exercises

This document outlines protocols for the workshop exercises listed in Table 2 of the main paper. The protocols are those used in the Scania, Sweden workshop. In the German workshops, the exercises were tailored to the workshop context, and the style of the moderators present, and therefore the protocols are not an exact account of the exercises in all locations. However, those presented here provide the general model to represent the process that participants undertook.

Exercise: Networks
Process:

1. Each participant to write the name of their organisation on a post-it note.
2. Participants to write further names of organisations that are relevant for implementing CAP.
3. Post-it notes should be arranged in clusters depending on levels (EU, national, regional, local, etc.). Participants may write the same organisation on multiple post-its if it covers more than one level.
4. The moderator should control the collection of post it notes and clarify why there are multiples of one organisation, and which level it belongs to if there is uncertainty.
5. What this level is, and what it constitutes should be clarified with participants.
6. Within these clusters, post-its should be arranged onto flipchart paper to represent who is connected to who in implementing agri-environment policy. Lines can be drawn to represent links.
7. If time is running short, the moderator should try to clarify just the core section of the network, and then ask participants to add themselves to this core network.
8. Note takers will take notes on the main points of the discussion, including disagreement and agreement points, key problems encountered, key uncertainties.

Prompt questions might be:

- Who does this actor report to?
- Who is in charge?
- What is the role of this actor?
- Who else do they work with to fulfil that role?
- Where do you fit into this diagram?
- Who are key actors in CAP implementation? What makes them key actors?

Exercise: CAP Measures
Process:

1. Display Table B1 to participants (on big paper or white board), and ask them to provide content to fill it in. Measures in the first column of Table B1 are tailored to the case study in question, as outlined in Table B2.
2. Arguments are summarized on cards and added to the pro or con columns.
3. In general, participants should consider pros and cons for agriculture as well as for biodiversity.

Table B1
Discussion table for CAP measures. Measures in the first column are tailored to the case study in question, as outlined in Table B2. Measures 1 to 5 represent the five options accepted as Ecological Focus Area (EFA) in the recently implemented CAP reform. Measures 6 to 11 were chosen to cover a range of different options both from a biodiversity point of view (i.e. from targeted towards specific goals such as bird fields or buffer zones, to more general measures such as organic farming) as well as from a farmers perspective (i.e. from management support for existing habitats, to options entailing that (parts of the) crops produced are not harvested).

Measure	Positives	Barriers	Solutions
1. Fallow			
2. Uncultivated field edges			
3. Short rotation coppices			
4. Ley in a main crop			
5. Nitrogen fixing crops			
6. Maintain semi-nat. pastures and meadows			
7. Organic production			
8. Maintain/create wetlands and ponds			
9. Buffer zones			
10. Restore/Re-create landscape elements (walls, alleys, fences, etc.)			
11. Bird field			

Table B2
Measures discussed in each location.

Location	Measures discussed
Lower Saxony	Fallow; flower or conservation strips/areas; intercropping; cultivation of leguminoses; diverse crop rotation; landscape elements; extensive management of grassland; spring repose; diverse grassland; grazing and mowing on special biotopes; measures for the conservation of Nordic visitor birds
Saxony	Fallow land/strips; flowered areas/flower strips; cover crops; plant legumes; crop rotation; ecologically sound crop production; strip-till/no-till; creation of biotopes through mowing/pruning; plant hedges/trees; habitat creation; environmental protection counselling ("Betriebsplan Natur")
Scania	Fallow; uncultivated field edges; short-rotation coppices; Ley in a main crop; Nitrogen fixing crops; Maintain semi-natural pastures and meadows; organic production; maintain/create wetlands and ponds; buffer zones; restore/re-create landscape elements; bird fields.

4. We know that many of the participants might not be an expert either on agriculture or on biodiversity or even maybe on both, but we ask them for their personal opinions.
5. Note takers should take notes of key emerging themes, points of agreement or disagreement, and problems with the process.

Prompt questions might include:
Positives

- What are the positive outcomes (from your perspective) from implementing this measure?
- What do you like about this measure?
- What are the good things about implementing this measure?

Barriers

- Farmers: What would be needed to implement this measure (equipment, consulting)?
- Others: What is needed to implement this measure?
- What practical support (e.g. consulting) is provided to implement this measure?
- What are the negative outcomes (from your perspective (agriculture, environment, administrative etc.) from implementing this measure?
- Are the rules of the measure strong enough or not?
- What don't you like about this measure

Solutions

- What would need to change in order for you to more support this measure?
- Who could help make this measure better for you?
- What other positive outcomes would need to be delivered by this measure?
- Which barriers (identified in the table) would need to be addressed?

Exercise: Alternative Implementation
Process:

1. The moderator will start by asking participants to talk about other measures that they know about, or examples they have seen for managing biodiversity in agricultural landscapes. They should be encouraged to think about on-farm, but also more broadly. Each idea or example should be written on a piece of paper.
2. Once there is a collection of ideas and examples, the participants should select some measures (2 or 3) that they think would be effective at promoting biodiversity *and* they would support. These should be written in the centre of the flipchart paper.
3. Note takers will also be taking notes on the pros and cons of each measure while they are being discussed by participants.
4. From these measures, the moderator should add options for supporting the measure (blue) and barriers to implementing the measure (red). These may connect to each other.
5. Note takers should take notes on key points of agreement and disagreement, on the criteria that were used for selecting the measures, and on the problems encountered by participants.

Prompt questions might include:

- Have you seen other measures that could be useful for biodiversity and agriculture?
- Could farmers collaborate in some way?
- What would make you do this?
- What is positive about this measure/idea?
- Why don't you do this measure now?
- What would you need to consider in order to implement this measure?
- How could this be supported by your organisation?
- How would you need others to act to support this measure?

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Article 3 'Scenarios'

Landscape Scale Biodiversity Governance: Scenarios for reshaping spaces of governance

Abstract

In this paper we present an alternative governance system for managing biodiversity in agricultural landscapes. Focusing primarily on the European Union, we start with the premise that there is a need to rethink biodiversity governance to bring together land managers for collaboration, and to close mismatches between levels of governance and ecological scales. We therefore create four archetypal governance scenarios that represent hypothetical extremes in two variables. The first variable is the scale of governance, and differentiates between a primary focus on administrative units (e.g. country, state, county) versus ecological scales (bioregion, landscape). The second variable is the degree of decentralisation and devolution, and differentiates between a top-down, central-state system, versus a bottom-up, broad actor-network system. Based on their considered strengths and weaknesses, we present a hybrid scenario as our proposed alternative governance system. This system brings together decision-makers, land managers, and a broader range of stakeholders at a landscape scale to plan biodiversity goals and actions. This, in turn, will more closely match the biophysical conditions for effective biodiversity conservation than existing EU approaches, without overly increasing the administrative burden.

Keywords

agriculture; ecology; environmental policy; EU; interplay; multilevel governance.

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RESEARCH ARTICLE

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Landscape-scale biodiversity governance: Scenarios for reshaping spaces of governance

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Abstract

In this paper, we present an alternative governance system for managing biodiversity in agricultural landscapes. Focusing primarily on the European Union (EU), we start with the premise that there is a need to rethink biodiversity governance to bring together land managers for collaboration and to close mismatches between levels of governance and ecological scales. We therefore create four archetypal governance scenarios that represent hypothetical extremes in two variables. The first variable is the scale of governance and differentiates between a primary focus on administrative units (e.g., country, state, and county) versus ecological scales (bioregion and landscape). The second variable is the degree of decentralization and devolution and differentiates between a top-down, central-state system, versus a bottom-up, broad actor-network system. On the basis of their considered strengths and weaknesses, we present a hybrid scenario as our proposed alternative governance system. This system brings together decision makers, land managers, and a broader range of stakeholders at a landscape scale to plan biodiversity goals and actions. This, in turn, will more closely match the biophysical conditions for effective biodiversity conservation than existing EU approaches, without overly increasing the administrative burden.

KEYWORDS

agriculture, ecology, environmental policy, EU, interplay, multilevel governance

1 | INTRODUCTION

Around the world, there is a need to rethink governance systems for managing biodiversity in agricultural landscapes in order to avert the current trajectory of biodiversity loss. In intensively used agricultural landscapes in the European Union (EU), there is a reliance on the Common Agricultural Policy (CAP) to deliver biodiversity management and conservation through agri-environment schemes and ecological focus areas. The 2014 reforms of the CAP are feted as the "greenest" CAP yet. However, they are considered unlikely to deliver meaningful biodiversity benefits (Pe'er et al., 2014). CAP reforms evolved as a product of the preexisting policy structures, and the derived norms shape and limit changes that can be made to it (Kay, 2003). As a practical result, biodiversity measures are limited by an agricultural production rationale. For example, individual farmers are targeted to take actions for biodiversity conservation on their own farms, meaning that biodiversity conservation takes place at a farm scale, rather than a more ecologically meaningful landscape scale (Leventon et al., 2017). This pattern is exacerbated by research tending to critique existing policies and suggest improvements within the existing structures (e.g., changing payment levels or measure design), rather than challenging the underlying rationale of the structures or systems in place (Abson et al., 2017; Fischer et al., 2007). Path dependency in policy and research, in turn, means that existing policy systems are rarely questioned or reformed substantially such that they facilitate an ecologically more meaningful way of managing biodiversity.

The aim of this paper is to present an alternative governance system for biodiversity in agricultural landscapes that goes beyond simple reforms of CAP. Although we do not aim to propose a readily implementable solution, we deem it timely to more radically rethink

the existing institutional arrangements to stimulate debate. To this end, we develop a range of archetypical governance scenarios. A scenario represents a possible, plausible, and internally consistent future situation (Peterson, Cumming, & Carpenter, 2003). Often, scenarios are created with stakeholders to consider possible future outcomes, for example, of what a landscape could look like (Hanspach et al., 2014). Other scenarios aim to predict future situations based on current trends (Mann & Absher, 2014). Here, we explore alternative scenarios of how governance for biodiversity in agricultural areas could play out (Börjeson, Höjer, Dreborg, Ekvall, & Finnveden, 2006). Governance refers to the policy, polity, and politics of the actors engaged in setting and implementing policy (Piattoni, 2009; Rhodes, 2007). Under the EU framework, governance systems tend to be constructed by networks of actors over multiple administrative and decision-making levels (Börzel & Heard-Lauréote, 2009; Hooghe & Marks, 2003; Reed et al., 2009; Stephenson, 2013). Our governance scenarios are theoretical constructs that propose arrangements of actors and their roles and responsibilities, from EU to local levels.

Our scenarios are theorized constructs, devised as a thought exercise to elicit discussion among stakeholders. We created our scenarios as part of a broader project that examined the governance of biodiversity in agricultural landscapes,[1] with case studies in Saxony and Lower Saxony, Germany, and Skania, Sweden. The scenarios were created by us, the research team. We then applied them to the case study areas as illustrations, using our in-depth knowledge of the existing actors and their roles, in order to demonstrate which actors would have what roles and responsibilities under each scenario. A worked example of such an illustration for the Saxony case study is provided in Appendix A. We have taken these theoretical scenarios to workshops with stakeholders in each of the study areas and used them as a tool to explore barriers and opportunities to governance change. The outcomes of such discussions are published as Velten et al. (2018). In this way, our scenarios facilitated a process to share experiences among stakeholders, and for colearning and understanding different viewpoints, and provided space for discussing future changes (Oteros-Rozas et al., 2015). In this paper, we focus on the construction and content of the theoretical scenarios.

One important way in which the CAP has limited the success of biodiversity conservation is through a spatial scale mismatch between a management jurisdiction (e.g., farm), the scale over which ecological processes occur (Dallimer & Strange, 2015; Pelosi, Goulard, & Balent, 2010; Satake, Rudel, & Onuma, 2008) and the scale of ecological interactions (Ekroos, Leventon, Fischer, Newig, & Smith, 2016). For example, managing mobile species such as corncrakes and bumblebees may need to be done over a larger area than rare plants (Dorresteijn et al., 2015; Loos et al., 2015; Rundlöf, Bengtsson, & Smith, 2008). Where conservation management is coordinated over larger areas, there are beneficial impacts to biodiversity (Dallimer et al., 2010). However, under the current CAP system, biodiversity management is mainly done by individual farmers implementing small-scale agri-environment measures (e.g., creating buffer strips or planting hedgerows), which does not necessarily lead to coherent management of larger areas (Leventon et al., 2017). Collaboration between individual farms and coordination of biodiversity management should therefore be encouraged (Prager, 2010, 2015). Therefore, by looking at arrangements of actors, we initially consider the spatial scale at which actors could be working in order to account for spatial scale mismatches.

In constructing our scenarios, we also consider the powers that could be held by different actors by taking into account types of decentralization and devolution. We consider actors to include both individuals (e.g., farmers) and institutions (e.g., state governments), and we specifically consider administrative decentralization and devolution of powers. Administrative decentralization is a key trend in biodiversity management globally (Hutton, Adams, & Murombedzi, 2005), and more broadly for governance in the EU (Beckmann, Eggers, & Mettepenningen, 2009). It entails the shifting of powers and responsibilities from government bodies to a broad range of actors (Kaufman, 1969) and incorporates a broad range of societal participation. It incorporates the premise that participation in decision making improves legitimacy and environmental outcomes. Concurrently, the EU practices a principle of subsidiarity as a form of devolution, whereby actions and decisions are devolved to the most local appropriate level. This should be the level that best matches the scale of the issue to be managed (Marshall, 2008; Oates & Portney, 2003). More locally made decisions are likely to have higher democratic legitimacy, although also tend to be less effective in environmental terms (Newig & Fritsch, 2009). Indeed, participation in decision making does not necessarily lead to improved environmental outcomes (Young et al., 2013). Shifts in decision-making forums and in the number of decision-making levels impacts upon the complexity of the governance system, creating administrative, technical, and democratic challenges for the actors involved (Moss & Newig, 2010; Pahl-Wostl, Lebel, Knieper, & Nikitina, 2012).

This paper proceeds with a conceptual framework that outlines the concepts that underpin the construction of the scenarios (match to ecological scale and degree of decentralization and devolution). Drawing on these two considerations, we construct four possible scenarios for biodiversity governance (Section 3). We then consider how these scenarios would perform in terms of addressing ecological scale mismatch issues and problems of governance complexity (Section 4). On the basis of these considerations, we then outline a potential governance system that draws on the strengths of the theorized scenarios (Section 5). Through this, we outline our vision of landscape-scale biodiversity governance that brings together diverse interests for multiactor decision making at an ecologically meaningful scale.

2 | THE CONSTRUCTION OF GOVERNANCE SCENARIOS

2.1 | Multilevel governance in relation to ecological scales

We began thinking about governance scenarios by considering how constellations or structures of actors could be formed around

[1]The project was called "Rural Development through Governance of Multifunctional Agricultural Land Use" (MULTAGRI) and ran between 2014 and 2017. More information can be found here: https://www.cec.lu.se/research/finished-projects/multagri.

different decision-making units. The EU governance system is characterized by multilevel governance, whereby decision making takes place over multiple levels, and these levels are generally administratively defined and rigid (Hooghe & Marks, 2001). Thus, decision making occurs at EU, member state, federal state, county, and municipal levels. However, the appropriateness of the boundaries of such administratively defined decision-making units for managing environmental resources has been challenged (Young, 2002), particularly with regard to, for example, water resources (Moss & Newig, 2010; Newig, Schulz, & Jager, 2016). Such criticism originates in the creation of spatial scale mismatches, whereby the spatial scale of management does not match that of the physical resource and processes. As a result, some resources are managed according to their physical scales in cross-boundary collaboration. This has been attempted by the EU Water Framework Directive, whereby river basins are planned and managed by new administrations (river basin management authorities). These authorities were formed specifically for managing water resources and overlap with existing local, district, and national jurisdictions (Kallis & Butler, 2001). In order to consider spatial scale mismatches in our scenarios, we contrasted the two types of decision-making boundary (administrative units vs. ecological boundaries). The first (Figure 1a, left) is a traditional representation of administrative decision-making levels at the national level and subnational level according to existing administrative boundaries. The most local level is represented by individual farms. We have included individual farms as a level because this is the most local implementation or action-taking level in the current CAP; they are bound by the rules and procedures of the governance system but can choose which agri-environment measures to engage with. Under this system, administrative levels are unlikely to fit to ecologically meaningful management units.

Alternatively (Figure 1a, right), a governance system could make decisions according to levels that are tailored to ecological processes, such that actors collaborate around nontraditional spatial units (Ekroos et al., 2016). If considering decision-making levels for biodiversity conservation, meaningful designations would mean that supranational levels are based around bioregions (Ankersen, Regan, & Mack, 2006). National and subnational levels would be structured around landscape scales in order to improve the match between ecological and administrative scales (van Oosterzee, Dale, & Preece, 2014). A bioregion is defined as a collection of similar landscapes, and landscapes are defined as social-ecological units of coherent character, delineated by common geographies, including land use type, topography, social structures, and climate, and can range from a few hundred meters to a few kilometers (Forman, 2008; Sayer et al., 2013). A landscape is not the optimal scale for management of all species; however, it is an important compromise scale. It is known that the impact of existing agri-environment measures depends on landscape context (Holzschuh, Steffan-Dewenter, Kleijn, & Tscharntke, 2007). Furthermore, landscape structure affects all species (Loos et al., 2019). Thus, we use the landscape scale as the key designation to best reduce the mismatch between ecological processes and management.

2.2 | Decentralization and devolution of power

In thinking about the roles of each level in these constellations, they can be positioned along an axis of decentralization (Figure 1b), which refers to both broadening societal participation (moving powers from

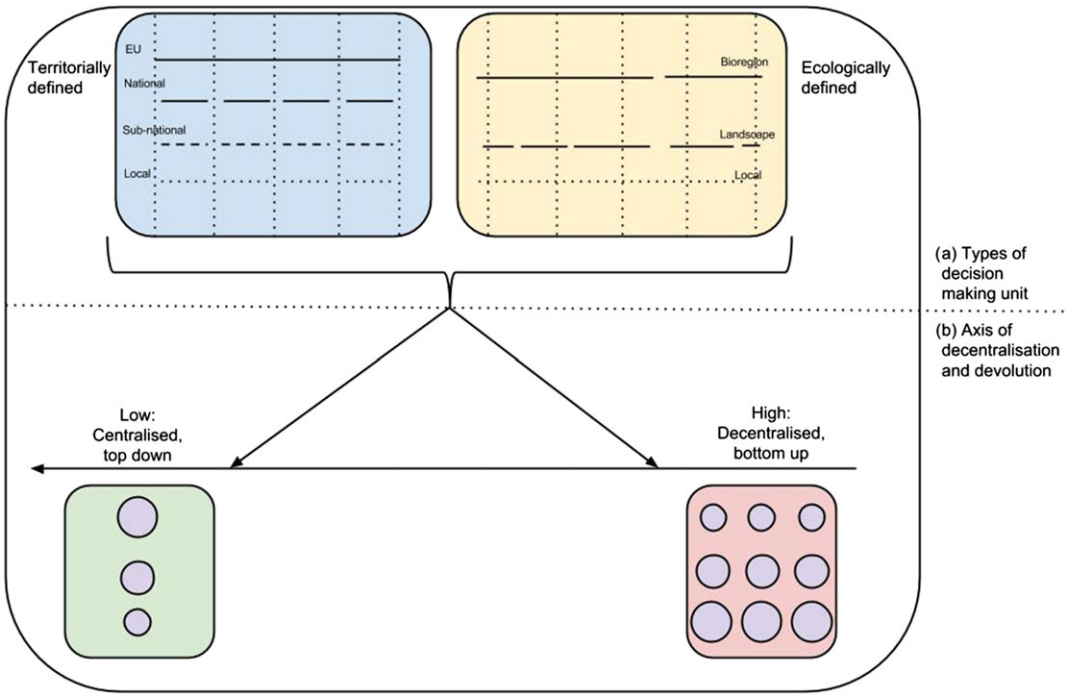

FIGURE 1 The construction of governance scenarios. (a) This part indicates the types of decision-making unit, either administratively defined (left) or ecologically defined (right). (b) This part demonstrates the extremes along the axis of devolution and decentralization: to the left, greatest power (circle size) rests with central government actors (single circle); to the right, greatest power rests at the local level, with decentralized actors (multiple circles) [Colour figure can be viewed at wileyonlinelibrary.com]

central state to a broad range of actors) and devolution (power assigned to more local levels of decision making). We specify between Lukes' (1974) dimensions of power and their roles in structuring institutions and behaviors: agenda setting, decision making, and action powers. These dimensions of power help us to understand how the actions of an individual (e.g., farmer) are shaped by the decisions taken at higher levels or by the agendas set by broad institutional structures (Gale, 1998). We consider which powers the levels hold over other levels within their jurisdictions or territories and topics. We are not considering individual actors and how they exercise power or their forms of power, other than to say that actors present at a given level can participate in the realization of the powers given to that level.

We apply these different forms of power within the topic of biodiversity policy. Simplistically, agenda-setting powers would be to set biodiversity goals and targets, as well as to set broad parameters on how these can be achieved (e.g., budget). Such agenda-setting powers are currently represented by the EU Biodiversity Strategy to 2020. Decision-making powers are held by those who can decide on the structures and procedures within these agendas. Currently, these agendas are set by the EU in the overall policy framework but also by individual member states as they transpose policies into national legislation. Such decision-making powers may be held by multiple governance levels, with different levels taking more specific decisions than others, or decisions about different components of these procedures (e.g., finance, monitoring, and allowable activities). Action-taking powers are held by actors who implement these decisions on the ground in order to meet the set agenda. In reality, these three different types of powers are not neatly divided within a given topic; farmers may have action-taking powers in terms of implementing biodiversity management measures, whereas a government agency may have action-taking powers in terms of spending a budget to support such measures.

Our axis of decentralization also refers to broadening societal participation, such that powers are moved away from central government and given to a broad range of stakeholders. To the left of the axis (Figure 1b), power is more centralized to government bodies and is not devolved: Central government actors at higher levels hold agenda-setting powers; decision-making powers are held also by central government actors, perhaps at lower levels; local, nongovernment actors are only empowered to act according to decisions made higher up and by government agencies. To the right of the axis, power is more decentralized, away from government representatives, and is devolved to a large degree: local, nongovernmental actors (e.g., farms and local level non-governmental organizations [NGOs]) are empowered to set agendas as to what needs to be managed and how. Rather than holding these "higher" forms of power, central governments should be playing a facilitation role.

In order to construct scenarios, the different decision-making units (administratively defined vs. ecologically defined) can be moved along an axis of decentralization and devolution (low vs. high). We therefore combine two variations of decision-making units with two extremes on the axis of devolution and produce four scenarios. Figure 1 demonstrates how both variations of decision-making units can be combined with either a high degree of centralization or a high degree of decentralization and devolution. These scenarios are summarized in Table 1, and described in more detail in Section 3.

3 | THE GOVERNANCE SCENARIOS

3.1 | Scenario 1: Administrative hierarchy

Scenario 1 "administrative hierarchy" incorporates administrative decision-making units, with a low level of decentralization and

TABLE 1 The governance scenarios for managing biodiversity in agricultural areas

Scenario	Name	Devolution and decentralization	Agenda setting powers	Decision-making powers	Action-taking powers
1	Administrative hierarchy	Low	Supranational and national governments set goals	Supranational and national governments set budgets and policy frameworks Enforcement by government agencies	Individual farmers as implementers
2	Autonomous farmers	High	Individual farmers set goals, in collaboration with local governmental, private, and civil society actors	Farmers and governments, supported by private and civil society actors, create policy frameworks and budgets to implement goals	Individual farmers as policy maker–implementers, supported by governmental, private, and civil society actors
3	Ecological scale hierarchy	Low	Administrative bodies (comprising national and subnational governments) at bioregion level set goals	Administrative bodies (comprising national and subnational governments) at landscape level set budgets and policy frameworks	Collectives of farmers as implementers Enforcement by government agencies
4	Collaborative actors	High	Collectives of farmers at landscape scale set goals, in collaboration with local governmental, private, and civil society actors	Collectives of farmers at landscape scale, in collaboration with bioregion authorities, supported by private and civil society actors, create policy frameworks and budgets to implement goals	Collectives of farmers supported by governmental, private, and civil society actors

devolution. Biodiversity planning and management is carried out within administrative boundaries, for example, at the EU level, national level, and then subnational levels down to the local. Decentralization and devolution are low, meaning that government actors and agencies are responsible for decision making, and agenda-setting and decision-making powers over biodiversity management are largely held at the EU and national levels, by government actors. In this way, the EU sets overarching legislation and the minimum budget requirements and mechanisms for operation. National governments can then play a role in refining policies or supplementing funding available for them. Farmers are left with the power to act by implementing policies.

In setting mechanisms for achieving conservation goals, distributing funds and enforcing measures, supranational and national governments would need to select and design policy instruments. This scenario is in fact most similar to the current governance system for managing biodiversity in agricultural landscapes. There are several measures under CAP that deliver biodiversity benefits. In addition to cross compliance requirement, in Pillar 1 of the CAP, 30% of the direct payments are subject to fulfilling the greening requirements, which define that farmers must devote 5% of their farms to ecological focus areas (EFAs), plant a diversity of crops, and maintain permanent grassland. Additionally, under Pillar 2, farmers can receive payments for participating voluntarily in agri-environment schemes (AES). The requirements for EFAs and AES are defined at the EU level and are then refined and implemented by national and subnational authorities. For example, they can refine the measures that are included within AES to make them most relevant to the ecology and farming requirements of the member state.

3.2 | Scenario 2: Autonomous farmers

Scenario 2 "autonomous farmers" incorporates administrative decision-making units, with a high level of decentralization and devolution; all powers are assigned to the local level, including individual farmers and a range of nonstate actors. Administrative levels remain tiered as they currently are in Scenario 1, at the EU, national, state, county, district, and/or municipal levels, and down to the individual farm as a jurisdiction, with powers for biodiversity planning and management being devolved to the local level and decentralized to include a broad range of stakeholders. Ultimately, the farmer has the responsibility to decide what is important to preserve or manage on their own land and to dictate how this is achieved. This scenario is radically different to the current system, whereby farmers are provided with targets and rules and have only freedom to decide which measures to adopt (e.g., under the EFA) in order to meet regulatory requirements. In this scenario, other actors at the local level (state and nonstate) work alongside farmers in deciding biodiversity and spending priorities, and actors in the higher levels of the system play a role in facilitating such planning and action. Practically, this requires the availability of specialist advisors that farmers can access for advice and guidance. In particular, there is a need to apply ecological knowledge to the individual farm scale, requiring place-specialized ecologists. Furthermore, higher governance levels need to consider how to support and facilitate such farmer decision making, for example, by creating funding distribution mechanisms or facilitating decision-making forums.

In order to set policies to shape how funding is distributed, and which measures are supported, national and/or subnational levels could establish decision-making platforms with farmers. In this scenario, providing a clear, transparent mechanism on how to administer funds is difficult without outlining what will be funded and how, yet local level actors need to decide this. A decision-making platform would engage farmers with a broad range of other stakeholders, such as ecologists, environmental NGO's, and government actors in order to discuss priorities, measures, and funding arrangements. This is a significant undertaking for local farmers and stakeholders, which could be a key barrier in the feasibility of this scenario. However, such collaborative governance decision-making platforms have been successfully established, for example, Schwilch, Bachmann, and Liniger (2009) outline such processes for engaging farmers in sustainable land management. They present bottom-up processes focused on identifying local land management problems and designing locally appropriate and accepted solutions for implementation. These take place over a series of facilitated workshops and meetings, supported by information services. Thus, the process promotes mutual learning and allows local priorities to take precedence (Dougill et al., 2006).

3.3 | Scenario 3: Ecological scale hierarchy

Scenario 3 "ecological scale hierarchy" incorporates ecologically informed decision-making units, with a low level of decentralization and devolution. In this scenario, all decision-making levels are based around ecological units: the bioregion and the landscape. Where a landscape crosses traditional administrative boundaries, administrative bodies are compelled to collaborate to produce biodiversity management plans. These necessarily engage multiple sectors, such as agriculture, recreation, and nature conservation, in order to ensure complementarity between sectoral planning. Similarly, where a bioregion crosses international boundaries, national governments collaborate for the purposes of bioregion agenda and policy setting. Thus, the bioregion and landscape levels do not replace the traditional administrative units but serve to reshape the space of governance by promoting collaboration between actors from intersecting administrative units at ecologically meaningful scales.

The approach is top-down and centralized, with powers held by government bodies at the bioregion and landscape levels. The bioregion works to define agendas. In this way, bioregions need to be defined, and national governments within any bioregion need to collaborate to set overarching goals for that region. Landscapes within the bioregion then translate these goals into landscape-scale plans and thus hold decision-making powers. Whichever policy approach is taken by higher governance levels, the landscape scale can use plans to outline collaborative actions between farmers in order to meet these goals, in ways that are tailored to local conditions. Therefore, these plans serve to coordinate the actions of individual farmers within a landscape.

In the EU, the Water Framework Directive, which creates river basin districts as an administrative unit for water management, is a

proxy for such an idea (Kallis & Butler, 2001). River basins were defined and governmental authorities within the river basin must collaborate to make plans. However, such authorities can be weak compared with the decision-making competencies retained by the territorial jurisdictions (Jager et al., 2016). Sub-basins are also defined, and authorities within the subbasin also work together to ensure that their sub-basin contributes to the overall river basin management plan. However, it should be noted that the Water Framework Directive is not a centralized, top-down process as described for this scenario. It also has not necessarily lead to improved environmental decision making; indeed the process of decision making in the river basins is an important determinant of the quality of environmental decision making (Kochskämper, Challies, Newig, & Jager, 2016).

3.4 | Scenario 4: Collaborative actors

Scenario 4 "collaborative actors" incorporates the same ecologically informed decision-making units as Scenario 3 but with a high degree of decentralization and devolution. Thus, agenda-setting powers are devolved to multiple actors at the landscape level. In this way, landscapes and bioregions are again delineated. However, rather than representing just governmental authorities, these ecological levels include a large range of nongovernmental stakeholders, including private companies, NGOs, and farmers. Because powers are devolved to the local level, these landscape levels are charged with establishing priorities, plans to meet them, and with creating mechanisms to distribute funding. Therefore, in this scenario, engaged stakeholders need to assign coordination responsibilities, perhaps in the form of a landscape authority. Such a landscape authority promotes collaboration across the landscape scale for biodiversity management and creates mechanisms to coordinate this. In this scenario, the bioregion serves to integrate landscape scales, perhaps providing coordination and coherence between the different landscapes. In doing so, the constituent government bodies at each level provide support and funding to the landscape level, perhaps facilitating collaborative planning processes, as in Scenario 2. Although this means there are similarities with Scenario 2 (because of the high degree of decentralization and devolution), the core difference results from the use of ecological scales for the decision-making units. Thus, farmers are not deciding about only their own land; rather, there is specific emphasis on collaboration for delivering biodiversity management across the whole landscape, for example, to jointly plant woodland or to devote one farm to biodiversity production and another to food production. Potentially, such collaboration could also occur between landscape scales in order to promote coherence at the bioregion scale.

Although it is difficult to find a clear example of this scenario in practice, lessons could be learned from community-based natural resource management (CBNRM). CBNRM has been extensively employed in development projects; communities are given a level of ownership over natural resources and in exchange are paid for ecosystem services they provide. Such services might include carbon sequestration (Dougill et al., 2012) or wildlife for tourism and/or hunting (Barnes, Macgregor, & Chris Weaver, 2002). Ideally, community councils work with facilitating organizations, in partnership with government, and with the input of specialists around the resource but drawing on traditional knowledge (Phuthego & Chanda, 2004). Interestingly, such schemes are increasingly utilized within a bioregion designation through cross-boundary national parks (e.g., Nyika in Malawi and Zambia). In our scenario, the community council would be analogous to the landscape level. Thus, farmers are engaged in deciding how to manage resources and in deciding how they are incentivized to do so.

4 | THE POTENTIAL IMPACT OF THE SCENARIOS

4.1 | Biodiversity conservation outcomes

Addressing the spatial scale mismatch would initially appear harder in those scenarios designed around administrative units. These scenarios have no explicit recognition of the spatial scale of biodiversity conservation, and thus it would be easy for them to neglect the coherent planning of conservation measures that "fit" together. However, the logic of administrative units does not necessarily negate collaborative actions that would alleviate the spatial scale mismatch (Moss, 2003). In Scenario 1, there is scope for higher governance levels to mandate (or at least facilitate) collaboration between individual land owners, and neighboring districts could coordinate their planning. Similarly, in Scenario 2, land owners are free to collaborate to achieve the biodiversity goals they have set themselves. However, in these scenarios, such collaboration is not the default option; it is something that requires further effort to establish and thus relies on the motivation of the individuals and officials involved. Therefore, such collaboration would be easier around some kind of landscape plan that agreed and specified targets and measures.

Although the ecological scale scenarios explicitly address the spatial scale mismatch in biodiversity conservation and provide such landscape scale plans, they may not automatically lead to improved biodiversity outcomes. Rather, these will be dependent on the values and beliefs of the people engaged throughout the system and the powers they have to act on these values. Under Scenario 4, where farmers have complete control to collaborate through a landscape or Scenario 2 where they manage their farms individually, if their priorities are not aligned to biodiversity conservation, then it is possible that no action will be taken. Similarly, under Scenario 3, where there is top-down control, if top-level policy makers do not priorities biodiversity conservation, then there will be only low targets and weak measures set. And even where ambitious biodiversity targets are set, previous research (Leventon, 2014) has shown that all actors within the system need to agree with their need in order to fully implement them. Thus, although governance around ecological scales can promote improved biodiversity outcomes, this can only be achieved where actors within the system view biodiversity conservation as a desirable goal. Furthermore, the landscape scale is not perfect for management of all species and thus is not the only solution for achieving all biodiversity goals.

4.2 | Administrative complexity

Administrative complexity is certainly lower in those scenarios that follow the existing administrative structures (Scenarios 1 and 2). Keeping structures arranged around existing administrative units requires no rearranging away from the status quo. Conversely, arranging around ecological scales (Scenarios 3 and 4) can require a high degree of administrative complexity. Whereas the administrative units would not be removed, a range of units would need to collaborate around the ecological scales (bioregion and landscape). This can require national and subnational governance levels to collaborate across international, national, and subnational borders. Such collaboration is difficult to coordinate and conduct. For units in particularly complex environments, for example, within an international bioregion, with multiple smaller landscapes, including those that span administrative boundaries, the burden could be very high.

Such complexity in administration is further complicated in the bottom-up scenarios (particularly in Scenario 4, which is both bottom-up and based on ecological scales). In these scenarios, there is a broad range of actors to coordinate and engage with. The danger is that actors end up contributing to decision-making processes over multiple scales in multiple bioregions and landscapes, exhausting resources and capacity. Thus, although such scenarios should improve democratic accountability by engaging affected actors in the decisions that affect them, the danger is of creating a burden that negates such democracy in practice. A trade-off therefore emerges between ecologically coherent and administratively simpler governance arrangements, and this trade-off needs to be balanced.

5 | AN ALTERNATIVE GOVERNANCE SYSTEM FOR BIODIVERSITY IN AGRICULTURAL LANDSCAPES

On the basis of the potential for biodiversity impacts and governance complexity, it is apparent that an alternative governance system would need to take elements from different scenarios in order to balance priorities and practicalities (see Table 2).

From the perspective of achieving biodiversity conservation outcomes, a governance system that works according to ecological scales, but that is neither highly decentralized nor highly centralized, would be a constructive approach. Such an approach would draw on the logic of ecological scales, facilitating planning at the landscape scale. However, this would not be relied on as an automatic way to secure improved biodiversity conservation. Rather, the balance of powers would need to be considered 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. Instead, forums should be created that allow all actors in the system to influence biodiversity agendas, decision making, and action taking. Such an approach would imply that there are elements of a top-down hierarchy, in that policies should set goals that plans below must follow, and there can be an element of enforcement. But there would also be multiactor engagement at the landscape level to shape goals and decisions, bringing together land owners, farmers, ecologists, conservationists, and policy makers and also actors from other interests that intersect with biodiversity management, such as water, forestry, or tourism.

From the perspective of complexity, some level of compromise could be achieved by simplifying to include just a landscape scale designation (and not a bioregion) as the primary unit for biodiversity conservation planning, nested within existing administrative structures. Single administrative units are likely to be within multiple landscapes, and thus there is some complexity. But rather than engaging with multiple actors over multiple scales, the process is simplified to focus on bringing together actors at a landscape scale.

We therefore offer for discussion a hybrid scenario, whereby the current EU governance system for biodiversity conservation in agricultural areas should be reshaped around collaborative landscape scale planning, as outlined in Figure 2. This idea echoes previous calls for biodiversity conservation at a landscape scale (Pressey & Bottrill, 2009; Tscharntke et al., 2007), but we offer greater detail as to how this would work as a governance system. Specifically, administrative levels continue to exist but come together within a landscape-level decision-making forum to produce landscape biodiversity plans and implementation strategies (as depicted to the left of Figure 2). Such documents would outline goals and actions for biodiversity conservation within that landscape (see the right of Figure 2). This has the advantage that biodiversity conservation can be designed in an ecologically coherent manner within an ecologically coherent unit (the landscape). Similar to the Water Framework Directive, member states could retain autonomy over deciding how to administer and facilitate such landscape scale planning. For example, specific bodies (landscape management authorities) could be formed, existing authorities could subsume responsibility for leading this process, or a group of existing actors could share the responsibilities between them in a more diffuse organization.

TABLE 2 Strengths and weaknesses of the theorized scenarios for delivering effective biodiversity governance

Scenario	Conditions for impact to biodiversity	Impact to governance complexity
1. Administrative hierarchy	Higher levels to mandate collaborative biodiversity targets	Low; no additional requirement to collaborate across boundaries
2. Autonomous farmers	Requires motivation to collaborate and coordinate	Low; no additional requirement to collaborate across boundaries
3. Ecological scale hierarchy	Dependent on higher levels prioritizing biodiversity	High; requirement for administrative actors to coordinate across multiple ecological boundaries
4. Collaborative actors	Dependent on local actors prioritizing biodiversity	Highest; broadest range of actors needed to collaborate across a range of scales

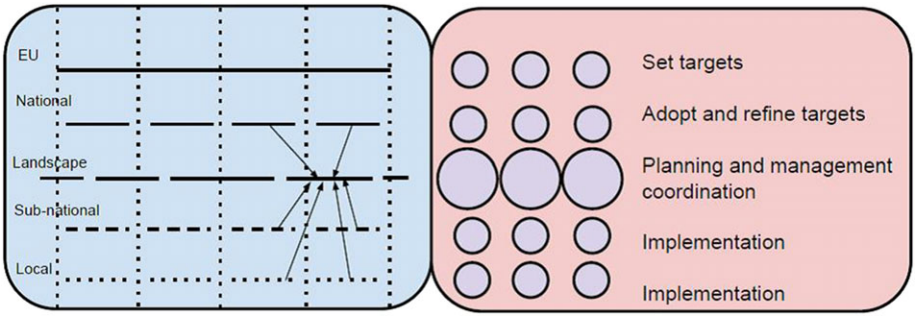

FIGURE 2 Landscape scale governance for biodiversity in agricultural landscapes. To the left, the figure depicts the governance levels engaged in the system. Arrows indicate that various administrative levels come together at landscape scale. To the right, the distribution of power is considered. Multiple actors (multiple circles) are involved at all levels. Power is dispersed through the system (circles are a similar size), although the landscape level has greater power through its function to produce plans and landscape targets, and outline how management should occur [Colour figure can be viewed at wileyonlinelibrary.com]

Within this proposed system, there remains an element of hierarchy, such that landscape-scale plans can be enforced and higher administrative levels can influence goals and outcomes (e.g., through the EU biodiversity strategy and national targets). However, these are combined and balanced by engagement processes at the landscape scale that bring together all stakeholders in agenda setting and decision making. In this way, stakeholders at the landscape scale are able to influence the way in which management plans are designed and implemented, shaping landscape-specific biodiversity targets and management actions. There is room for the diverse priorities of actors to be heard and balanced, and there is less risk that the biodiversity goals are undermined by the goals of a small number of actors with competing interests.

Such a changing of the governance system reshapes the space of governance to overcome actor, and issue, fragmentation. Planning at a landscape scale allows for the creation of biodiversity measures that must be implemented by multiple land managers, for example, for multiple farmers to plant trees that collectively form a larger patch of woodland. In this way, opportunities are created to overcome the actor fragmentation noted by Leventon et al. (2017) and to fulfil calls for collaborative land management (Dallimer et al., 2010; Prager, 2015). However, the bringing together of multiple actors and interests at this scale can also serve to reshape the space of governance by changing the way in which places, policies, and actors interact (Healey, 2006; Moss, 2004). Currently, EU governance can suffer from a critique of silo thinking, whereby the interplay between sectoral policies is not well considered, resulting in trade-offs between interests on-the-ground (Paavola, Gouldson, & Kluvánková-Oravská, 2009). Under a collaborative landscape-scale planning process, issues of water management will be brought together with issues of agricultural production, and both will be considered alongside biodiversity conservation and all over a range of scales. In this way, trade-offs and synergies can be explicitly considered and managed. Potentially, this reshaping has positive outcomes for environmental and social outcomes beyond the topic of biodiversity conservation. Such benefits merit further consideration when discussing whether, and how, to implement such an alternative system.

Implementing a landscape scale approach is not automatic and requires substantial planning, design, and consideration of practicability; there are many factors that would need in-depth consideration. Demarcating landscapes is a practical challenge, particularly as landscapes are currently not a universally defined unit and are often based around subjective judgements. Establishing processes for collaboration and engagement in planning processes is also not straightforward. Indeed, experience from, for example, the Water Framework Directive, shows us that participation needs to be carefully designed to allow for meaningful engagement (Kochskämper et al., 2016; Koontz & Newig, 2014). For example, intensive local participation can increase the quality of environmental outputs, and stakeholder acceptance of outputs is related to the process of engagement rather than the output itself (Kochskämper et al., 2016). Furthermore, financial and human resources need to be accounted for to ensure that such a system can function. New roles are created, for example, for ecologists specialized in specific landscapes, in order to provide context specific input to plans. Moreover, planning processes will require financing. Such considerations will be pertinent in those areas with multiple landscapes intersecting within a single administrative unit, that is, where there is a complexity of multiple small landscapes intersecting. This is likely to occur more often in those areas with smallholder agriculture and diverse topography, which often coincides with economically poorer areas in Europe, for example, Romania (see, e.g., Mikulcak, Newig, Milcu, Hartel, & Fischer, 2013). Particular attention must therefore be given to how to facilitate and finance a restructure to the governance system.

In relation to practicability, we also acknowledge the need to think about governance complexity beyond the topic of biodiversity. Biodiversity conservation is not the only topic to be advocating for planning and management according to the physical scales of the processes that should be managed. Clearly, water is already being managed according to the river basin scale. Furthermore, there have been calls for, and examples of, management units based around airsheds (Cushing, 2009), coastal zones (Sorensen, 1993), and seascapes (Pressey & Bottrill, 2009). If all such designations are superimposed on top of existing administrative structures, there is a danger of overstretching the capacity of existing authorities. Potentially, they would need to collaborate in multiple processes at multiple scales, and therefore capacity would need to be increased to support this. This issue of multiple collaborations is particularly relevant to stakeholders such as conservation NGOs and farmers whose activities and interests intersect into multiple interests (e.g., water, biodiversity, and air pollution). Expectation to

collaborate in multiple decision-making processes is unlikely to lead to meaningful and effective participation; indeed it creates administrative, technical, and democratic challenges (Moss & Newig, 2010; Pahl-Wostl et al., 2012). Indeed it would be necessary to explore options to find complementarity between the system for biodiversity governance and systems for other issues. For example, consultation and planning forums could be coordinated across issues, allowing input to multiple issue plans through one participation process.

In addition to thinking about the practicalities of redesigning the system for managing biodiversity, we need to consider the goals and values that underpin it (cf., Abson et al., 2017). For there to be systemic change, actors must support the goals the system is seeking to achieve. Furthermore, the success of our scenarios in delivering biodiversity benefits relies on actors valuing biodiversity and having goals to preserve biodiversity (see Section 4). A governance system that is reshaped according to our suggested alternative system therefore represents a wholesale shift in policy paradigm. Changing the policy paradigm goes beyond mere logistics, and shifts actors' powers, and the goals and structures of governance systems (Hall, 1993). Governance systems tend to be resistant to such change—they are path dependent, and opportunities for change are constrained by what has gone before (Jordan, Wurzel, & Zito, 2003). We therefore fully recognize the hypothetical nature of our governance scenarios. However, we offer them as a basis to stimulate thought and discussion, with the hope that we can think beyond the current constraints of the existing system.

6 | CONCLUSIONS

We have outlined an alternative governance system for the conservation of biodiversity in agricultural areas in the EU. We created this proposal by first theorizing four idealized governance scenarios. These scenarios were designed around extremes of decentralization and devolution, combined with contrasting decision-making units (administrative levels vs. ecological scales). By considering how each scenario has the potential to improve biodiversity outcomes and the impact of each on administrative complexity, we highlighted the strengths and weaknesses of each. Based around the strengths of our various scenarios, our proposed governance system brings multi-sector, multi-topic actors together at a landscape scale in order to set goals and make decisions around biodiversity conservation. This approach provides a forum for coordinating individual and collaborative land management actions for biodiversity and helps to integrate diverse interests, thus allowing for the management of trade-offs and synergies between sectors.

However, implementing this scenario would come with challenges and indeed is unlikely to be realistic as a wholesale, sudden change. Practical implementation would be complicated, particularly around demarcating landscapes and facilitating the landscape planning process. This is likely to be challenging in more complex landscape contexts. Key to ensuring the success of such a scenario would be to consider the change in powers, roles, and responsibilities to actors within the system. We therefore recommend that our proposals are used to stimulate discussion around priorities for biodiversity conservation in agricultural landscapes. In particular, we suggest that our hypothetical scenarios should prompt thinking amongst policy actors and farmers through collaborative forums. Such thinking needs to go beyond the current system of governance, to ask if we can find ways to provide more fundamental policy change that answers the core challenges (such as spatial scale mismatches) experienced in biodiversity conservation policy.

Important to such a discussion would be consideration of the actual impact of the scenarios and in particular of our proposed hybrid alternative. Although we have provided a hypothetical consideration of this in this paper, it would be useful to have empirical evidence. We thus point to evidence of landscape scale management producing positive biodiversity outcomes (Dallimer et al., 2010; Prager, 2010, 2015). However, we suggest it would be useful to further explore case study examples of landscape scale collaborations from a governance change perspective, asking questions of the barriers and opportunities for actors to collaborate, their acceptance, and how this case fits within the broader governance system. We therefore offer this challenge for future biodiversity management research.

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APPENDIX A

ENACTING SCENARIOS: A WORKED EXAMPLE FROM SAXONY, GERMANY

Materials and methods

In order to see how the scenarios would pay out in a real world context, we explored the governance system in Saxony, Germany. We started by identifying stakeholders and their roles in managing biodiversity in agricultural landscapes. We consider stakeholders to be anyone that can affect, or is affected by, the topic in question (Reed et al., 2009). We conducted our review by starting with the Common Agricultural Policy (CAP). We considered CAP to be the core policy instrument for managing biodiversity in intensive agricultural landscapes.[2] We therefore conducted an internet search to identify stakeholders that were engaged in CAP. However, in recognizing that biodiversity conservation is not only achieved via CAP, we then expanded the

[2]Natura 2000, under the Habitats directive is also an important policy instrument for biodiversity conservation in the EU. It establishes protected areas for key species, and its implementation and management should be supported through CAP, both by helping to link protected areas and in ensuring these areas are well managed and supported by landowners and land managers.

search to specifically look for stakeholders that were engaged in projects relating to biodiversity and agriculture in Saxony. We thus searched for actors that are not part of the formal policy-led system but nevertheless are part of biodiversity governance in Saxony. Once the research team were confident that they had a full collection of stakeholders, the list was verified during workshops held in October 2014. Attendees (36) were invited from the list of stakeholders. During the workshop, they were asked to consider other stakeholders that they knew of that were not already included in our lists. The resultant list is shown in Table A1, Column D.

To consider the changes necessary to enact each scenario, we focused on the roles and powers that each stakeholder has in relation to biodiversity governance and could have under our governance scenarios. We thus characterized stakeholders according to their current role in biodiversity conservation in Saxony. We considered both formal powers under the CAP system, and non-CAP roles. For formal CAP roles, we referred to how stakeholders' roles were described in policy documents and in their own reports and documentation. We considered the primary focus of the stakeholder (environmental protection, agricultural production, and etc.) and the sector (NGO, private company, and etc.), as well as the governance level at which they work. We furthermore considered the types of power that the stakeholder had under the current CAP-led policy system; we thus categorized them according to whether they played agenda setting, decision making, or action taking roles in CAP. At this stage, the additional category of "supplementary powers" emerged for actors that were involved in agenda setting, decision making, or action-taking but were not formally delegated in policy, for example, consultancies that worked with farmers to advise on how to implement CAP. The role of parallel projects also emerged as being separate to CAP actions but also working towards biodiversity conservation. Following this characterization, we considered how the roles, powers, and governance levels would change under each scenario.

The scenarios in Saxony, Germany

The current governance system in Saxony for biodiversity in agriculture can be characterized as a Type I MLG system. The governance system incorporates a number of decision-making levels: The federal state is a powerful subnational designation, and the state of Saxony is further divided into districts (Landkreise) and then into municipalities. Stakeholders with direct roles in implementing CAP are largely organized according to these administrative levels (see Table A1, Column D). However, some organizations work at a region level, reflecting a historical legacy. In 2008, three Landesdirektionen were founded to cover three administrative regions in Saxony. In 2012, these Landesdirektionen were merged to become the Landesdirektion Sachsen, although there are still branches in the three regions. Additionally, different landscapes (Landschaftsgliederung) have been demarcated for the purposes of nature conservation. The 37 landscapes form the basis for landscape planning and goals and strategies are developed for each. For agricultural purposes, Saxony has also been divided into 11 "comparison areas" (Vergleichsgebiete), based on the climatic conditions, soil-related data, and similar conditions for agriculture (LfULG 2012). However, these are not administrative units, and actors work according to the landscapes or areas included within their administrative area.

The existing system displays a low degree of devolution. The main agenda for CAP is set at the EU level, outlining targets for biodiversity management (e.g., the EU Biodiversity Strategy to 2020), as well as for agricultural production. CAP policies, such as the amount of funding available, the types of measures supported, the rules of operation, and mechanisms for distributing funding, are also agreed at the EU level. For example, in the 2014 reform, it was agreed that compulsory ecological focus areas were included as part of the greening component under CAP and that farmers would receive less CAP support unless these, and other items of environmental legislation, were fully implemented. The national and subnational levels of government then play a role in translating CAP into national policy, in refining measures under the agri-environment schemes, and in administering payments. They thus have decision-making powers. Farmers are the implementers of measures and have power mainly through choosing schemes they access or by choosing to access none. Other than individual farmers, the actors with official CAP functions are largely state actors (Table A1, Column E).

The existing system has some degree of decentralization through the supplementary roles played by nonstate actors (Table A1, column E). Private companies (consultancies) work with farmers to advise them on the policy and plan implementation and thus have supporting powers under CAP. Furthermore, a range of civil society groups have influence as lobbyists or consultants or by doing related project work. These actors are primarily NGOs with specific agendas to protect nature and the environment more generally (Column B). The lobbying role has been formalized for some actors (e.g., NABU Landesverband and a number of farmer and environmental organizations) through the Wirtschafts- und Sozialpartner (WiSo; economic and social partners) network. Partners in the network are engaged in the development of the rural development programs in the state, and some are also members of the monitoring committee for these programs during implementation. They thus have some degree of influence over decisions made around CAP but do not hold decision making or agenda setting powers.

There is a broad range of supplementary powers provided by actors (Table A1, Column E). In addition to the essential administration of CAP and its payments, there are consultancies specialized in understanding this administration and in understanding how different measures will work on different farms. The nature protection NGOs tend to act as ecological specialists, inputting knowledge to try to improve the ecological benefit of measures, and pushing for wider implementation of actions that increase biodiversity. Alongside, farmers associations assist in optimizing production, and ensuring that production and business viability are considered in decision making. Currently, these skills are most available at the state and at the farm level, feeding into decision making at the state level and into action at the farm level.

Under the governance scenarios, the changes to these roles are summarized in Table A1, Columns F–I.

TABLE A1 The governance scenarios in Saxony—Changes to the status quo

Actors (current system)					**Roles and responsibilities (in the scenarios)**			
A. Level	B. Sector	C. Focus	D. Example Actor	E. Current Role	F. S1 Administrative hierarchy	G. S2 Autonomous farmers	H. S3 Ecological scale hierarchy	I. S4 Collaborative actors
European Union (EU)	Government/ administration	Agriculture, environment	EU Commission	Agenda setting	Agenda setting	Decision making (distribution of funding)	Agenda setting (setting targets and goals for bioregions; setting budget requirements)	Decision making (distribution of funding)
National	Government/ administration	Agriculture, environment Environmental conservation, rural development	Federal Ministry of Food and Agriculture (BMEL) Federal Agency for Nature Conservation (BfN)	Agenda setting; concrete decision making (distribution of funding and etc.) Agenda setting; concrete decision making (distribution of funding and etc.); supplementary role (research)	Decision making (select and design policy instruments, refining EU legislation, distribution of financial means)	Decision making (collaborative; on funding arrangements at national level; distribution of funding) Supplementary (facilitation of collaborative decision making)	Decision making (select and design policy instruments for the natural region, together with authorities from Poland and Czech Republic; distribution of funding)	Decision making (collaborative; on funding arrangements for natural regions, together with actors from Poland and Czech Republic; distribution of funding) Supplementary (Integration/ coordination of landscape scales; facilitation of collaborative decision making)
	Private sector Civil society	Agricultural production Environmental conservation, rural development Imkerei	German Farmers' Association German Association for Landcare German Beekeepers‘ Federation	Supplementary role (consultancy, lobbying) Supplementary role (lobbying)	Supplementary (e.g., consultancy, lobbying)	Decision making (collaborative; on funding arrangements at national level) Supplementary (provision of knowledge and support)	Supplementary (e.g., consultancy, lobbying, training)	Decision making (collaborative; on funding arrangements for natural region, together with actors from Poland and Czech Republic) Supplementary (provision of knowledge and support)
Between national and federal state level	Private sector Civil society	Agricultural production Agriculture, environment	Bioland regional association East Syndicate of Traditional Agriculture (AbL) regional association Saxony	Supplementary role (consultancy, production guidelines) Supplementary role (lobbying)		Decision making (collaborative; on funding arrangements at state level)		Decision making (collaborative; on funding arrangements for natural region, together with actors from other federal states)

(Continues)

TABLE A1 (Continued)

Actors (current system)					Roles and responsibilities (in the scenarios)			
Federal state	Government/ administration	Agriculture, environment	Saxon State Ministry of the Environment and Agriculture (SMUL)	Agenda setting; concrete decision making (distribution of funding and etc.); supplementary role (consultancy, research, knowledge transfer)	Decision making (on actual measures, refinement of German legislation; distribution of funding)	Decision making (collaborative; on funding arrangements at state level; distribution of funding) Supplementary (facilitation of planning and action at regional and local levels)	Decision making (on actual measures for the natural region, together with authorities from Lower Saxony, North Rhine-Westphalia, Hesse, and Saxony-Anhalt; distribution of funding)	Decision making (collaborative; on funding arrangements for natural region, together with actors from Lower Saxony, North Rhine-Westphalia, Hesse, and Saxony-Anhalt; distribution of funding) Supplementary (Integration/ coordination of landscape scales; facilitation of collaborative decision making at the level of the natural region; facilitation of farmer collaborative processes)
		Environmental conservation, rural development	Saxonian State Foundation Nature and Environment (LaNU)	Concrete decision making (distribution of funding and etc.); supplementary role (consultancy)				
	Private sector	Agricultural production	Saxonian Farmers' Association	Supplementary role (consultancy, lobbying, cultivation and production guidelines	Supplementary (e.g., consultancy, lobbying, and training)	Decision making (collaborative; on funding arrangements at state level)	Supplementary (e.g., consultancy, lobbying, and training)	Decision making (collaborative; on funding arrangements for natural region, together with actors from Lower Saxony, North Rhine-Westphalia, Hesse, and Saxony-Anhalt)
	Civil society	Agriculture, environment	German Association for Landcare (DVL) regional association Saxony	Supplementary role (lobbying and consultancy)				
		Environmental conservation, rural development	State Union Saxonian Cultural Heritage Management	Supplementary role (lobbying and consultancy)				
		Beekeeping	Regional Association of Saxonian Beekeepers	Supplementary role (lobbying and consultancy)				
Regional	Government/ administration	Agriculture, environment	Educational and Training Center (FBZ) Nossen	Concrete decision making (distribution of funding); supplementary role (consultancy)	Decision making Supplementary (compliance; consultancy)	Decision making (collaborative; on funding arrangements at local level) Supplementary (Provision of knowledge and specialist support)	Tailored to fit the landscapes! Decision making (on landscape-scale plans) Supplementary (compliance; consultancy)	Tailored to fit the landscapes! Decision making (collaborative; on objectives, landscape-scale plans; distribution of funding) Supplementary (promotion and coordination of (on the ground) collaboration for BD management; provision of knowledge and support to farmers)
	Private sector	Agricultural production	Regional Farmers' Association Muldental;	Supplementary role (consultancy)	Supplementary (e.g., consultancy, lobbying, and training)		Supplementary (e.g., consultancy, lobbying, and training)	
	Civil society	Agriculture, environment	Landcare Association Torgau-Oschatz	Implementation; supplementary role (consultancy)				
			LEADER LAG Lommatzscher Pflege	Supplementary role (consultancy)				

(Continues)

TABLE A1 (Continued)

Actors (current system)					Roles and responsibilities (in the scenarios)			
		Environmental conservation, rural development						
District	Government/ administration	Environmental conservation, rural development	District Leipzig—Local Nature Protection Agency	Concrete decision making (distribution of funding); supplementary role (control and execution)	Decision making Supplementary (compliance; consultancy)		Decision making (on landscape-scale plans) Supplementary (compliance; consultancy)	Decision making (collaborative; on objectives, landscape-scale plans; distribution of funding) Supplementary (promotion and coordination of (on the ground) collaboration for BD management; provision of knowledge and support to farmers)
	Private sector	Agriculture, environment Agricultural production Beekeeping	Specialised Office for Nature Conservation and Landscape Ecology EXAgT – Office for Precise Agronomy local beekeepers' associations	Supplementary role (consultancy) Supplementary role (consultancy) Implementation; supplementary role (consultancy)	Supplementary (e.g., consultancy, lobbying, and training)		Supplementary (e.g., consultancy, lobbying, and training)	
Local	Private sector	Agricultural production	Farmers	Action taking	Action taking (implementation of measures)	Agenda setting (goals and priorities for on-farm biodiversity) Decision making (on actual measures; funding arrangements) Action taking (implementation of measures)	Action taking (in collaboration with other farmers and as outlined in the landscape-scale plans)	Agenda setting (collaborative; goals and priorities on a landscape scale) Decision making (collaborative; on landscape-scale plans; distribution of funding) Action taking (in collaboration with other farmers, facilitated and coordinated by landscape level)

Article 4 'Acceptability of alternatives'

Rethinking biodiversity governance in European agricultural landscapes: Acceptability of alternative governance scenarios

Abstract

Biodiversity conservation in agricultural landscapes continues to be a key challenge in the European Union (EU). However, to date the Common Agricultural Policy (CAP), which is central for addressing this issue, has proven ineffective in improving biodiversity outcomes. In contrast to solutions that focus on individual policies or measures, we take a holistic approach to explore changes in the broader governance system for biodiversity conservation. For this purpose, we draw on a set of four theoretical, ideal-typical scenarios which represent alternative governance approaches and used them to stimulate discussion about the acceptability of contrasting governance approaches among a broad range of actors in three case study areas in Germany and Sweden. Our results highlight that acceptability of alternative governance approaches is shaped by a large variety of factors. Additionally, despite differences between the views and interests of different stakeholder groups, our findings show universal support for governance approaches that fundamentally differ from the status quo approaches. Thus, evaluating and addressing acceptability of alternative governance approaches needs to consider the preferences of many different stakeholders and requires a more holistic perspective. We therefore argue that designing a potentially widely acceptable alternative governance solution for biodiversity conservation in agricultural landscapes requires a blend of different governance approaches. We outline principles that can guide the design of such a blended governance approach and discuss key challenges arising from the suggested changes for both practitioners and future research.

Keywords

Biodiversity conservation; Common Agricultural Policy; European Union; multi-level governance; scenarios; transformation.

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Rethinking biodiversity governance in European agricultural landscapes: Acceptability of alternative governance scenarios

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ABSTRACT

Biodiversity conservation in agricultural landscapes continues to be a key challenge in the European Union (EU). However, to date the Common Agricultural Policy (CAP), which is central for addressing this issue, has proven ineffective in improving biodiversity outcomes. In contrast to solutions that focus on individual policies or measures, we take a holistic approach to explore changes in the broader governance system for biodiversity conservation. For this purpose, we draw on a set of four theoretical, ideal-typical scenarios which represent alternative governance approaches and used them to stimulate discussion about the acceptability of contrasting governance approaches among a broad range of actors in three case study areas in Germany and Sweden. Our results highlight that acceptability of alternative governance approaches is shaped by a large variety of factors. Additionally, despite differences between the views and interests of different stakeholder groups, our findings show universal support for governance approaches that fundamentally differ from the status quo approaches. Thus, evaluating and addressing acceptability of alternative governance approaches needs to consider the preferences of many different stakeholders and requires a more holistic perspective. We therefore argue that designing a potentially widely acceptable alternative governance solution for biodiversity conservation in agricultural landscapes requires a blend of different governance approaches. We outline principles that can guide the design of such a blended governance approach and discuss key challenges arising from the suggested changes for both practitioners and future research.

1. Introduction

Biodiversity conservation in agricultural landscapes continues to be a key challenge in the European Union (EU). The EU's primary policy framework for tackling biodiversity issues on farmland is the Common Agricultural Policy (CAP). The objectives of the CAP originally focused on achieving efficiency in the agricultural sector, stabilizing prices, providing a reliable and affordable supply of food, and ensuring an equitable distribution of income to farmers (Gray, 2000). These objectives have been broadened and now also comprise environmental aspects, including natural resources and biodiversity conservation (European Commission, 2014). However, the effectiveness of agri-environment schemes (AES), the CAP's key policy instrument for biodiversity conservation, is questionable (see e.g. Batáry et al., 2015). To exacerbate this, the 2014 CAP reform has fallen short on improving biodiversity protection due to its weak requirements and many exceptions (Pe'er et al., 2014) and first results on the biodiversity benefits of ecological focus areas indicate a lower uptake of options that are considered to be more beneficial for biodiversity (Pe'er et al., 2016). In addition to the CAP's shortcomings in terms of policy design, farmers' voluntary participation in AES is typically higher in less intensively farmed areas (Rundlöf and Smith, 2006; Zimmermann and Britz, 2016), which are less prone to biodiversity decline. To date, the CAP framework and its measures thus have not achieved the EU's goal of reversing the loss of biodiversity (European Commission, 2011).

By now, actions to counteract biodiversity loss have been of piecemeal character and therefore of limited effectiveness. These attempts have focused predominantly on how individual policy sectors or existing policy instruments can be improved. For example, payment levels of AES have been changed, and expanding results-based payment approaches instead of the current action-oriented payments are being tested and proposed for improving the CAP's biodiversity benefits (Herzon et al. 2018). In order to extend the scope of discussions beyond the level of individual agri-environment schemes, we take a holistic approach and focus on alternative governance approaches for biodiversity conservation. Single elements that could constitute such alternative governance approaches have already been discussed in the literature. For example, landscape-scale management is increasingly

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advocated in the context of biodiversity conservation and the provision of ecosystem services (Tscharntke et al., 2005), providing an opportunity to overcome the current mismatch between the scales of ecological processes and the scales at which management actions are taken (e.g. Pelosi et al., 2010). Furthermore, collaborative approaches in agri-environmental management provide opportunities to create beneficial environmental impacts at the landscape scale (Prager, 2015; Westerink et al. 2017).

One key challenge for alternative governance approaches is their implementability, which requires the acceptance and the support of affected actors (Macnaghten and Jacobs, 1997). Thus, the overarching goal of this paper is to explore the acceptability of alternative governance approaches for biodiversity conservation in agricultural landscapes. To gain an understanding of the factors shaping the acceptability of alternative governance approaches of environmental and biodiversity conservation, we consider literature on environmental governance, institutional change as well as more specific research on farmers' acceptability of AES. Additionally, we draw on a set of four theoretical, ideal-typical governance scenarios which represent alternative governance approaches for biodiversity conservation in agricultural landscapes. They are conceptually situated at the extreme ends of two governance dimensions: (i) centralized, top-down vs. decentralized, bottom-up decision-making, and – in order to take into account the cross-boundary nature of biodiversity loss – (ii) decision-making based on administrative boundaries vs. decision-making based on ecological boundaries (cf. Leventon et al., 2018). These scenarios do not per se present better or worse ways of managing biodiversity. Instead, we used these exploratory scenarios (following Börjeson et al., 2006) to stimulate discussion about the acceptability of contrasting governance approaches among a broad range of actors in three case study areas in Germany and Sweden.

To achieve this overarching goal, this paper pursues two objectives. First, we aim to understand how stakeholders evaluate the different alternative governance approaches (objective 1), that is, which governance scenario(s) stakeholders prefer and in which way acceptability differs among stakeholders. Second, we explore factors shaping acceptability of these different alternative governance approaches to explain variation in scenario acceptability (objective 2). To this end, we assess the influence of acceptability factors suggested in the literature on environmental governance, farmer acceptability of AES, and institutional change. Additionally, we assess rationales for accepting or rejecting these scenarios expressed by the stakeholders themselves. The paper continues by outlining four governance scenarios and subsequently describes the theoretical basis as well as the methodology for evaluating their acceptability before presenting and discussing the results.

2. Four theoretical governance scenarios for biodiversity conservation in agricultural landscapes

Scenarios offer a way to visualize different plausible alternatives, assess their implications, and explore their acceptability in a risk-free space, which is unfettered by the restraints of usual policy-making (Volkery and Ribeiro, 2009). We base our assessment of alternative governance approaches for biodiversity conservation in agricultural landscapes on a set of four exploratory governance scenarios (sensu Börjeson et al., 2006) that represent different governance approaches (Table 1). These scenarios differ in two gradients that reflect key challenges and trends in environmental management, i.e. the scenarios represent combinations of the following characteristics:

- top-down decision-making, where power rests centrally with governmental actors vs. bottom-up decision-making, where power is decentralised to the local level and distributed among a broad range of actors;
- multi-level governance (MLG) based on territorial (MLG type I) vs. functional (MLG type II) system boundaries (Frey and Eichenberger, 1996; Hooghe and Marks, 2003).

The implications of the different forms of these characteristics for the effectiveness of environmental governance have been widely debated (e.g. Hooghe and Marks, 2003; Newig and Fritsch, 2009; Ekroos et al., 2017). For all of these characteristics both arguments supporting their usefulness and arguments challenging their positive effects for effective environmental governance have been raised. For example, task-specific governance units as in MLG type II are expected to perform better in terms of integrating environmental spillovers, but at the same time raise issues of accountability and legitimacy, given a multitude of overlapping, task-specific jurisdictions (Newig et al., 2016). Thus, no combination of these extremes is per se more or less appropriate for the governance of biodiversity management in agricultural landscapes than the current governance system. However, considering the effects of different combinations of these characteristics can be a way to explore the potential for improvement in the governance of biodiversity management.

Departing from the status quo, we consider differences in specific features that result from the general characteristics of the four scenarios, including changes in the roles and responsibilities of different actors and governance levels as well as the mode of actor collaboration. The latter, for example, ranges from the absence of actor collaboration (scenario 1); through cross-border collaboration of only governmental bodies (scenario 3) and broad stakeholder collaboration within territorial borders, covering only part of the relevant issues (scenario 2); to broad stakeholder collaboration across territorial borders and for a comprehensive set of biodiversity issues (scenario 4). For more details on the conceptual basis of the scenarios see (Leventon et al., 2018). We consider that none of these four scenarios is inherently superior to the current governance system. Rather, we see them as theoretically plausible extremes that may differ in their strengths, weaknesses and biodiversity outcomes.

3. Conceptual framework on stakeholder acceptability

Our conceptual framework on stakeholder acceptability of different governance scenarios builds on literature on environmental governance, institutional change, and research on farmer acceptability of AES. We selected these literature strands because they contribute elements which are crucial in the context of changes to the governance system in relation to biodiversity conservation in agricultural landscapes. As we detail below, one important aspect in environmental governance literature is the question of what determines how acceptable different approaches of environmental policy are to stakeholders. Institutional change literature scrutinizes the resistance of institutions towards change as well as ways to overcome this resistance. Research on farmer acceptability of AES acknowledges the crucial role of farmers in implementing policies on the ground, and explores factors that explain why farmers voluntarily participate in AES.

Literature on environmental governance sees the acceptance of environmental policies by society as an important pre-condition for these policies to be legitimate and effective. A variety of factors have been identified as shaping acceptance of environmental policies (e.g. Rhodes et al., 2017). This literature stresses that environmental justice is especially important and therefore highlights *procedural* and *distributive fairness* for increasing stakeholder acceptance (e.g. Gross, 2007; Vainio, 2011; Visschers and Siegrist, 2012; Hall et al., 2013). *Procedural fairness* refers to fairness in the processes in which decisions are made. To be considered fair, a decision-making process needs to offer the opportunity to participate and to have a voice. Furthermore, the responsible authorities need to be neutral, stakeholders need to trust the motives of these authorities, and they need to be treated in a respectful way during the process (Tyler, 2000). Fair decision-making processes are conducive to greater acceptance and support of policies because

Table 1
Ideal-typical and theoretical governance scenarios that represent alternative governance approaches for biodiversity conservation in agricultural landscapes. For each actor group the specific roles are briefly outlined.

Scenario 1: **administrative level hierarchy** *top-down; centralized decision-making within administrative boundaries* **Governmental actors:** Decide and organise everything Greatest decision-making power at EU and national levels **Non-governmental actors:** no role in formal decision-making processes **Farmers:** Carry out decisions made at higher levels Receive conventional consultancy from state agencies	**Scenario 2: autonomous** farmers *bottom-up; decentralized decision-making within administrative boundaries* **Governmental actors:** Participate in collaborative decision-making processes about compensation mechanisms Higher levels have a coordinating role **Non-governmental actors:** Participate in collaborative decision-making processes about compensation mechanisms **Farmers:** Greatest decision-making power: Decide what they want to do for biodiversity on their individual farms Participate in collaborative decision-making processes about compensation mechanisms Receive consultancy in form of knowledge transfer from state and non-state organisations
Scenario 3: ecological scale hierarchy *top-down; centralized decision-making within ecological boundaries* **Governmental actors:** Greatest decision-making power at EU and bioregion levels Collaborative decision-making of different countries for the whole bioregion Lower administrative levels collaboratively define landscape-scale conservation plans **Non-governmental actors:** No role in formal decision-making **Farmers:** Carry out measures defined by the landscape-scale plans; collaborate as required to implement certain measures Receive conventional consultancy	**Scenario 4: collaborative actors** *bottom-up; decentralized decision-making within ecological boundaries* **All actors (at the landscape level):** Decide collaboratively on objectives for biodiversity conservation, measures and their financing **Governmental actors (on bioregion level):** Coordinating role Ensure coherence of landscape-scale decisions **Farmers:** Carry out measures individually or, where appropriate, collaboratively Receive consultancy as knowledge transfer

they promote the belief that the responsible authorities are legitimate (Tyler, 2000; Vainio, 2011). This can even lead to a 'fair process effect', where decisions are accepted irrespective of the favourability of the actual outcome for the stakeholders (Leventhal, 1980; Tyler, 2000; Visschers and Siegrist, 2012), although the validity of this effect has been questioned (Skitka et al., 2003). *Distributive fairness* is about the equitable allocation of gains and losses (Gross, 2007; Hall et al., 2013). Unjust distributions can undermine the acceptance of a decision and its outcomes by damaging the social well-being of a community through the creation of winners and losers (Gross, 2007).

Apart from aspects of environmental justice, works on the acceptability of environmental policies also emphasize the importance of *underlying norms, values, and attitudes.* They make frequent reference to the value-belief-norm (VBN) theory of environmentalism by Stern and colleagues (e.g. Stern, 2000). VBN theory suggests that environmental behaviour is guided by personal norms that are based on an individual's beliefs about human-environment relationships, which in turn are rooted in the rather general and stable values held by the individual. Empirical works (e.g. Nilsson and Biel, 2008; Steg et al., 2011; Rhodes et al., 2017) confirm the validity of VBN theory also for explaining the acceptability of environmental policies. Regarding governance of biodiversity conservation, this would mean that depending on the prevailing beliefs and values of the affected actors, different governance approaches may be appropriate.

Institutional change theory argues that the values and beliefs of stakeholders are important; where values are not aligned with those embodied in the policy, policy actors are likely to act to change or resist the policy (e.g. Sabatier, 1998; Leventon, 2014). Streeck and Thelen (2005) outline four types of institutional change, shaped by whether or not the process of change is abrupt or incremental, and whether the outcome of the change results in continuity of the institution. A sudden shift to a different governance system would represent an abrupt process of change with discontinuity of the institutional structure. Such wholesale change is reminiscent of the institutional change experienced during accession by the EU's new member states. Studies on these processes of change demonstrate that the acceptability of change depends on the values of the actors involved, and thus on whether or not they *support their roles* within the new institutional arrangement, and whether or not actors have the *capacities necessary to fulfil their new roles* (e.g. Leventon, 2014, Carmin and Vandeveer, 2004).

In the literature on farmers' acceptance of AES, *access to relevant information and knowledge by farmers* has been identified as an important factor influencing stakeholder acceptance of management practices (e.g. Niens and Marggraf, 2010; Meyer et al., 2015) as especially pronounced knowledge and skills by farmers are necessary for sustainable farming practices (Meyer et al., 2015). Furthermore, several studies highlight that farmers' willingness to implement AES can be increased through improved *communication and collaboration*, both among farmers and between farmers and other stakeholders (see e.g. Prager and Freese, 2009; Niens and Marggraf, 2010). Improved communication assumedly helps building trust and understanding. Additionally, a higher degree of involvement was observed to change attitudes from being altogether critical of AES to becoming supportive of at least some measures (Prager and Freese, 2009). Moreover, a great number of studies reviewed by Niens and Marggraf (2010) and Lastra-Bravo et al. (2015) have identified the existence and appropriateness of *financial incentives* for implementing AES as a key factor for farmers to accept AES.

In building our conceptual framework, we used the factors outlined above as inputs into a general model of decision-making processes on environmental issues. A model that comprehensively describes the different elements of public environmental decision-making is the 'SCAPE' framework by Newig et al. (2013). SCAPE builds on a multitude of different theories (e.g. federalism and multi-level governance, social learning, sociological systems theory, policy implementation, and many others), thus capturing and structuring a wide range of characteristics of environmental decision-making that are hypothesized to affect the impact of decisions on environmental quality. SCAPE divides these characteristics into *context, process, substantive output, social outcomes, substantive outcomes,* and *environmental impact.*

Combining the factors that shape acceptability retrieved from the literature and the SCAPE framework (Fig. 1) allowed us, on the one hand, to better structure the factors identified in the literature and, on the other hand, to identify further aspects that could be relevant in shaping stakeholder acceptability of alternative governance approaches. Whereas the factors we retrieved from the literature only consider context, process characteristics, substantive outputs, and social outcomes, SCAPE suggests that also substantive outcomes and the environmental impact are relevant elements of decision-making processes. 'Substantive outcomes' describe how and to which extend outputs of decision-making processes are implemented. The element 'environmental impacts' characterises in which way the state of the environment changes after implementing the output. We argue that also aspects related to these elements could play a role in shaping stakeholder acceptability: If a governance system creates great difficulties or high expenses for the implementation of decisions, it may be less acceptable than a governance system that is likely to allow for easy implementation at reasonable costs. Likewise, a governance system that is expected to be little successful in bringing about what it has been set out to achieve (here: biodiversity conservation) will probably meet little support.

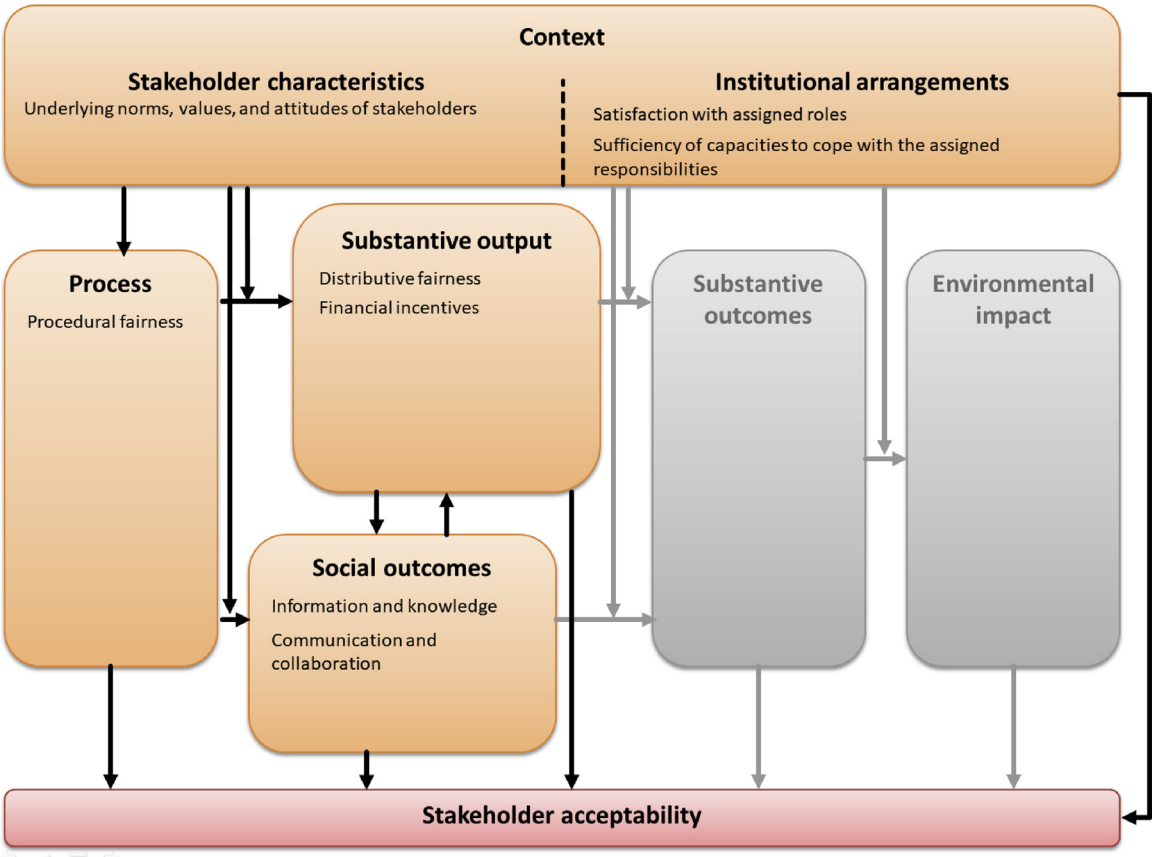

Fig. 1. Conceptual framework combining the elements of environmental decision-making processes from SCAPE (context, process, substantive output, social outcomes, substantive outcomes, and environmental impact) with the factors shaping stakeholder acceptability of changes in governance systems for biodiversity conservation retrieved from literature on environmental governance, institutional change theory and farmer acceptability of AES (adapted from Newig et al., 2013). The SCAPE elements of 'substantive outcomes' and 'environmental impact' are not considered in the reviewed literature.

4. Methods

4.1. Research approach and description of case study sites

To explore the acceptability of the different governance scenarios, we took a case study approach. We selected three study areas with varying degrees of agricultural intensity: Southern Oldenburg (Germany), Central Saxony (Germany), and Scania (Sweden). The Southern Oldenburg Area in Germany is characterized by intensive livestock farming and is part of the "silicon valley of the agri-food sector" (Windhorst and Grabkowsky, 2007, own translation). The Central Saxonian loess area is among the areas with the highest yield potential in Saxony and dominated by arable land primarily used for the production of wheat (Heinrich et al., 2009). In contrast, the province of Scania in Southern Sweden is a more diverse agricultural landscape (Persson et al., 2010), accommodating both intensively managed, homogeneous agricultural landscapes and heterogeneous areas with mixed farming (Dänhardt et al., 2010). Despite the differences in the political systems of Germany and Sweden – in Germany, a federal system granting significant decision-making power to the federal states and in Sweden, a more centralized system – previous work in the three case study areas showed that the current CAP framework creates common challenges in fostering greater collaboration for biodiversity conservation in these case study areas (Leventon et al., 2017).

In each case study area, we conducted one multi-stakeholder workshop in February and March 2016. We invited stakeholders that had been involved in a previous round of workshops organized in the context of the same project in autumn 2014 (cf. Leventon et al., 2017). This selection of stakeholders was complemented by actors that were named by participants of the workshops in autumn 2014 as being relevant for CAP implementation and biodiversity issues in the case study areas. The invited actors operate at the local and regional levels and represent governmental, nature conservation and farming interests (see list of participant organisations in Supplementary Material 1). To enhance inclusivity and effective participation, the workshops in Germany were led by an experienced professional facilitator. An overview of the workshop programme can be found in Supplementary Material 2.

4.2. Data collection

We first presented the core features of each scenario to the participants who were then asked to form groups of three to six participants in order to deliberate about what they liked and disliked about each scenario. We asked participants to agree on up to three positives and negatives for each scenario. Subsequently, each group briefly presented their positives and negatives to the remaining participants. This was followed by a plenary discussion, which aimed to stimulate discussion about similarities between the scenarios as well as a possible and desirable alternative scenario. Based on recordings of the group discussions, we compiled detailed discussion notes.

After the group discussions, we distributed questionnaires to be filled out by individual participants (see questionnaires in Supplementary Material 3). In part one of the questionnaires, respondents were asked to classify their organisation and to rank the four scenarios in order of their preference. Additionally, in the second part of the questionnaire they were asked to indicate how important preserving biological diversity in agricultural landscapes was to their organization. Furthermore, they were asked to specify for each scenario

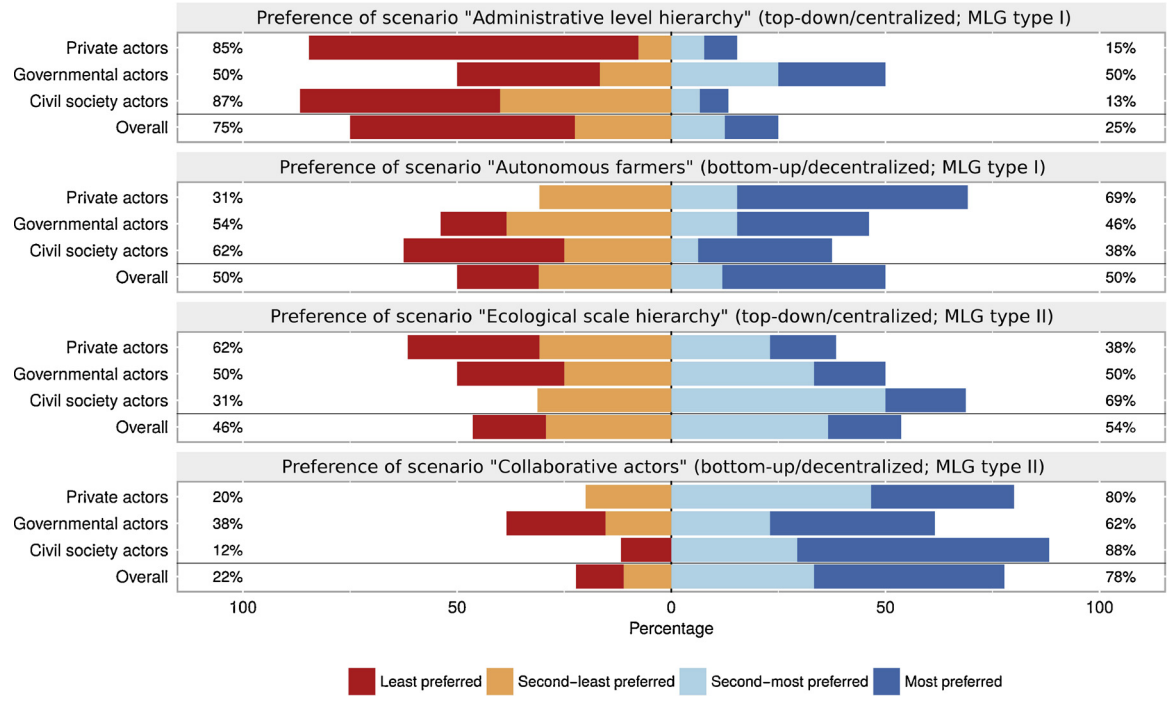

Fig. 2. Preference for the governance scenarios, overall and by stakeholder cluster. The analysis is based on questionnaires (n = 51). MLG Type I refers to decision-making levels being based on traditional territorial levels; MLG Type II means decision-making levels are based on ecologically defined units such as bioregions and landscapes.

individually to which degree they agreed with seven statements, each representing one of the acceptability factors retrieved from the literature in our conceptual framework (see Section 3).

4.3. Data analysis

Based on the data obtained through the questionnaires, we evaluated scenario preference (objective 1), both overall and differentiated between stakeholder groups. For categorizing the different organisations that took part in our workshops, we conducted a hierarchical cluster analysis to group the participants according to how they classified the focus, sector, role, and level of their organisation in the questionnaire. The cluster analysis used the Unweighted Pair Group Method with Arithmetic Mean (UPGMA) based on the Bray-Curtis dissimilarities in order to describe the group structure and the similarities between organisations (Legendre and Legendre, 2012).

Our assessment of the influence of acceptability factors (objective 2) was conducted in two ways. Firstly, we focussed on the factors identified in the literature (Section 3 of this paper). For this purpose, we used the data from the questionnaires to evaluate to which degree respondents (dis-)agreed with the statements representing the acceptability factors from the literature. Here, we focussed on the respondents' most and least preferred scenarios. Our underlying assumption is that the factors for which rates of (dis-)agreement show strong differences between the most and least preferred scenarios play a role in shaping acceptability. We also assessed overall responses as well as responses of the different stakeholder groups previously determined through the cluster analysis. To gain a better understanding of the influence of the social context (*underlying norms, values, and attitudes of stakeholders*), we compared the respondents' ranking of the importance of biodiversity with their scenario preference.

Secondly, and in order to identify additional acceptability factors, we performed a bottom-up analysis of the group discussions. For this purpose, we conducted a qualitative content analysis of the detailed group discussion notes following Mayring (2015), based on an open, inductive coding process. The categories identified through this approach were then structured according to the SCAPE framework. Also, the topics selected as the main positives and negatives for the different scenarios by each discussion group were matched with these categories. Here, we counted how many times each factor was mentioned as either main positive or negative of a scenario to assess the relevance of these additional factors. We considered one mention to be if a factor was named either as advantage or as disadvantage for one scenario by one discussion group. This means that overall a factor could potentially be mentioned up to 80 times (10 discussion groups discussing both advantages and disadvantages of 4 scenarios).

This analytical approach has both advantages and disadvantages. In terms of advantages, it allowed us to identify areas of broad consensus. In terms of disadvantages, we recognize that points can be extremely important even if they are made by a very small number of stakeholders. We acknowledge that our approach primarily highlights areas of consensus, but might potentially gloss over some important points that were made infrequently. Similarly, we are acutely aware of the limitations posed by group dynamics that can potentially skew the results in settings such as the one described above (e.g. because of power imbalances among members of a group). To counteract these potential disadvantages, we tried to create an inclusive workshop atmosphere where everyone felt free to share his or her points of view on the topics discussed, even if presenting minority viewpoints.

5. Results

5.1. Objective 1: stakeholders' evaluation of alternative governance approaches

The questionnaires were filled out by 51 participants (19 in Lower Saxony, 23 in Saxony, and 9 in Scania). Overall, the scenario "administrative level hierarchy" was the least preferred across all case study areas, while "collaborative actors" was the most preferred scenario (Fig. 2).

Because there were no systematic differences in scenario preference between the case study areas, we pooled data for all further analyses.

Cluster analysis of different types of stakeholders identified three groups of stakeholders (see dendrogram of the cluster analysis in Supplementary Material 4). The first cluster consisted of civil society organizations that focus on nature conservation (21 respondents), such as the Saxony branch of a German nature conservation organization. The second cluster consisted of governmental actors who focus on agriculture or biodiversity conservation (19 respondents), such as the Swedish Board of Agriculture. The third cluster comprised private actors focusing mainly on agricultural production in the roles of producers or advisers (11 respondents), for example the local farmers' associations in Lower Saxony.

Preference for the four scenarios varied strongly between the stakeholder clusters. Civil society actors mainly preferred the two scenarios that were based on a MLG type II approach – that is the scenarios "ecological scale hierarchy" and "collaborative actors" – which base biodiversity management on ecological scales. In contrast, private actors had a clear preference for bottom-up approaches (scenarios "autonomous farmers" and "collaborative actors") and an aversion towards top-down approaches. For the governmental actors, preference was ambiguous – all scenarios received similar ratings, but the scenario "collaborative actors" was slightly preferred.

5.2. Objective 2: factors shaping acceptability of governance scenarios

Based on the data obtained through the questionnaires, we first evaluated which of the factors suggested in the literature play a role in shaping stakeholder acceptance of alternative governance approaches for biodiversity conservation in agricultural landscapes. We found that for almost all factors, respondents expressed high agreement that a given factor was fostered by their preferred scenario and low agreement that the same factor was fostered by their least preferred scenario (Fig. 3). Therefore, almost all of the included factors seem to have an influence on stakeholder acceptability. This is especially true for the factors *distributive* and *procedural fairness*. The only exception is the factor *sufficiency of capacities*, which received similar rates of (dis-) agreement in both the most and the least preferred scenarios. Furthermore, regarding the importance attributed to biodiversity conservation *(underlying norms and attitudes)*, most participants (85.0%) valued biodiversity conservation very highly or highly. However, almost all of the remaining respondents (12.5%) who attributed low to medium importance to biodiversity conservation selected the scenario "autonomous farmers" as their preferred scenario (see table in Supplementary Material 5).

In comparing how the different stakeholder groups evaluated the scenarios, we found several major differences. The biggest difference was that governmental actors saw more potential for *improved collaboration and communication* in MLG type I approaches than the remaining stakeholder groups. Evaluations by the different stakeholder groups deviated from each other most clearly for the scenario "autonomous farmers": Whereas civil society actors seemed to have doubts about the *procedural fairness* and *distributive fairness* of this scenario, governmental actors were rather confident that such a governance approach would lead to fair processes and private actors remained undecided regarding this point. Yet, private actors were more satisfied with their *roles* in this scenario than the other stakeholder groups (see also Supplementary Material 6 for an overview of the rates of (dis-) agreement of the stakeholder groups to the statements).

Our analysis of group discussions shows that overall stakeholder acceptability was influenced by a diversity of different factors that goes beyond the factors we had identified in the literature (Fig. 4). The acceptability factors mentioned in the discussions pertain to almost all elements of environmental decision-making of SCAPE. Only **institutional arrangements** were not referred to in the group discussions. Across all group discussions, the most mentioned factors were *costs and efforts of administration* (**substantive output**, 28 mentions), *procedural fairness / involvement* (**process**, 18 mentions), *communication, coordination, collaboration* (**social outcomes**, 18 mentions), and *expected effectiveness* (**biodiversity impact**, 17 mentions) (see Supplementary Material 7 for an overview of the mentions of the different factors).

The factors that influenced why actors liked the scenario "administrative level hierarchy" were predominantly related to its **substantive outcomes**: Almost all groups expected this governance approach to result in reduced *costs and efforts for administration* (8 mentions) as participants expected this scenario to lead to uniformity during implementation, effective enforcement of decisions, and reliability in planning.

> *This scenario"has little need for coordination. One saves much of the coordination costs. Everything is determined top-down and then it gets done. You don't have to think much about it anymore."(Lower Saxony group 3).*

Additionally, the scenario was considered to lead to easy monitoring, evaluation, and *controls* (3 mentions). Also, participants appreciated the general clarity of rules, goals and legal structures as well as the possibility to set overarching goals which was expected to lead to more *clarity for implementation and compliance* (**substantive output**, 3 mentions).

The main shortcoming of this scenario was considered to be its lack

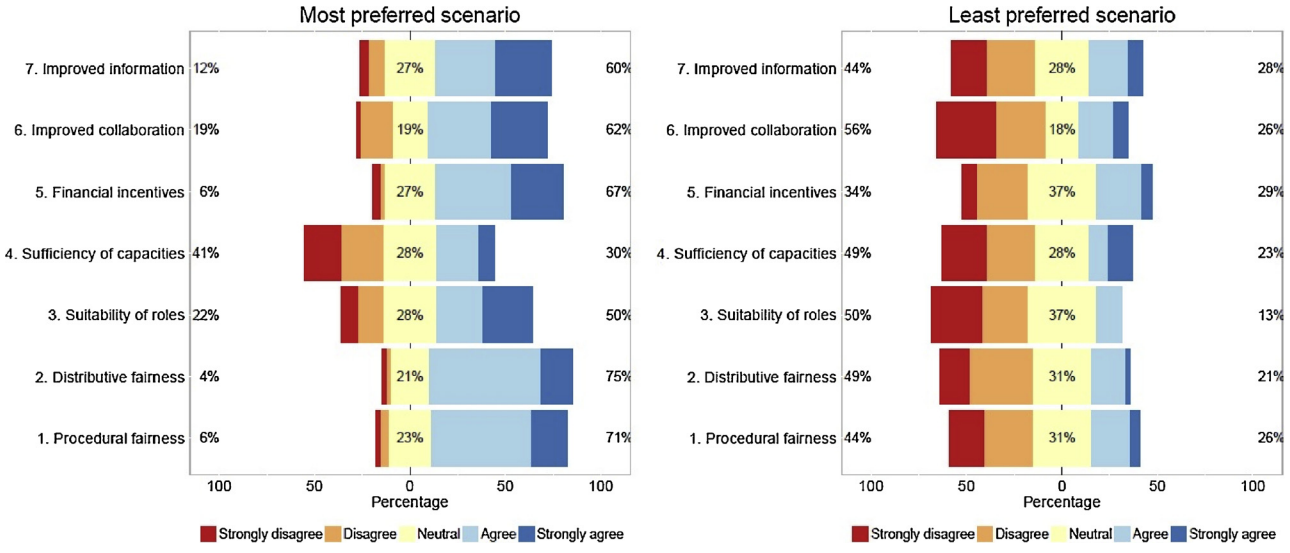

Fig. 3. Respondents' rates of agreement with the statements reflecting the acceptability factors from the literature regarding their most and least preferred scenarios.

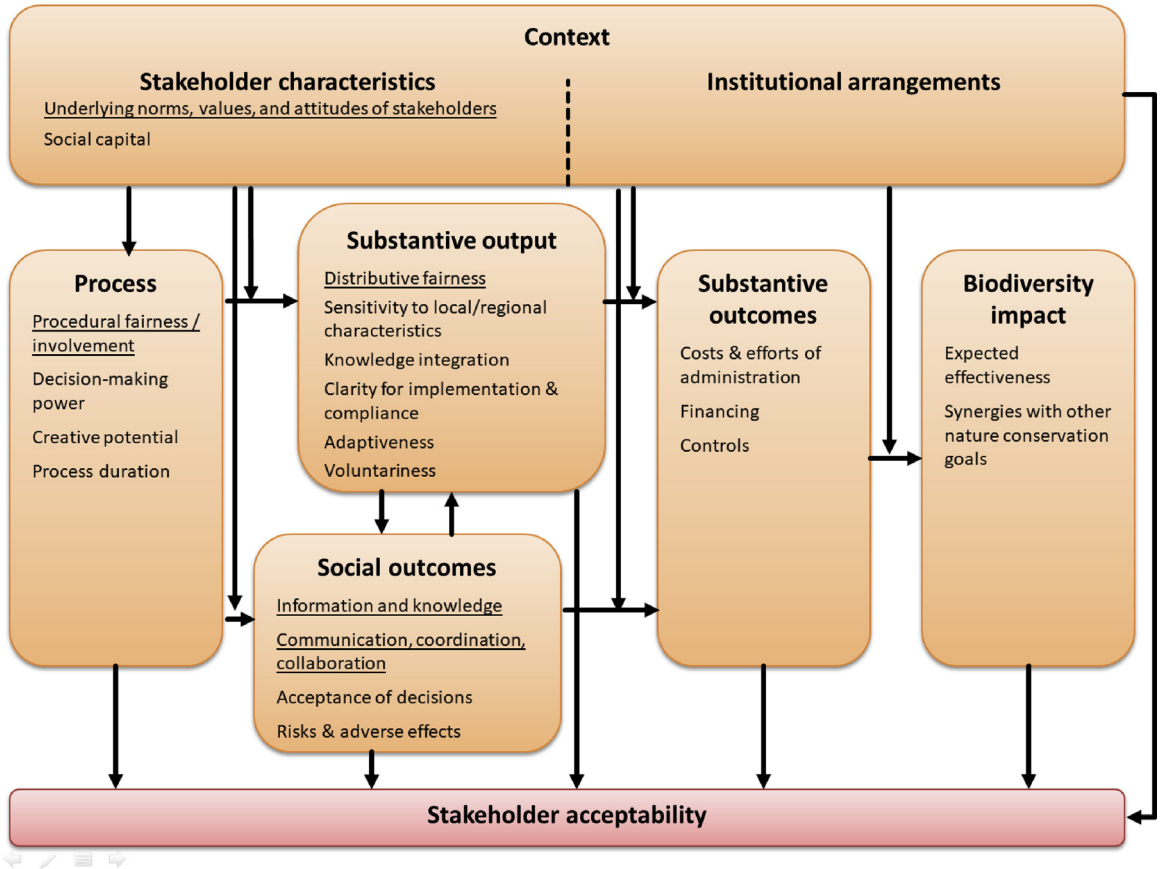

Fig. 4. Factors influencing governance scenario acceptability mentioned by the workshop participants in the group discussions, embedded in the SCAPE framework (Newig et al. 2013). Factors that matched factors retrieved from the literature are underlined.

of *adaptiveness* (**substantive output,** 5 mentions) because of the low flexibility and rigidity of the framework and its rules.

> *"I think of the date for sowing the flower strips, for example, which is in mid-April. And we would actually need it in May. Apparently, it is not possible to change this. […] It just stays the way it is and is completely unpractical. We don't need the flowering season at the time when we have the flower strips. So it's completely worthless for the insects. But you can't change it."(Lower Saxony group 3–with reference to the current governance system, which is similar to the scenario"administrative level hierarchy").*

Although participants valued this scenario for its ease of administration, at the same time they also saw difficulties regarding the *costs and efforts of administration* (**substantive outcomes**, 3 mentions). Especially participants in Saxony expected this scenario to result in uncertainty for actors, high costs and unclear implementation beforehand. Moreover, the **social outcomes** of *acceptance of decisions* (3 mentions) were considered critical, resulting in low willingness by actors to do more than necessary.

Participants appreciated the scenario "autonomous farmers" especially because of its decision-making **processes**. They liked that this scenario would lead to more *involvement* (5 mentions) – in terms of greater actor diversity, self-responsibility, autonomy, and joint decisions.

> *"There, you have the participation of the region or the farms. So, here I can really decide what makes sense, here in the region or on my farm."(Lower Saxony group 1)*

Additionally, this scenario was expected to foster higher innovation and *creative potential* (3 mentions) and result in a higher identification with and *acceptance of decisions* (**social outcomes,** 3 mentions) at the local level due to a perceived democratic process. Furthermore, *costs and efforts for administration* (**substantive outcomes**, 3 mentions) were believed to be less of a burden in this scenario because implementation was believed to be easier, and because the units in which decisions would be taken and implemented already exist.

Participants primarily disliked the scenario "autonomous farmers" because of issues regarding *communication, coordination, and collaboration* (**social outcomes,** 5 mentions). It was considered to result in a lack of collaboration and coordination in favour of biodiversity and, at the same time, to lead to a higher need for coordination in joint decision-making processes.

> *"A negative point of scenario 2 [autonomous farmers] is that there is no coordination at all. Everybody just does what they want. So there is virtually zero coordination among each other. Because everybody looks at the needs of their own businesses and says'what is the most important thing for my farm?'[…] Because–even if they receive consultancy or money–you don't have anybody who coordinates this, who is behind this and says'Now that one does this, the other one does that.'"(Lower Saxony group 2)*

For the scenario "ecological scale hierarchy", overall fewer advantages and disadvantages were mentioned. The main advantage expected of this scenario was its supposed *effectiveness* in terms of biodiversity conservation (**biodiversity impact**, 5 mentions). The main difficulty related to its *costs and efforts of administration* (**substantive outcomes,** 6 mentions). Participants were concerned with the multitude of administrative structures involved in the implementation of decisions.

> *"This collaboration on the landscape level is a [collaboration] in addition to the EU, national, regional–that is Saxony–and county [levels]. There*

already are so many hierarchical levels where decisions and choices are made, where people meet and so on. And when we then get such a landscape level on top of that, that won't be effective."(Saxony group 2)

Additionally, participants deemed it difficult to define the boundaries of the natural areas for which decisions were supposed to be taken.

Just like the "autonomous farmers" scenario, the scenario "collaborative actors" was also appreciated because of its **social outcomes,** especially its expected high level of *collaboration and communication* (3 mentions)

"What scenario 4 [autonomous farmers] could maybe ideally offer is that the involved actors could learn from each other which reasons they have and which constraints they have. And thus they could have and develop a greater understanding for the others if they have to exchange opinions why one is able and wants to do one thing and why the other is not able and does not want to do another thing."(Saxony group 3)

Particularly in the German case study areas, participants expected the decision-making **processes** of this scenario to be characterized by broad *involvement* of stakeholders (4 mentions). Additionally, similar to the scenario "ecological scale hierarchy", discussants expected this scenario to be more *effective* in terms of actual biodiversity conservation (**biodiversity impact**, 4 mentions).

Likewise, the downside of this scenario was the complex and resource intensive *administration* of the implementation (**substantive outcomes**, 4 mentions). Moreover, while participants valued this scenario for the high level of *involvement* in decision-making processes, they also voiced various concerns regarding this point, such as conflicting interests, power imbalance between the involved actors and problems to involve all relevant stakeholders (**process,** 3 mentions). Similarly, they also feared that in terms of *communication, coordination, collaboration* **(social outcomes**, 3 mentions) a lack of willingness to collaborate as well as difficulties to find common ground might impede farmer collaboration for the implementation of decisions

"As one barrier, I see bringing the farmers themselves together. If all had the same conception, it would be relatively easy. But then nature and the environment are dearer to one farmer than to another. And maybe this is the weak point of scenario 4 [autonomous farmers]."(Lower Saxony group 2)

Additionally, they expected a high need for coordination of biodiversity management actions and too little higher-level coordination in this scenario.

6. Discussion

Our results show a support for fundamentally different governance approaches for biodiversity conservation in agricultural landscapes. First and foremost, this is demonstrated by our findings on stakeholder preference of the different governance scenarios. On the one hand, stakeholders expressed the strongest preference for the scenario most different from the current governance system of biodiversity management in agricultural landscapes, namely the scenario "collaborative actors". On the other hand, workshop participants displayed the strongest aversion towards the scenario most similar to the current situation, namely the scenario "administrative level hierarchy". Hence, in face of their dissatisfaction with the status quo-like scenario "administrative level hierarchy", workshop participants did not just support incremental changes to improve the situation. Rather, they favoured the scenario "collaborative actors", which represents the complete opposite of "administrative level hierarchy". Thus, our findings support arguments put forward for fundamental changes to the governance system (e.g. anonymized reference 2) due to the ineffectiveness of the current system in protecting biodiversity (Pe'er et al., 2014).

Furthermore, our results show that acceptability is shaped by a large array of factors pertaining to all different elements of decision-making processes outlined by SCAPE. Key factors identified from the literature on environmental governance, institutional change, and research on farmers' acceptability of AES (e.g. procedural and distributive fairness) proved to be relevant but they alone do not explain scenario preference of stakeholders. Instead, our bottom-up approach provided a more nuanced understanding of factors shaping acceptability. Most prominently, the costs and efforts related to administering an alternative governance system, followed by issues of procedural fairness in terms of actor involvement in decision-making processes, communication and coordination for the implementation of decisions, and enhanced biodiversity effectiveness frequently influenced participants' evaluations of the different alternative governance approaches represented by our scenarios. Moreover, the additional acceptability factors identified through the group discussions covered almost all elements of the SCAPE framework, i.e. context of stakeholder characteristics, process, substantive output, social outcomes, substantive outcomes, and the environmental impact. To move beyond piecemeal approaches with little biodiversity benefits, we therefore argue that stakeholder acceptability needs to be evaluated and addressed more holistically.

Additionally, our results highlight substantial heterogeneity in stakeholder views and interests. Acceptance of different governance approaches varied notably between different kinds of stakeholders. Civil society actors mainly interested in nature conservation preferred MLG type II approaches, i.e. decision-making based on ecologically defined units, whereas private farming actors preferred bottom-up approaches. Moreover, different stakeholders perceived the scenarios differently. For example, in relation to the scenario "autonomous farmers" governmental actors would support the statement that this scenario leads to procedural and distributive fairness, whereas civil society actors were doubtful about this point. Given such disparities in preferences and evaluations of the different governance approaches, none of the presented governance scenarios alone offers an option that would be acceptable across the entire suite of stakeholder groups.

We therefore argue that designing a potentially widely acceptable alternative governance approach for biodiversity conservation in agricultural landscapes requires a blend of different governance approaches and, with this assertion, we go beyond suggestions for improved biodiversity conservation that consider individual policies or focus on single sectors. Our results highlight principles that can guide the design of such a blended alternative governance approach to biodiversity conservation in agricultural landscapes: stakeholders expected that decisions made via top-down processes would not be widely accepted. In contrast, bottom-up approaches were considered to generate a greater degree of acceptance. Additionally, whereas a high level of actor involvement was generally appreciated in the bottom-up scenarios, participants were also aware of the accompanying challenges of increased communication, coordination and collaboration. Regarding the different types of multi-level governance, costs and efforts of administration were considered to be lower in the MLG type I, i.e. where decision-making takes place within administrative boundaries, than in the MLG type II approaches – albeit at the expense of environmental effectiveness.

Thus, we provide empirical evidence supporting a hybrid governance approach that combines the different approaches represented by the scenarios, thus emphasizing their strengths and attenuating their weaknesses. In the suggested approach, decisions on the objectives for biodiversity conservation would be taken in a top-down, centralized manner and for ecologically defined units (MLG type II). Hence, conservation targets would be defined by decision-makers that have greater competency (Rockloff and Moore, 2006) and the necessary overview while being less driven by narrow self-interests (Koontz, 1999; Newig and Fritsch, 2009), thus avoiding regional spillovers (cf. Oates, 1999) and a 'race to the bottom' (Vogel, 1997). Additionally, such an approach would allow to better account for and address the cross-boundary nature of environmental problems (Dahl, 1994). While

objectives for biodiversity conservation would be meaningfully set from the top down and for ecologically defined landscape units, the decisions on particular measures and specific schemes to achieve these objectives would be decided upon in a bottom-up, decentralized manner within existing administrative units (MLG type I) requiring coordination and collaboration between a broad range of actors at the local level. Thus, the process to achieve these objectives would be characterized by joint decision-making power of a broad range of actors, e.g. regarding how resources are used. Furthermore, measures could be better adapted to local conditions (Ostrom, 1990) and acceptance of decisions could be increased (Newig et al., 2017). Taking decisions on the implementation within existing administrative boundaries would avoid the involvement of a large number of different administrative structures and thus the onerous and expensive administration expected of a full MLG type II approach. Yet, some degree of coordination between different local administrative units would be possible and desirable.

The suggested hybrid governance approach for biodiversity conservation in agricultural landscapes would have implications similar to the re-scaling of governance in the context of the implementation of the EU's Water Framework Directive (Newig et al., 2016) where management in river basin units allows for internalizing spill-overs (see Moss and Newig, 2010). Furthermore, our approach would also enable evidence-based biodiversity conservation embedded in a multi-level governance system as has been outlined by Ekroos et al. (2017). This would mean that conservation targets would be defined in a top-down manner for ecological scales on multiple, nested levels and being refined at increasingly local levels. Here, decisions on conservation targets for whole bioregions would be based on broader-scale ecological principles, while empirical evidence relevant to the different landscapes would inform decisions on targets for landscape-scale management plans. Decisions on the implementation would then be taken within local level administrative districts by collaboration of a wide range of stakeholders and be underpinned by the evidence of local studies. However, despite being able to better address some of the key issues of the current governance system, our suggested governance approach would raise questions around the degree of stakeholder participation in decision-making (e.g. Arnstein, 1969) for the overall objectives. Moreover, there is a discrepancy to the various calls to involve stakeholders in all stages of the policy process (e.g. Mann et al., 2015).

7. Conclusion

Our findings support calls for fundamental changes in the current governance system of biodiversity conservation in agricultural landscapes. Furthermore, our results indicate that evaluating and addressing acceptability of alternative governance approaches requires a more holistic perspective and needs to differentiate between different kinds of stakeholders. Hence, conceiving an appropriate alternative governance system holds several challenges. To address these challenges, we provide principles for a hybrid governance approach where decisions on objectives take place in a top-down, centralized manner and for ecologically defined units, while decisions on achieving the set targets are taken in a bottom-up, decentralized manner within existing administrative boundaries.

Admittedly, our considerations have remained on a rather conceptual level. In practice, such an approach brings challenges in itself both for practitioners and has implications for future research. Even when overarching principles for the design of an alternative governance system for biodiversity conservation are set, and assuming democratic legitimacy could be ensured in such a major approach to restructure a whole institutional system, the detailed elaboration of an alternative governance approach would require considering all elements of environmental decision-making as outlined by the SCAPE framework to ensure the acceptability of this new approach. Challenges pertain particularly to different forms of collaboration and coordination between actors at different levels, especially the issue of whether and how to involve stakeholders also in the top-down decision-making process on conservation objectives.

Conflicts of interest

None.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.landusepol.2018.05.032.

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Supplementary material

S1: list of participant organizations in the three case study areas

participant organization (name in brackets)	number of representatives
Southern Oldenburg (Germany)	
local hunters' associations	3
Federal state representation of a national environmental non-governmental organization	1
local groups of two national environmental non-governmental organizations	4
Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency (NLWKN)	1
Regional association of machinery rings	1
County office for building and civil engineering	1
Environmental Foundation of Lower Saxony	1
North German organic farming organisation	1
State level beekeepers' organization	1
local representation of Lower Saxony's Farmers' Association	3
branch office of Chamber of Agriculture Lower Saxony	1
Lower Saxony Association of District Councils	1
Sum	**19**
Central Saxony (Germany)	
federal state representation of a national environmental non-governmental organization	2
Saxon State Agency of Environment, Agriculture and Geology (LfULG)	9
federal state representation of the German Association for Landcare (DVL Landesverband Sachsen)	1
Saxony State Foundation for Nature and the Environment	1
Private research centre for environmental research	1
local farming business	1
Saxon State Ministry of the Environment and Agriculture (SMUL)	1
green political party, state level	1
University of Göttingen	1
local level representation of the green political party	2
local beekeeping organization	1
federal state representation of Saxon bee-keepers	1
Evangelical Lutheran Church of Saxony	1
organization offering consultancy in the field of process engineering and environmental technology	1
Sum	**24**
Scania (Sweden)	
farmers	3
Scania's Ornithological Society	1
County Administrative Board in Scania	1
Swedish Board of Agriculture	1
bee-keeper	1

Rural Economy and Agricultural Societies	1
Swedish Environmental Protection Agency	1
food company	1
sugar manufacturer	1
Sum	**11**

S2: workshop agenda model (slightly adapted for the different workshops)

Exercise	Purpose	Method in brief	Data output
Introduction	Provide a common understanding of the key issues in the area. Provide an understanding of the current state of academic research on the topic.	Presentations by team members on the overall project and on the results from the first round of workshops. Presentation by external researchers on biodiversity issues in agricultural landscapes.	Notes on key points of discussion.
Scenario presentation	Provide an understanding of the four theoretical, ideal-typical scenarios	Presentation on the theoretical background of the scenarios, detailed presentation of each of the four scenarios and its implications for different actor groups.	Notes on key questions or misunderstandings.
Group discussions	Elicit discussions on the benefits and caveats of each scenario.	Participants form mixed groups and are asked to discuss and agree on up to three main advantages and disadvantages per scenario. Each group is assisted by a member of the research team, whose main task is to clarify emerging questions on the scenarios and the task. The groups are asked to lead the discussions on their own and not to expect guidance or facilitation from the researchers (although the assisting researchers are allowed to support discussions if they get stalled or deviate to far from the task).	Recordings of and notes on discussions.
Questionnaires	Elicit individual preferences of the scenarios.	In part one, participants classify their organization based on a number of suggested categories and rank the importance of biodiversity to their organization. In part two, participants indicate to what degree the acceptability factors derived from the literature are present in each of the scenarios.	Filled out questionnaires (provided in S3).
"Scenario 5"	Elicit discussion about	Positives and negatives for	Recordings of and

	the strengths and weaknesses of the scenarios. Explore what an acceptable alternative "scenario 5" could look like.	the scenarios are collected from all groups. Participants discuss points of (dis-)agreement. Participants discuss what a realistic and widely acceptable scenario 5 could look like.	notes on discussion.

S3: questionnaire (version for Sweden; question 1D was slightly different for the German case study areas)

Understanding Acceptance of Governance Scenarios

Part 1: Understanding your organisation

Please answer these questions for the office of the organisation that you are here representing today. For example, if your organisation has a national office and a Lower Saxony office, and you are a representative of the Lower Saxony office, then answer questions from this perspective (and not for the national office).

1A Name of your organisation: ……..

1B Primary focus of your organisation (tick only the most important option):

☐ Nature conservation
☐ Agricultural production
☐ Land use policy and planning
☐ Rural development
☐ Education and/or research
☐ Other –Please specify……..

1C What sector does your organisation represent? (tick only one)

☐ Civic sector (NGO etc.)
☐ Private sector (private company or business association)
☐ Government/civil service
☐ Academic

1D What physical area does your organisation represent? (tick all that apply)

☐ Farm
☐ Municipality
☐ County
☐ Region (please specify) .....
☐ Whole of Sweden

1E What is your organisation's current role relating to biodiversity management in agricultural areas? (tick all that apply)

- ☐ Carrying out on-farm management (including, but not limited to CAP actions)
- ☐ Advising/consulting with farmers (including but not limited to CAP actions)
- ☐ Administering payments (e.g. under CAP)
- ☐ Monitoring and regulation
- ☐ Policy and decision-making
- ☐ Lobbying
- ☐ Other (please specify) .....

1F How important is it to your organisation to protect biodiversity in agricultural landscapes in Skåne? Please circle the number, where 1 is very important, and 5 is not important at all

very important **1** **2** **3** **4** **5** *not important at all*

1G Please put the scenarios in order of preference. Imagine that anything is possible, and that you don't have to think about whether or not a scenario is realistic (number 1-4 in order of preference, where 1 is your favourite, and 4 is your least favourite)

- ☐ Scenario 1: Administrative hierarchy
- ☐ Scenario 2: Autonomous farmers
- ☐ Scenario 3: Ecological scale hierarchy
- ☐ Scenario 4: Collaborative farmers

Part 2: Understanding the scenarios

In this section, we will address each scenario in turn. Please rate your personal agreement with each of the statements, where 1 is strongly agree, and 5 is strongly disagree.

Scenario 1: Administrative hierarchy

	strongly agree				*strongly disagree*
Statement	**1**	**2**	**3**	**4**	**5**
I believe this scenario will lead to fair decision-making					
I believe this scenario will lead to fair outcomes					
I am overall happy with the role for my organisation under this scenario					
My organisation already has the capacity (finance, personnel, skills, time) to fulfil its role under this scenario					
I think that this scenario can create financial incentives for farmers to enhance biodiversity management					
I believe that the scenario will foster collaboration and communication between farmers and with other actors					
I think that overall the scenario will improve the information and knowledge that farmers have about actions for biodiversity conservation					

Scenario 2: Autonomous farmers

	strongly agree				*strongly disagree*
Statement	**1**	**2**	**3**	**4**	**5**
I believe this scenario will lead to fair decision-making					
I believe this scenario will lead to fair outcomes					
I am overall happy with the role for my organisation under this scenario					
My organisation already has the capacity (finance, personnel, skills, time) to fulfil its role under this scenario					
I think that this scenario can create financial incentives for farmers to enhance biodiversity management					
I believe that the scenario will foster collaboration and communication between farmers and with other actors					
I think that overall the scenario will improve the information and knowledge that farmers have about actions for biodiversity conservation					

Scenario 3: Ecological scale hierarchy

	strongly agree				*strongly disagree*
Statement	**1**	**2**	**3**	**4**	**5**
I believe this scenario will lead to fair decision-making					
I believe this scenario will lead to fair outcomes					
I am overall happy with the role for my organisation under this scenario					
My organisation already has the capacity (finance, personnel, skills, time) to fulfil its role under this scenario					
I think that this scenario can create financial incentives for farmers to enhance biodiversity management					
I believe that the scenario will foster collaboration and communication between farmers and with other actors					
I think that overall the scenario will improve the information and knowledge that farmers have about actions for biodiversity conservation					

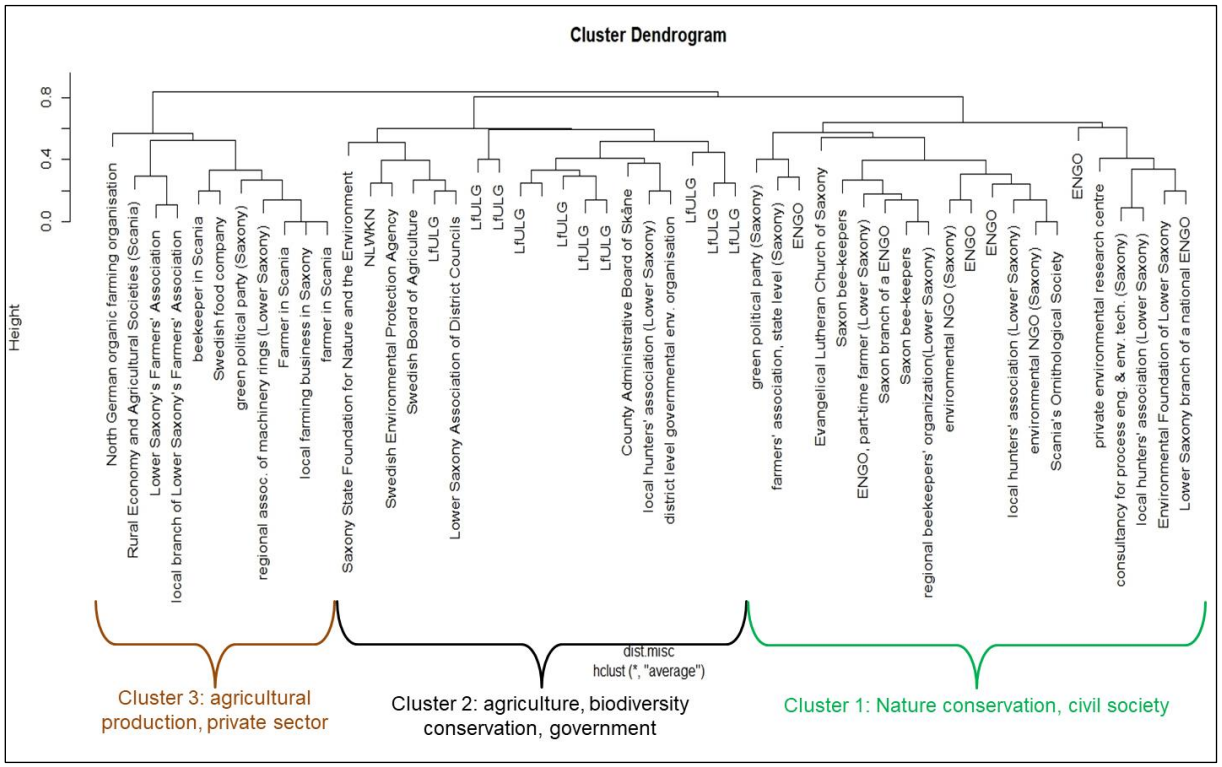
Scenario 4: Collaborative farmers

	strongly agree				*strongly disagree*
Statement	**1**	**2**	**3**	**4**	**5**
I believe this scenario will lead to fair decision-making					
I believe this scenario will lead to fair outcomes					
I am overall happy with the role for my organisation under this scenario					
My organisation already has the capacity (finance, personnel, skills, time) to fulfil its role under this scenario					
I think that this scenario can create financial incentives for farmers to enhance biodiversity management					
I believe that the scenario will foster collaboration and communication between farmers and with other actors					
I think that overall the scenario will improve the information and knowledge that farmers have about actions for biodiversity conservation					

End of Questionnaire

Thank you for filling out the questionnaire!

S4: dendrogram of cluster analysis



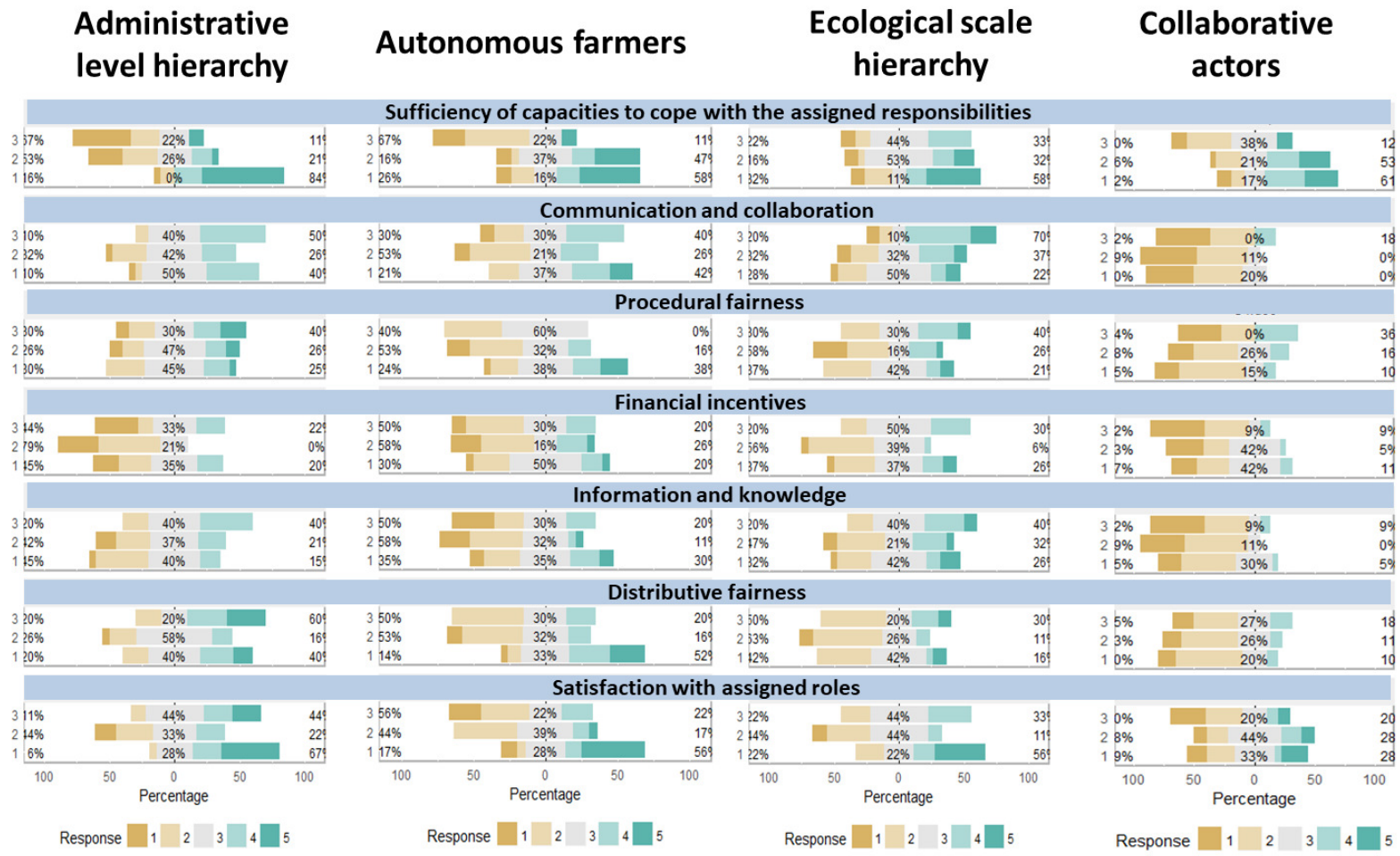
S5: table with ranking of biodiversity importance and scenario preference

	Most preferred scenario			
Importance of biodiversity conservation	**1**	**2**	**3**	**4**
1 very important	4	7	5	15
2	-	3	1	5
2.5*	1	-	-	-
3	-	2	1	-
4	-	2	-	-
5 not at all important	-	2	-	-

** One participant put the mark between 2 and 3, which we interpreted as 2.5*

While 51 participants filled out the questionnaires, only 48 respondents provided information on their preferred scenario(s) and could therefore be considered in this table.

S6: graphic showing for each of the four scenarios the rates of agreement and disagreement of the three stakeholder groups to the seven statements about the acceptability factors suggested in the literature



Group 1: Civil society groups with nature conservation focus
Group 2: Government organisations with policy/admin focus
Group 3: Private actors with production/farming focus

S7: table showing how many times the acceptability factors were mentioned as main positives and negatives

		Element	Context		Process				Substantive output						Social outcomes				Substantive outcomes			Biodiversity impact	
		Aspect	Underlying norms, values, and attitudes of stakeholders	social capital	decision-making power	involvement/ procedural fairness	process duration	creative potential	distributive fairness	sensitivity to local/ regional characteristics	knowledge integration	clarity for implementation & compliance	adaptive-ness	voluntari-ness	communication, coordination, collaboration	acceptance of decisions	information and knowledge	risk & adverse effects	costs & efforts of administration	financial aspects	controls	expected effective-ness	synergies with other nature conservation objectives
Administrative level hierarchy	+	Lower Saxony	-	-	1		1					1			1				2	1	1	1	
		Saxony	-	-		1	1				1	1							4		1		
		Scania	-	-	1						1	1	1				1		2		1		
		TOTAL	0	0	2	1	2	0	0	0	2	3	1	0	1	0	1	0	8	1	3	1	0
	-	Lower Saxony	-	-	1					1			2		1	1							
		Saxony	-	-			1												2		1	1	
		Scania	-	-									3	1	1	2			1				
		TOTAL	0	0	1	0	1	0	0	1	0	0	5	1	2	3	0	0	3	0	1	1	0
Autonomous farmers	+	Lower Saxony	-	-		1	1	1					1			2			1			1	
		Saxony	-	-	1	3		1					1		1	1	1		1				
		Scania	-	-		1		1						1			1		1			1	
		TOTAL	0	0	1	5	1	3	0	0	0	0	2	1	1	3	2	0	3	0	0	2	0
	-	Lower Saxony			1	1	1						1		3								
		Saxony			1	1									1				1			1	
		Scania	1						1						1	1			1		1	1	
		TOTAL	1	0	2	2	1	0	1	0	0	0	1	0	5	1	0	0	2	0	1	2	0
Ecological scale hierarchy	+	Lower Saxony																	1				
		Saxony				1													1			2	
		Scania		1											1	1						3	
		TOTAL	0	1	0	1	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0	5	0
	-	Lower Saxony				1				1	1		1						1				
		Saxony				1													4		1		
		Scania			1										2				1				
		TOTAL	0	0	1	2	0	0	0	1	1	0	1	0	2	0	0	0	6	0	1	0	0
Collaborative actors	+	Lower Saxony				1										1							
		Saxony				3								1	1	1	1					2	
		Scania													2							2	
		TOTAL	0	0	0	4	0	0	0	0	0	0	0	1	3	2	1	0	0	0	0	4	0
	-	Lower Saxony													1				1				
		Saxony				2	1								1				2			2	
		Scania				1			1						1				1	1	1		
		TOTAL	0	0	0	3	1	0	1	0	0	0	0	0	3	0	0	0	4	1	1	2	0
POSITIVES TOTAL			0	1	3	11	3	3	0	0	2	3	3	2	6	6	4	0	13	1	3	12	0
NEGATIVES TOTAL			1	0	4	7	3	0	2	2	1	0	7	1	12	4	0	0	15	1	4	5	0
TOTAL			1	1	7	18	6	3	2	2	3	3	10	3	18	10	4	0	28	2	7	17	0

Article 5 'Success of collaboratives'

Success of Collaboration for sustainable agriculture: a case study meta-analysis

Abstract

More and better collaboration between farmers and other stakeholders has repeatedly been identified as a key strategy for sustainable agriculture. However, for collaboration to actually benefit sustainable agriculture certain conditions have to be met. In this paper, we scrutinize the conditions that support or hamper the success of collaborative efforts in the context of sustainable agriculture. For this purpose, we conducted an exploratory case study meta-analysis to consolidate insights from 30 case studies on local and regional collaborative groups for a more sustainable agriculture in the EU. Through multiple regression, we evaluated which factors influence the 'success' of such collaboratives as measured through explicit and comprehensive success criteria. We found two external, five internal actor-related, and five internal organization and management-related factors to decisively influence the five applied success criteria. Overall, our results highlight that collaboration success requires defining priorities, as for each of the success criteria a different set of factors is decisive. Although, our results showed trade-offs between the achievement of social and economic goals, it is possible to pursue some success criteria simultaneously to achieve different sustainability goals. Furthermore, our results give reason to be optimistic about the performance of collaboratives: Internal factors that are in the hand of the collaboratives are likely to be of greater importance than uncontrollable external conditions. Additionally, conditions encountered at the outset of a collaborative matter less than the way these conditions develop towards later stages. Thus rather than depending on external and predefined conditions, success largely depends on the agency within the collaboratives.

Keywords

Case survey method; multiple regression; collaboratives; European Union; local, regional.

Success of Collaboration for Sustainable Agriculture: a Case Study Meta-Analysis

Sarah Velten, Nicolas W. Jager, Jens Newig.

Abstract

More and better collaboration between farmers and other stakeholders has repeatedly been identified as a key strategy for sustainable agriculture. However, for collaboration to actually benefit sustainable agriculture certain conditions have to be met. In this paper, we scrutinize the conditions that support or hamper the success of collaborative efforts in the context of sustainable agriculture. For this purpose, we conducted an exploratory case study meta-analysis to consolidate insights from 30 case studies on local and regional collaborative groups for a more sustainable agriculture in the EU. Through multiple regression, we evaluated which factors influence the 'success' of such collaboratives as measured through explicit and comprehensive success criteria. We found two external, five internal actor-related, and five internal organization and management-related factors to decisively influence the five applied success criteria. Overall, our results highlight that collaboration success requires defining priorities, as for each of the success criteria a different set of factors is decisive. Although, our results showed trade-offs between the achievement of social and economic goals, it is possible to pursue some success criteria simultaneously to achieve different sustainability goals. Furthermore, our results give reason to be optimistic about the performance of collaboratives: Internal factors that are in the hand of the collaboratives are likely to be of greater importance than uncontrollable external conditions. Additionally, conditions encountered at the outset of a collaborative matter less than the way these conditions develop towards later stages. Thus rather than depending on external and predefined conditions, success largely depends on the agency within the collaboratives.

Keywords: Case survey method; multiple regression; collaboratives; European Union; local, regional.

1. Introduction

More and better collaboration among farmers and between farmers and related actors has repeatedly been identified as a key strategy for sustainable agriculture (Beus and Dunlap 1990; Pretty 1995b; Cobb et al. 1999; Warner 2007; Velten et al. 2015). Collaboration is considered to directly and indirectly contribute to the generation of ecological, social, and economic benefits in agricultural contexts: Arguably, collaboration allows for the effective management of natural resources and coordination of farming practices at geographically and ecologically appropriate scales as well as for the harmonization of multiple objectives, resulting in a reduction of habitat fragmentation and better connected ecological networks (Uetake 2014; Prager 2015; Leventon et al. 2017). In terms of social outcomes, collaboration is said to increase social interaction and capital. It thus is supposed to enhance the feeling of belonging within a community as well as the willingness of people to provide advice and mutual support (Ingram et al. 2008; Prager 2015). Furthermore, it has been argued that collaborative groups have greater negotiation power, are able to realize bigger, joint investments (Oerlemans and Assouline 2004) and are more

likely to receive funding by donor organizations than individual actors (Ramdwar et al. 2013). Additionally, collaboration supposedly allows for increased efficiency through minimization and sharing of costs (Uetake 2014; Prager 2015; Fischer et al. 2018). It has also been suggested that collaboration facilitates pooling and sharing of knowledge and capacities (Oerlemans and Assouline 2004; Shaw et al. 2009; Uetake 2014), individual and collective learning (Oerlemans and Assouline 2004), and more legitimate, flexible, and locally relevant solutions (Uetake 2014; Prager 2015), all of which can further support the generation of social, ecological and economic benefits.

However, collaboration does not automatically generate the above mentioned benefits and also faces challenges (Uetake 2014; Prager 2015). Arguably, certain conditions have to be met in order to render collaboration successful. In this paper, we scrutinize the conditions that support or hamper the success of collaborative efforts in the context of sustainable agriculture. In fact, there already exists a noteworthy number of publications that consider conceptually or empirically which conditions affect the success of collaborative initiatives in areas similar to sustainable agriculture, for example literature on farmer collaboration for agri-environmental management (Ingram et al. 2008; Prager 2015), collective action (Ayer 1997; Oerlemans and Assouline 2004; Mills et al. 2011) and social networks (Lubell and Fulton 2007; Newman and Dale 2007). However, existing literature lacks a specific focus on collaboration in the context of sustainable agriculture (exceptions are Shaw et al. 2009; Moschitz et al. 2014; Hubeau et al. 2017) and mostly investigates only few cases. Although small-N case study research allows deep insights into causal mechanisms, it does not allow for the identification of overall patterns, and generalizability of the results remains critical.

Therefore, in this paper we aim at consolidating insights from a larger number of case studies on collaborative initiatives for a more sustainable agriculture in order to evaluate against explicit and comprehensive success criteria which factors influence success of such initiatives. Such factors include both external conditions as well as aspects of composition, organization, and management of collaborative groups. For this purpose, we conducted an exploratory case-meta analysis, also referred to as case survey (Lucas 1974; Larsson 1993; Newig and Fritsch 2009), on local and regional collaborative initiatives for a more sustainable agriculture in the EU. Our approach is exploratory because the research field is dominated by a considerable amount of small-N case studies and evidence is rather scattered. Thus, there is a need for consolidation of knowledge rather than for hypothesis testing. By quantitatively coding variables for each case study, the case meta-analysis is especially useful here as it allows for statistical analysis of qualitative case study narratives. This, in turn, allows producing findings of broader relevance beyond a single case study.

The remainder of this paper is organized as follows: The subsequent section introduces the conceptual background of our research. Here, we clarify core concepts of our research and present our analytical framework. Section 3 describes our research methods and case selection. The results of a regression analysis explaining sustainable outcomes by the 'success factors' developed previously are presented and discussed in sections 4 and 5. In the final section, we draw conclusions and highlight future research needs.

2. Conceptual background

Below, we first describe our understanding of the core concepts: collaboration and sustainable agriculture. Afterwards, we introduce our analytical framework with its dependent variables (success criteria) and independent variables (success factors).

2.1 Clarification of core concepts

2.1.1 Collaboration

Based on Margerum (2011), we refer to 'collaboration' as an approach to solving complex problems in which a diverse group of autonomous stakeholders makes collective decisions and translates these decisions to tangible results. With that, we only refer to collaboration in the way also Schoon and Cox (2018) use the term ("working together as a collective entity") and do not include what they describe as coordination ("conducting individual actions while informing the 'other' about what is being done"). Furthermore, we also adopt Margerum's (2011) term 'collaborative' to describe the groups carrying out collaboration.

2.1.2 Sustainable agriculture

With 'sustainable agriculture' we mean here an approach that applies specific strategies in a variety of fields of action in order to achieve sustainability goals in an integrated way. Strategies for sustainable agriculture can be, for instance, adaptive management, holistic and complex systems thinking, an ecology-based or an economics-based strategy. Such strategies can be applied in diverse fields of action such as the agri-food system, management and technological solutions, or the social, political, and economic environment (Velten et al. 2015). Such a broad view of sustainable agriculture allows us to embrace a great variety of collaboratives that contribute to sustainable agriculture, ranging from farmer initiatives in search of more sustainable production techniques to agricultural supply chain initiatives with diverse involved actors trying to establish sustainable standards, and to consumer or citizen initiatives seeking ways to support sustainable agriculture.

2.2 Analytical framework

In order to gain an understanding of the kinds of factors that potentially influence the success of collaboratives for a more sustainable agriculture, we reviewed conceptual and empirical literature investigating conditions for success of collaborative ventures in the context of agriculture and rural development, especially works related to environmental and sustainability issues. The reviewed literature included works on collaborative common-pool resource institutions (e.g. Ostrom 1990; Agrawal 2001), farmer collaboration for agri-environmental management, (Ingram et al. 2008; Prager 2015) community-based natural resource management (Measham and Lumbasi 2013), collective action (e.g. Ayer 1997; Oerlemans and Assouline 2004; Mills et al. 2011), social networks (e.g. Lubell and Fulton 2007; Newman and Dale 2007), advocacy coalitions (Schlager 1995; Sabatier 1988), partnerships (Clark 2006; Dyer et al.

2013), cooperatives (e.g. Carlberg et al. 2003; Azadi et al. 2010), as well as public policy design related to sustainability and land management (e.g. Cocklin et al. 2007; Prager et al. 2011).

Based on the reviewed literature, we developed our analytical framework (Figure 1): Different kinds of external and internal success factors can impact on the overall success of a collaborative by supporting or hampering different success criteria. While there are likely to be many interconnections and feedback loops among and between the different success factors and success criteria, here we are only interested in the effects of the potential success factors on the different success criteria. The following sections explain the different success factors and success criteria.

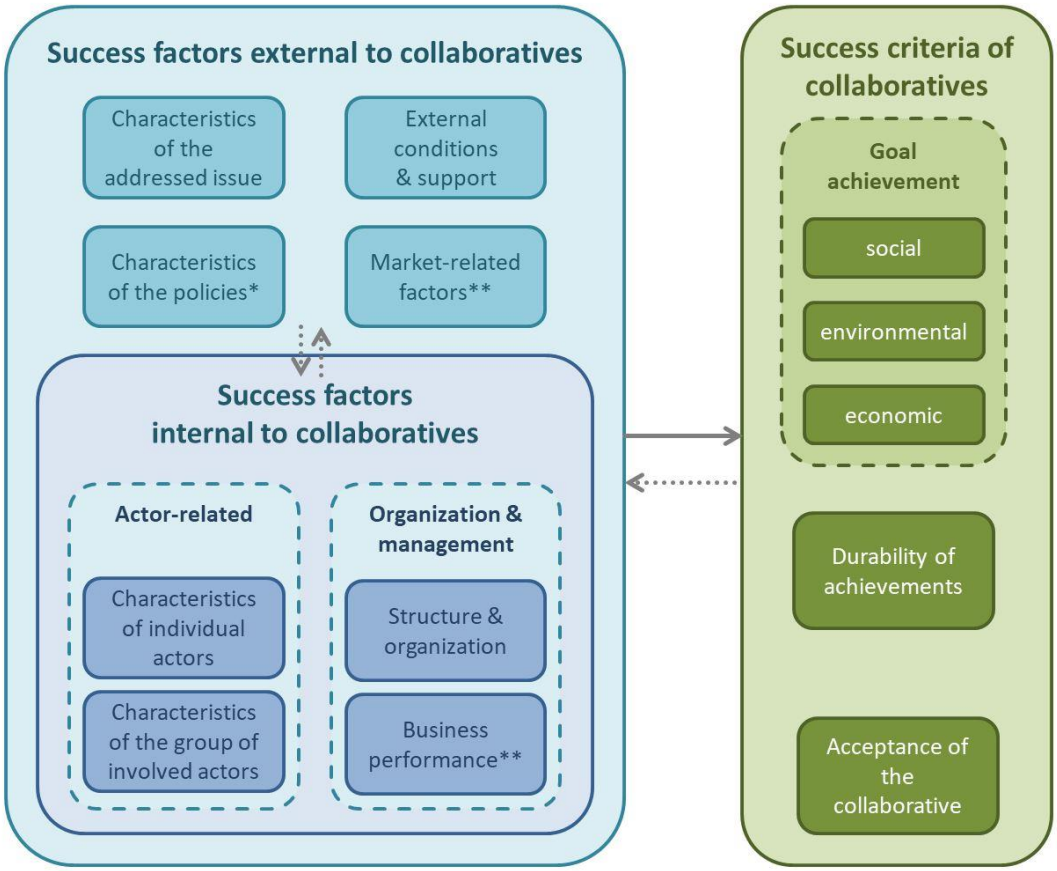


Figure 1 Conceptual framework including the different kinds of potential success factors identified in the literature (left side) and success criteria (right side). The arrows show potential influence between success factors and success criteria as well as between external and internal success factors: The continuous arrow shows the relation of interest to the research presented here; the dotted arrows represent other possible relations, which are not of interest to this investigation. Additionally, also interrelations within the groups of internal and external success factors are possible but are not the focus here. * Only relevant for collaboratives that include the implementation of or compliance with legislation ** Only relevant for collaboratives that include the marketing of goods or services

2.2.1 Success of collaboratives for a more sustainable agriculture

In contrast to the great detail on factors influencing the success of collaborative efforts, we found few clear definitions or explanations of how success of a collaborative is understood in the reviewed litera-

ture. However, in order to assess the impact of a success factor on the performance of a collaborative, an explicit understanding of the concept of success is necessary. Therefore, by departing from and extending McConnell's (2010) definition of policy success we derived a list of success criteria (see Anonymized Reference for more detail):

- *Achievement of the social, environmental, and economic goals of a collaborative*: Estimation of the extent to which a collaborative was able to realize the objectives it set out to achieve.
- *Durability*: Estimation of the actual or likely endurance of a collaborative and its achievements despite changing conditions (e.g. ceasing of financial support).
- *Acceptance of a collaborative* : Estimation of the extent to which a collaborative itself is supported or opposed by the involved and other affected actors; different from the other measures, this measure is not related to (intended or unintended) tangible outcomes but rather to the way the collaborative operated and achieved its outcomes.

Apart from these criteria, we also deem positive and negative side-effects to be important aspects of the performance of a collaborative. However, they are not in the focus of the research presented here.

2.2.2 Potential success factors for collaboratives for a more sustainable agriculture

The reviewed literature provides a very great number and variety of conditions that can contribute to or hamper the success of collaboratives. These potential success factors can be divided into three main groups: External factors, internal factors related to characteristics of the involved actors, and internal factors related to organization and management of the collaborative itself. Each of these groups comprises a number of sub-groups of thematically related success factors (Table 1).

Table 1: Overview over the main and sub-groups of potential success factors of collaboratives for a more sustainable agriculture that were identified in the reviewed literature.

Success factor groups	Explanation	Examples
EXTERNAL FACTORS		
Characteristics of the addressed issue	Factors related to the nature of the issue(s) addressed by a collaborative.	• Importance of the issue to the involved actors; • Mobility of the resource; • Public good character of the issue; • Co-production of benefits.
Characteristics of the policies	Factors related to the design of the policies a collaborative intends to implement or comply with (only for collaboratives that include the implementation or compliance with legislation).	• Stakeholder participation in the development of the relevant policies • Clarity of the rules of the relevant policies to the addressees;
External conditions & support	Factors describing the general environment of a collaborative, including the way and extend to which a collaborative was supported or opposed to by external actors and the legal framework as well as other factors of the external environment.	• Support and stimulation of/ opposition to and hindrance of collaboratives by authorities and existing legislation; • Availability and adequacy of

		external funding, technical support, and group facilitation. • Occurrence of important external events.
Market-related factors	Factors describing characteristics of the market in which a collaborative operates to sell its products or services (only for collaboratives that include the marketing of goods or services)	• Demand for the products/ services of the collaborative; • Stability and level of prices for inputs and outputs of the collaborative.
INTERNAL FACTORS: ACTOR-RELATED		
Characteristics of individual involved actors	Factors describing knowledge, skills, and attitudes of the individuals involved in a collaborative (either as representatives of organizations or on behalf of themselves) as well as factors capturing the economic situation of the involved non-state actors.	• Knowledge about and relevant to the issue addressed by the collaborative; • Environmental values; • Commitment to collaboration; • Motivation for active participation.
Characteristics of the group of involved actors	Factors describing size and composition of the group of actors involved in a collaborative, nature and strength of social capital in the group, as well as dysfunctional relations in the group.	• Trust; • Pre-existing relations; • Network density; • Conflict.
INTERNAL FACTORS: ORGANIZATION & MANAGEMENT		
Structure & organization	Factors describing the way a collaborative is organized and operated. This includes a variety of aspects including, among others, the kinds of tasks, objectives, and rules of a collaborative; the way the members of the group relate to each other, communicate, and interact; decision-making on important, strategic decisions; characteristics of the leader(s); availability of financial and human resources	• Incentives for collaboration; • Relevance of the objectives to the involved actors; • Sufficient financial resources.
Business performance	Factors relevant for collaboratives that include the marketing of goods or services, e.g.the competitiveness of the products of the collaborative, logistical aspects, business and marketing professionality, as well as the financial performance.	• Product quality and uniqueness; • Competence in marketing; • Application of methods of professional business management; • Investments; • Profits.

The group of external success factors comprises the factors that may have an influence on the performance of a collaborative but which the collaborative can hardly influence itself. This main group includes firstly, the sub-group of the characteristics of the issue addressed by a collaborative. The factors contained in this sub-group stem mainly from literature on collaborative common-pool resource institutions (Wade 1988; Ostrom 1990; Baland and Platteau 1996; Agrawal 2001). This literature argues that the characteristics of a resource managed by a collaborative institution are decisive for the success of the collaborative. The reason for this is that resource characteristics supposedly influence the ease with which the resource can be managed. For instance, smaller and stationary resources are easier to manage than large and mobile resources. Furthermore, also the motivation of resource users to collaboratively manage and conserve the resource may be influenced by the characteristics of the resource, e.g. if the

resource users are highly dependent on the resource (Gibson et al. 1999) or if collaborative management leads to a co-production of benefits, such as environmental outcomes along with increased revenues (Ayer 1997).

Policy characteristics and market-related factors make up the second and third sub-groups of external factors. While policy characteristics are relevant only for collaboratives that are concerned with the implementation of or compliance with policies, the market-related factors concern only collaboratives that market any goods or services. Also these kinds of external factors can impact on the performance of a collaborative by influencing the ease with which the collaborative can perform its tasks: A collaborative will be better able to implement or comply with a well-designed policy that matches the specific ecological, political and economic situation as well as the capacities of the stakeholders (Cocklin et al. 2007). Additionally, the characteristics of a policy can also influence the willingness of stakeholders to implement and comply with the policy. This willingness can be increased, for example, if the concerned farmers and other policy addressees have had a voice in the formulation of the policy (Horlings 1994; Cocklin et al. 2007) and if the issues of the policy are generally accepted by these stakeholders (Horlings 1994). Likewise, with regards to the economic environment, moving towards sustainable agriculture and selling sustainable products will be easier for a collaborative in an economic situation of stable and favorable prices (Carlberg et al. 2003; Mburu and Wale 2006), high demand (Warner 2007; Vuylsteke et al. 2008), and little competition (Carlberg et al. 2003).

The last sub-group of external factors deals with external conditions and support, i.e. factors that characterize the general environment in which a collaborative is inserted. One part of this is the political environment, which can arguably facilitate collaboration for sustainable agriculture when governments explicitly support and actively encourage collective action, and vice-versa (Lamprinopoulou et al. 2006; Ramdwar et al. 2013). However, there is a sensitive balance between too little and too much: It is argued that state intervention needs to be limited in order to not stifle collaborative dynamics. Rather, governments need to enable and stimulate self-regulation (Schlager 1995; Lamprinopoulou et al. 2006; Mburu and Wale 2006; Shiferaw et al. 2011; Measham and Lumbasi 2013).

Another aspect of the sub-group of external conditions and support is the degree and kind of external support that a collaborative receives. Such support can take the form of financial means, technical knowledge or process facilitation and can be provided by governments or by other sources such as NGOs or private foundations. Such support can enhance the performance of a collaborative by firstly, providing incentives to participate in the collaborative, e.g. by compensating for the extra costs of collaboration (Ramdwar et al. 2013; Prager 2015) or for the generation of public goods and services (Prager 2015; Agrawal 2001); second, by closing resource gaps, e.g. through the provision of starting capital, technical information and knowledge (Lamprinopoulou et al. 2006; Prager 2015), or group process facilitation skills (Markelova and Mwangi 2010; Ramdwar et al. 2013); and third, by building capacity of the involved actors through facilitation of collective learning (Oerlemans and Assouline 2004; Mills et al. 2011) and the development of collaboration skills (Mills et al. 2011). But also here, too much support can create dependency and hamper the durability of a collaborative (Markelova and Mwangi 2010; Mills et al. 2011).

The internal factors, which can be influenced by the collaborative itself, are divided into two parts: Factors related to the composition and structure of the group of involved actors and factors related to the way a collaborative is organized and managed. The first sub-group of the internal actor-related success

factors concerns the characteristics of the individual involved actors. These can on the one hand have an influence on actors' capacity and motivation to address issues of sustainable agriculture. For instance, it is deemed more likely that a collaborative will succeed in achieving its objectives if the involved actors possess a high level of knowledge relevant to addressing the issues at hand (Newig et al. 2018) as well as pro-environmental attitudes (Lubell and Fulton 2007). On the other hand, also the ability and willingness of the involved actors to collaborate is partially determined by their knowledge, skills and attitudes, e.g. their collaboration skills (Oerlemans and Assouline 2004; Mburu and Wale 2006; Shiferaw et al. 2011) and their general commitment to collaborative principles (Oerlemans and Assouline 2004; Lamprinopoulou et al. 2006; Azadi et al. 2010).

The second sub-group of actor-related factors treats the relevant characteristics of the whole group of involved actors and is concerned with the size and composition of the actor group, with its level of social capital, as well as with negative group dynamics. These aspects are argued to have a crucial influence on the functioning of the collaborative process, on whether groups work together constructively and effectively or remain stalled; whether they continue to exist or fall apart. For example, trust, which is an important aspect of social capital, can encourage the development of norms of reciprocity and repeated interaction. This in turn motivates the group members to experiment with cooperation (Schlager 1995; Shiferaw et al. 2011). In contrast, mistrust creates a fear of being taken advantage of (Mburu and Wale 2006) and therefore reduces the willingness to cooperate. Negative group dynamics such as conflict may impair both the durability as well as the effectiveness of the collaborative in carrying out its tasks and fulfilling its objectives (McDougall and Banjade 2015).

However, regarding several aspects included in this sub-group there is considerable controversy on the way they affect the performance of collaboratives. For instance, it is argued that highly dense networks of relations among the involved actors facilitate collective action but provide little new information. In contrast, in less dense networks new information can become available and facilitate innovation but this information may be difficult to diffuse through the network (Isaac 2012).

Also the internal factors related to the organization and management are made up by two sub-groups: The sub-group of organization and management captures factors describing the modus operandi of the collaborative. This includes, among other things, features of the objectives and rules of the collaborative, aspects of leadership, financial questions as well as the ways in which major decisions are taken. Also these factors can have an impact on both the effectiveness and durability of a collaborative. For instance, similar to the characteristics of the issue addressed by a collaborative also the kinds of tasks and objectives a collaborative chooses to pursue can influence the motivation and incentives of the involved actors to collaborate and to contribute actively (Measham and Lumbasi 2013; Newman and Dale 2007; Shiferaw et al. 2011).

The second sub-group of the organization and management encompasses factors related to the way the business of a collaborative is managed. Therefore, also this sub-group is only relevant for collaboratives that engage in business activities. A good business performance cannot only contribute to the achievement of the economic goals of a collaborative but is also likely to support its durability by providing sufficient revenue to the collaborative and its individual members to allow them to keep up their activities. This may involve developing and offering products of high quality (Carlberg et al. 2003; Azadi et al. 2010; Burandt et al. 2013), skilled marketing of the goods or services at different markets and application of

methods of professional business management (Carlberg et al. 2003; Burandt et al. 2013) as well as the generation of some surplus, which allows for continued investments in the collaborative (Azadi et al. 2010) or even profits (Carlberg et al. 2003; Lamprinopoulou et al. 2006; Azadi et al. 2010).

3. Methods

3.1 The case-study meta-analysis method

For the systematic integration of the insights of a larger number of qualitative case studies, the case-study meta-analysis – also termed case survey method – is especially appropriate (Lucas 1974). The basic principle is to transform the qualitative case narratives into quantitative data and thus make them accessible to quantitative analysis. For this transformation, a predefined coding scheme is used, which consists of a set of questions about the case studies to be answered mostly with numerical values. Thus, the case-study meta-analysis draws on a rich account of diverse case material, devised by different researchers using different research designs, and brings them together under a common conceptual framework. While preserving a large amount of detail of individual case studies, the method allows for much wider generalization than single or small-N comparative case studies (Larsson 1993; Lucas 1974; Newig and Fritsch 2009).

Below, we describe each step of the performed case-study meta-analysis: (1) selection of existing case studies that are relevant to the research questions; (2) design of a coding scheme, (3) coding of the selected case studies by expert coders, (4) statistical analysis of the produced data (Larsson 1993). Online Resource 1.1 provides a detailed account of the methodology.

3.2 Case selection and sampling

For this case meta-analysis, we defined a case as *an intervention (initiative, project, putting a legislation into practice etc.) which is realized on the local or regional level (i.e. any level above farm-level and below national level), which aims at improving the sustainability of agriculture in the concerned locality or region and is carried out in any EU country in collaboration of several actors.*

Thus, aside from collaboratives with ambitious objectives and the intention to realize genuine sustainable agriculture we also include collaboratives that seek incremental improvements. There are two reasons for this: First, sustainable agriculture is a very vague and ambiguous concept (Culleton et al. 1994) and has been deemed impossible to be defined in a precise and absolute way (Pretty 1995a). Therefore it is difficult to assert whether a collaborative does in fact aim at – let alone attain – 'really' sustainable agriculture. Second, Pretty (1999) argues that "everyone can take small steps, and small steps added together can bring about big change in the end" (p. 261). Thus, rather than to expect current initiatives to perfectly provide for sustainable agriculture, also those initiatives should be valued that do not necessarily treat all sustainability dimensions equally but aim at improvements of the whole in an integrated and lasting way (Kemp et al. 2005). Hence, to be considered a relevant case for our case meta-analysis, a collaborative may focus on only part of the sustainability dimensions but still needs to pursue its objectives in a way that benefits or at least does not worsen the situation of the remaining, non-focal areas. Key selection criterion is whether there is some evidence that interventions actually aim at sustainability

improvements. Cases in which such aims were obviously merely symbolic and not sincere were not included.

In searching for relevant case studies, different internet-based search strategies were used. All publications up to 2014 in English, German, or French were considered. Subsequently, all identified publications were screened with two aims: first, to accomplish the identification and matching of all publications describing the same collaborative because the unit of analysis is an intervention, not a publication (Lucas 1974); second, to check whether the described collaboratives indeed matched the definition above and were described in sufficient detail. Of the 50 identified relevant and usable cases (see Online Resource 1.2) a random sample of 30 cases was drawn for further analysis. The analyzed collaboratives were located in Germany (7), The Netherlands (5), United Kingdom (5), Italy (5), Austria (3), France (2), Belgium (2), and Czech Republic (1). The development of seven analyzed collaboratives started before 1990, thirteen collaboratives came into existence in the 1990s and the remaining ten collaboratives started out after the turn of the millennium, with the earliest case starting to develop in 1965 and the latest in 2010. Regarding their spatial level, two collaboratives in the sample acted on municipal or lower level, four collaboratives involved several municipalities, six collaboratives spanned one or several counties, eight collaboratives ranged over one or several sub-national units (e.g. states, provinces), and ten collaboratives focused on a landscape rather than any administrative unit (see Online Resource 1.1, Table A1 for an overview over all analyzed cases).

To illustrate the kinds of analyzed collaboratives, we shortly describe three exemplary cases here: The case of the *Upländer Farmer Dairy* (Strauch et al.; Knickel et al. 2003; Staub 2008) began in 1986, when eight organic dairy farmers founded a cooperative in the Upland region in the state of Hesse, Germany. Initially, the cooperative sold their milk to another dairy for processing but for several reasons they opted to buy the recently closed local Upländer Dairy in 1996 and started to process and sell their milk themselves. Rates of increase in turnover and prices paid to farmers were remarkable and as of 2008, the dairy processed the milk of 130 organic dairy farmers, thus enabling and supporting their activities.

In contrast to the bottom-up initiated and purely farmer-led initiative of the Upländer Farmer Dairy, the case of the *Gailtal Alp cheese* (Rytkönen and Gratzer 2010; Borg and Gratzer 2013; Gratzer 2013) was initiated from the top down and included several types of actors. The case started with the foundation of the “Kärtner Agrarmarketing AG” corporation by the federal state of Carinthia, Austria in 1989. This corporation soon identified the Gailtal Alp cheese as a promising candidate for application for a Protected Denomination of Origin (PDO) at the EU. This cheese was produced with long tradition by fourteen mountain chalets in the administrative district of Hermagor. With the aim of halting the decline of farms and local dairies and protecting a traditional, extensive way of livestock rearing and cheese production, the state-owned corporation initiated local activity groups and networks among different interested local stakeholders,. These groups, which included farmers, chalet owners, and local businesses prepared the application for a PDO. The PDO certificate was granted in 1996. The very small scale cheese production itself is of lesser economic importance for the region. However, an annual festival initiated in 2001 related to cheese and ham from the Gailtal has had great positive effects on tourism, gastronomy and handicraft. Although the state had a very important and proactive role in the beginning of the process, it later shifted responsibilities to the stakeholders.

Different from the two previous examples, the case of the *Parish Grasslands Project* (Ingram et al. 2008; Peterken 2010, 2013) did not include the commercialization of specific products. In the communities of Brockweir, Hewelsfield, and St Briavels in Monmouthshire, UK the fields of a former common had largely remained in a semi-natural state. These fields were mostly owned by smallholders or local residents who let their fields to farmers based on informal contracts. When the BSE and Food and Mouth disease crises in the end of the 1990's resulted in increased bureaucracy and restrictions, residents faced breakdown of their informal arrangements that had supported conservation of the landscape. Thus, in 2001 local residents set up a parish organization with the aims of helping residents to maintain their fields as flowery grassland and to increase interest in and knowledge of the surrounding landscape. By engaging in education (lectures, field meetings, school programs, publications), a field-by-field survey, sharing knowledge and advice, and helping field owners to enter agri-environment schemes, the intervention has created a community network of local people (residents, farmers, smallholders), who want to manage and maintain their fields for biodiversity benefits.

3.3 Coding scheme

The coding scheme (see Online Resource 2) contains precise and operable definitions of the key concepts to be analyzed. These are a) the kinds and ambitiousness of the environmental, economic, and social goals of a collaborative; b) the dependent variables (success criteria); c) the independent variables (success factors). Included in the latter were all factors retrieved from the reviewed literature (see section 2.2.2). Moreover, the coding scheme includes control variables capturing information about the available publications describing the case (e.g. involvement / neutrality of the authors) as well as information characterizing the collaborative (e.g. start year, multi-level aspects, involved actors).

Some of the identified success factors can vary significantly during the trajectory of a collaborative (e.g. trust) and literature provides little clarity as to the point in time at which they matter most. For this reason, these success factors were translated into two variables, one evaluating the presence of the factor at the outset of a collaborative, the other variable doing the same at the latest known point in time.

Most variables in the coding scheme are questions about the case at hand and are usually answered with a numeric code. Answers are mostly expressed on a metric scale from 0 to 4, similar to a five-point Likert-scale. Additionally, the coding scheme requires for all variables a code expressing the degree of reliability of information on which the answer is based. These reliability codes range from 0 meaning 'insufficient information available' to 3 meaning 'explicit, detailed and reliable information available'.

3.4 Coding procedure

After a pre-test, coding of the case studies was shared between the first author and a student assistant. The case studies were mainly coded by only one of the coders. Seven case studies were coded by both coders in order to compare coding results, discuss strong deviations, and adjust coding if needed (cf. Lucas 1974). Afterwards, both code lists were consolidated into one code list by calculating the weighted means of the codes, using the reliability values as weights. Moreover, interrater agreement was determined with an average r_{wg} value (James et al. 1984) of 0.86 across all variables (standard deviation 0.17). With that, interrater agreement was at an appropriate level, indicating a high degree of agreement. Ad-

ditionally, for the cases coded by one coder, steps were taken to increase reliability of the codes, such as cross-check of the codes by the other coder.

3.5 Data preparation and analysis

The aim of our analysis was to determine which of the independent variables (representing success factors) have decisive effects on which dependent variables (representing success criteria).

We applied a stepwise exploratory approach to reduce complexity and arrive at robust and interpretable results. As a first step, we simplified and aggregated the measured constructs by means of principal component analyses (PCA) with oblique rotation (promax) on conceptually related variable subsets within each of the success factor sub-groups (see section 2.2.2). Where feasible, PCA integrates these variables into a smaller number of components, which represent more general constructs. Thus, PCA is able to reduce the dataset without losing much of the information provided by the original variables. All analyses were evaluated using Kaiser-Meyer-Olkin measures for sampling adequacy and Bartlett's test of sphericity, which for all analyses yielded acceptable results. All resulting constructs have acceptable reliability, with Cronbach's Alpha of at least 0.74 (for more information see Online Resource 1.3). Additionally, for the factors that can vary strongly over time, we calculated the differences between the variables evaluating these factors at the beginning of the collaboratives and at the latest known point in time. This way, additional variables representing the change of these factors over time were created.

Second, we mapped potential relations between dependent and independent variables by means of correlation analyses. Spearman rank correlations as well as partial correlations, that assess relations between variables and control for potential confounders, provided a robust overview over covariance structures in our dataset and facilitated subsequent variable selection for regression models.

Finally, we performed multiple regression in order to assess in a broader estimation which of the selected success factors impact on which success criteria. For the regression models, all independent variables were considered that proved to have a significant and robust relation with one of the dependent variables. Due to the small sample size, models were restricted to a maximum of four variables. Therefore, we assessed different models with varying combinations of variables from at least two of the major factor groups (external, internal actor-related, internal management-related). We evaluated the regression models regarding the assumptions of normality, linearity, multicollinearity, and homoscedasticity to evaluate their generalizability. We finally selected those models with the smallest value of the Akaike information criterion (AIC).

4. Results

A list of the frequency, mean values and standard deviations of all independent variables included in the regression models as well as success criteria ratings of the different cases are provided in Online Resource 1.4. PCA proved feasible for numerous groups of related variables Therefore, many of the variables included in the regression models are aggregates of several individual variables. Due to a high amount of missing values in the independent variables, all of our regression models are based on between 19 and 22 cases.

Table 2: Regression models explaining outcomes for the different success criteria for collaboratives for a more sustainable agriculture. "PCA" indicates that a variable was obtained through PCA and therefore includes several aspects. In the descriptions of these variables, (+) indicates that an aspect is positively related to the regression coefficient of the PCA-variable, (-) indicates a negative relation.

	Dependent variable:				
	ACHIEVEM. SOCIAL GOALS	ACHIEVEM. ENVIRONMENTAL GOALS	ACHIEVEM. ECONOMIC GOALS	DURABILITY	ACCEPTANCE
External success factors					
ISSUE CHARACTERISTICS (PCA): Includes several features of the addressed issue like public good (-) and co-production of benefits character (-) as well as possibility to store the benefits of the issue (+) and dependence of the involved actors on the issue or its resolution (+)	-0.358*** (-0.583, -0.132)	-	-	-	-
PRODUCT DEMAND END: General demand for the products of the collaborative at the latest known point in time.	-	-	0.392** (0.096, 0.688)	-	-
Internal actor-related success factors					
DEVOTEDNESS END (PCA): Includes the involved actors' loyalty to (+) and satisfaction with (+) the collaborative, their motivation for active participation (+) as well as their general environmental values (+) and commitment to collaborative principles (+) at the latest known point in time.	0.310** (0.095, 0.525)	-	-	-	-
KNOWLEDGE ISSUE AVRG: Average degree of the involved actors' knowledge about and relevant to the addressed issue.	-	-	-	-0.338* (-0.679, 0.002)	-
EXT REL MIN: Baseline of relations that existed between the involved actors before the start of the analyzed collaborative.	-	0.266** (0.071, 0.462)	-	-	-
NETWORK DENSITY DIF: Change of actor network density between the beginning of the collaborative and the latest known point in time.	-	-	-	0.196*** (0.073, 0.320)	-
TRUST END AVRG: Average trust between all involved actors at the latest known point in time.	-	0.440** (0.042, 0.838)	-	-	-
CONFLICT END: Level of conflict between involved actors at the latest known point in time.	-	-	-	-	-0.292* (-0.578, -0.006)

	Dependent variable:				
	ACHIEVEMENT SOCIAL GOALS	ACHIEVEMENT ENVIRON-MENTAL GOALS	ACHIEVEMENT ECONOMIC GOALS	DURABILITY	ACCEPTANCE
Internal success factors related to organization and management					
INITIATIVE ATTRACTIVENESS (PCA): Includes a narrow range of objectives (+) that favor individual rather than collective interests (+) and are highly relevant to the involved actors (+) as well as the existence of strong incentives to pursue the objectives (+) and to collaborate rather than to act individually (+).		-	0.405* (0.022, 0.788)	-	-
FINANCIAL RESOURCES: Average sufficiency of overall available financial resources.	0.292* (-0.016, 0.600)	-	-		
FINANCIAL RESOURCES DIF: Change of the sufficiency of overall available financial resources between beginning of the collaborative and the latest known point in time.	-	0.392*** (0.147, 0.637)	-	-	-
PRODUCT IDENTITY QUALITY (PCA): Includes the uniqueness (+) and quality (+) of the products of the collaborative as well as the choice of a product name that refers to the location where it originates from (+).	-	-	-	-	0.253* (0.007, 0.463)
BUSINESS PROFESSIONALITY (PCA): Includes high competence in marketing the goods or services of the collaborative (+) at different markets and through different marketing channels (+) as well as the application of methods of professional business management (+).	-	-	0.517*** (0.248, 0.787)	-	-
INVESTMENTS: Extent of continuous investment in the collaborative.	-	-	-	0.389*** (0.205, 0.573)	-
Constant	2.109*** (1.189, 3.029)	1.208** (0.120, 2.296)	1.891*** (0.941, 2.840)	3.656*** (2.497, 4.816)	3.320*** (3.020, 3.620)
Observations	19	20	20	19	22
R^2	0.679	0.656	0.648	0.713	0.315
Adjusted R^2	0.615	0.591	0.582	0.656	0.243
Residual Std. Error	0.471 (df = 15)	0.534 (df = 16)	0.589 (df = 16)	0.395 (df = 15)	0.552 (df = 19)
F Statistic	10.590*** (df = 3; 15)	10.158*** (df = 3; 16)	9.825*** (df = 3; 16)	12.448*** (df = 3; 15)	4.375** (df = 2; 19)
AIC	30.823	37.169	41.154	24.171	41.054
Note:					*p<0.1, **p<0.05, ***p<0.01

The following sections present the modeling results (see Online Resource 1.5 for the assessment of assumptions of the different models). Table 2 presents an overview of the regression models, each relating to a different success criterion as dependent variable. As we restricted our models to contain a maximum of four variables and selected for each dependent variable the variable combination making up the model with the smallest AIC, the models in Table 2 contain different sets of variables.

4.1 Factors influencing success of a collaborative in terms of the achievement of its goals

All of the models explaining the achievement of the different kinds of goals present very high regression coefficients (adjusted R-square^{-} between 0.58 and 0.62). Thus, they explain a very large amount of the variance of the respective success dimensions.

According to our results, for the achievement of the social goals of a collaborative the characteristics of the issues addressed and the involved actors' devotion to the collaborative at the latest known point in time are especially relevant. Regarding the former, collaboratives are more likely to achieve their social goals if the addressed issues can be characterized as a public good and co-production-of-benefits problem; if the benefits of the issue cannot be stored (which is the case e.g. for clean air or the beauty of a landscape, which are typical public goods); and if the issue is of less importance to the involved actors, that is if they are not dependent on the solution of the issue. The sufficiency of overall financial resources does not show a robust significant effect (confidence interval of this variable contains zero).

When it comes to the achievement of environmental goals, a collaborative is more likely to achieve these goals if the involved actors get to trust each other to a high degree towards the later stages of the collaborative and if the sufficiency of the overall available financial resources improves over time. Thereby, 'sufficiency' means 'having enough to carry out the tasks and functions of the collaborative'. Also, relevant for the achievement of environmental goals are a high baseline of pre-existing relations among the actors involved in a collaborative (i.e. all involved actors knew each other before at least to some extent).

The relevant factors supporting the achievement of economic goals are professional business management and the attractiveness of a collaborative to the involved actors. The latter includes among other things choosing objectives and tasks that are of high relevance to the involved actors and favor their individual interests rather than collective benefits. An additional relevant factor for the achievement of the economic goals is a high demand for the products of a collaborative at the latest known point in time.

4.2 Factors influencing success of a collaborative in terms of the durability of its achievements

Also in case of the durability of the achievements of a collaborative, the regression model explains a very large amount of the variance (adjusted R square of 0.66). The model deems the following factors relevant: continued investments in the collaborative (e.g. in infrastructure, marketing campaigns, training etc.) and an increasing density of the network of relations among the involved actors. The latter means that the involved actors establish more relations among each other over time. Also this model contains

an additional variable with p>0.1 whose confidence interval contains zero and whose correlation coefficient is therefore not significant (knowledge of the involved actors about the addressed issue).

4.3 Acceptance of a collaborative

Compared to the aforementioned regression models, the model for the acceptance of collaboratives explains a low amount of the variance (adjusted R squared of 0.24). The model indicates that the factors that are decisive in influencing the acceptance of a collaborative itself are a low level of conflict between the involved actors at later stages of the collaborative and products and services of clear and unique identity as well as high quality – if the collaborative markets any goods or services at all.

5. Discussion

Figure 2 summarizes which of the success factors impact on which success criteria of collaboratives for a more sustainable agriculture. First and foremost our results show that there is no "silver bullet factor" which alone could ensure wholesale success: Although we assessed in a multi-step procedure all variables of our coding scheme for their influence on the different success criteria, no single success factor proved to have a significant impact on all success criteria. Thus, for each success criterion a different set of factors is decisive.

Perhaps the most important finding on a more general level is that more internal factors than external factors show an impact on the success of a collaborative (we identified ten internal factors and two external factors, see Figure 2). Thus, we conclude with some caution that the performance of a collaborative is largely in the hands of the collaborative and its actors, and only to a lesser degree subject to external circumstances.

Furthermore, our results uncover a trade-off between social goals and economic achievements. For the achievement of economic goals, it is favorable if the collaborative pursues objectives that are of high relevance to the involved actors and contribute to the involved actors' individual self-interest rather than to collective goals. In contrast, the achievement of social goals is more likely if the involved actors are little dependent on the addressed issue and if it is a public good or co-production issue, which is of collective rather than of individual interest. This finding shows that collaboratives that put a greater focus on either economic or social achievements are more likely to succeed. However, at the same time we did not find a trade-off between environmental and the other goals. Thus, while a collaborative may need to decide whether social or economic goals are of greater importance, it is possible to achieve environmental goals along with economic and social goals.

Additionally, our results highlight the importance of success factors related to business and finances as they are central for many different success criteria: If a collaborative includes the marketing of goods or services, it is important that business and marketing are carried out in a professional way. This also entails assuring that the offered products or services have a unique identity and are of good quality. Furthermore, availability of sufficient financial means facilitates the achievement of environmental goals and continued investments into the collaborative can increase the durability of the collaborative. On first sight, these findings seem to be rather self-evident, especially the importance of business and finance-

related factors for economic achievements. However, these findings tell an important lesson: Also for initiatives aiming at the improvement of the sustainability of agriculture, pure idealism is not sufficient. Also classic economic criteria have to be taken into account to support a collaborative in achieving all of its goals in a durable way. Yet, as the generation of surplus profits did not prove to be decisive factor in our analysis, the main focus regarding these financial aspects is on economic viability rather than on profitability, i.e. on having enough means available for the collaborative to carry out its functions and to make continuous investments to improve its operations.

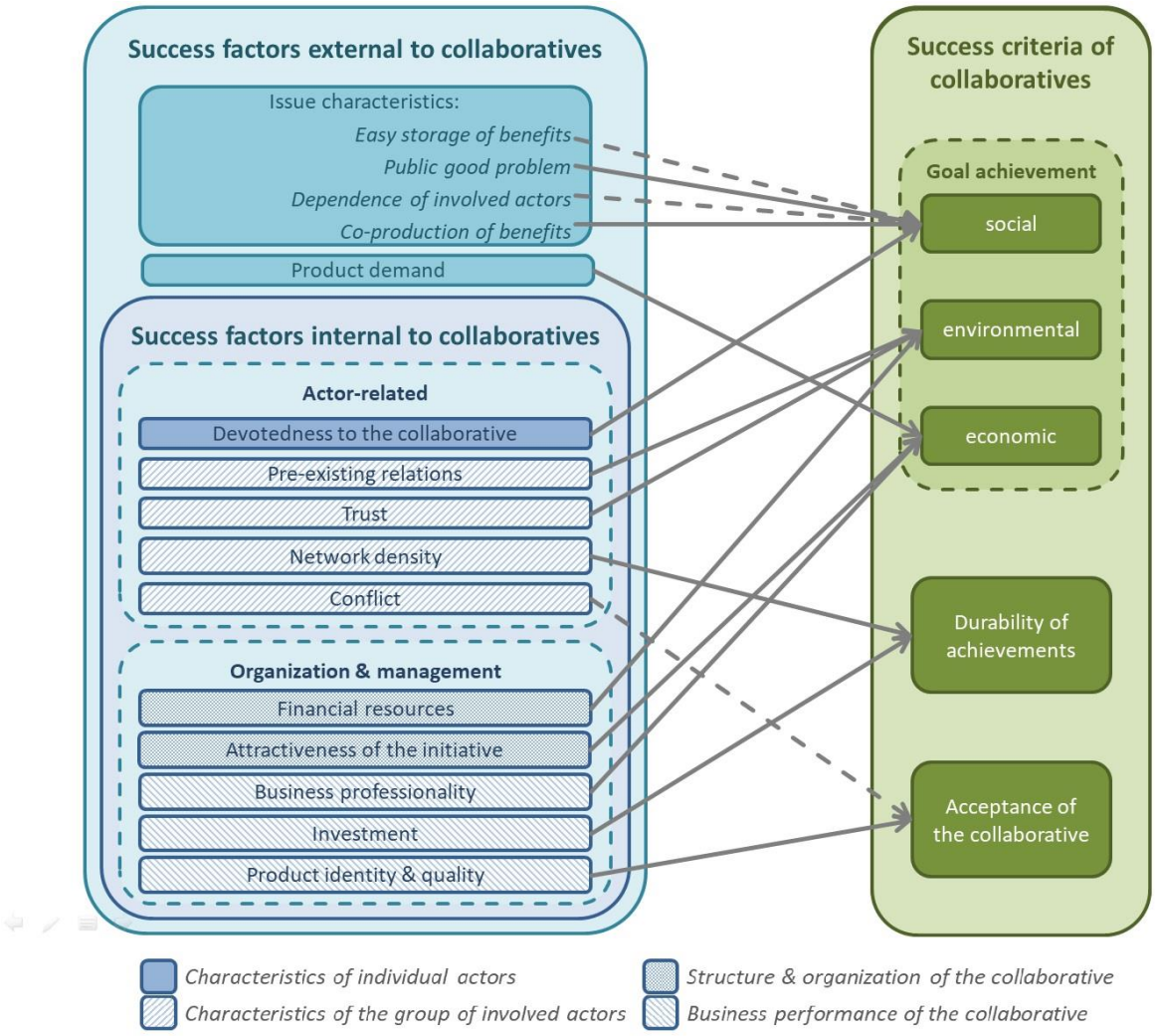


Figure 2 Impacts of the success factors on the different success criteria. Continuous arrows represent positive effects, dashed arrows negative effects. For the factor 'issue characteristic', which the PCA identified to be an overarching concept made up of several aspects, it is important to understand in which way its different aspects affect the achievement of social goals. Therefore, for this factor, the effects of its single aspects are shown here

For success factors that can vary to a great extend over the trajectory of a collaborative, we assessed their status at the beginning and at the latest known point in time as well as their change over time. Therefore, our analysis provides more detail about the point at which these factors are crucial. For these

factors, we found that either their change over time (for network density) or their status at the latest known point in time matters (for product demand, devotedness to the collaborative, trust, and conflict). However, our results do not reflect cases of collaboratives that do not even take off due to e.g. strong distrust, conflict or absence of commitment and motivation for a cause because such cases are rarely reported (publication bias). Thus, while we need to keep in mind that completely adverse initial conditions might impede a collaborative from taking off, success of a collaborative for a more sustainable agriculture seems to depend less on the given conditions encountered at its outset and rather on the way it develops over time.

What is more, our results also shed some light on the conceptually ambivalent effects of the factor of network density (see section 2.2.2). According to our results, it is not the absolute network density but rather an increase in network density over time that matters for the durability of a collaborative and its achievements. Thus, one can say that durable collaboratives manage to consolidate their relationships over time. This finding is also in line with findings from Berardo and Scholz (2010): They posit that actors in newly emerging policy arenas seek to establish relations with prominent partners in order to discover collaborative possibilities. This process creates high bridging capital in a network, which allows for efficient information exchange and is a characteristic of loose networks. However, as the policy arena matures, the advantages of bridging capital fades and bonding capital becomes more important. In this process the number of strong ties as well as the level of reciprocity increase and allow addressing more complex cooperation problems by providing credibility.

6. Conclusions

In this paper, we aimed at assessing which factors influence the success of local and regional collaboratives for a more sustainable agriculture. To this end, we conducted a case meta-analysis of 30 collaboratives from different EU countries. We considered a wide range of factors suggested to be relevant in the related literature. Our results provide insights not only on the kinds of decisive success factors and the ways they impact on success of collaboratives (i.e. which success criteria they affect) but also regarding the stage at which certain factors play a role.

Overall, our results show that there is no silver bullet: For each success criterion (achievement of ecological, social, economic goals; durability; acceptance), a different set of factors is decisive. Consequently, there is no selection of factors that, if addressed adequately, could ensure wholesale success for a collaborative. However, while we identified a trade-off between social goals and economic benefits, we did not find a trade-off between environmental and the other goals. What is more, we found several aspects related to finances and business management to contribute to almost all success criteria. In sum, while there is no simple way to achieve overall success and some priorities have to be set, it is possible to pursue different success criteria simultaneously and thus render a collaborative successful in many respects. Importantly, our results show that economic viability of a collaborative (i.e. the ability to sustain itself financially) is a precondition for overall success: If a collaborative cannot continue due to lacking economic viability, it can no longer deliver as well in an ecological or social sense.

Furthermore, our results give reason to be optimistic about the performance of collaboratives: Internal factors, i.e. the way collaboratives are composed and managed, are likely to have greater influence on

the performance as uncontrollable external conditions. Additionally, with the exception of extremely adverse initial preconditions, conditions encountered at the outset of a collaborative seem to matter less than the way these conditions develop towards later stages. Also, the process of growing together itself, which is reflected in an increasingly dense network of relations, helps the collaborative and its achievements to persist. Therefore, rather than depending on external and predefined conditions, success rather is a result of the agency within the collaboratives.

Despite this positive outlook, we point out that that even the most successful collaborative arrangement is never entirely perfect (Mfune 2014) and that collaboration is not a panacea. This implies that the feasibility and usefulness of establishing a collaborative have to be carefully pondered in each situation (Emerson and Nabatchi 2015).

Although our results contribute to clarifying which factors are especially important for the success of collaboratives for a more sustainable agriculture, our analysis presents certain challenges that could be overcome in future research: On the one hand, our analysis builds on a relatively small sample characterized by a great variety of collaboratives. Thus, future research could conduct an analysis similar to the one described here on a larger set of case studies or on more homogenous sets of collaboratives, e.g. just on farmer cooperatives or just on multi-stakeholder initiatives. Furthermore, with its essentially nomothetic approach our analysis tells little about the causal mechanisms through which the identified relevant factors influence the success of a collaborative. Therefore, we recommend in line with Goertz (2017) to combine the case meta-analysis with thorough within-case inference in order to identify the causal mechanisms underlying the statistical relations found here.

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Online Resource 1 to Velten, Sarah, Jager, Nicolas W., Newig, Jens: Success of Collaboration for Sustainable Agriculture: a Case Study Meta-Analysis; *Environment, Development and Sustainability*
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Online Resource 1.1 - Detailed description of the methodology

1. Case selection and sampling

For this case meta-analysis, we defined a case as *an intervention (initiative, project, putting a legislation into practice etc.) which is realized on the local or regional level (i.e. any level above farm-level and below national level), which aims at improving the sustainability of agriculture in the concerned locality or region and is carried out in any EU country in collaboration of several actors.*
Thus, aside from collaboratives with ambitious objectives and the intention to realize genuine sustainable agriculture we also include collaboratives that seek incremental improvements. There are two reasons for this: First, sustainable agriculture is a very vague and ambiguous concept (Culleton et al. 1994) and has been deemed impossible to be defined in a precise and absolute way (Pretty 1995). Therefore it is difficult to assert whether a collaborative does in fact aim at – let alone attain – 'really' sustainable agriculture. Second, Pretty(1999) argues that "everyone can take small steps, and small steps added together can bring about big change in the end" (p. 261). Thus, rather than to expect current initiatives to perfectly provide for sustainable agriculture, also those initiatives should be valued that do not necessarily treat all sustainability dimensions equally but aim at improvements of the whole in an integrated and lasting way (Kemp et al. 2005). Hence, to be considered a relevant case for our case meta-analysis, a collaborative may focus on only part of the sustainability dimensions but still needs to pursue its objectives in a way that benefits or at least does not worsen the situation of the remaining, non-focal areas.

In searching for relevant case studies, different search strategies were used such as searches in databases (mainly Scopus) and web search engines (Google Scholar) with search strings derived from the definition above; search in conference abstracts and on web pages of relevant research projects; as well as following up on references to other cases in already found texts (snowballing). Considered were all kinds of publications, from peer-reviewed journal articles over book chapters to project reports, in the languages English, German, and French published up to and including 2014, when the search was concluded.

In a further step, all found publications were screened with two aims: first, to accomplish the identification and matching of all publications describing the same collaborative as the unit of analysis is an intervention, not a publication (Lucas 1974); second, to check whether the described collaborative matched the definition above and was described in sufficient detail. For the latter, instead of establishing rules for exclusion of a case as proposed by Lucas (1974) and Larsson (1993), we derived criteria for inclusion of a case from our case definition. Thus, a case was deemed relevant and usable if it featured

all of the following criteria and if sufficient detail was provided in the available publications on each of these criteria:

- Does the case describe an *intervention* (in contrast to, for example, accounts of historical trajectories of the agriculture in a given region in general)?
- Did the intervention take place in an *EU country*?
- Was the intervention located on any *level* above a single farm and below the national level?
- Did the intervention pursue *environmental, economic, and social objectives* (whereas these different spheres did not have to receive equal weight)?
- Was the intervention realized in *collaboratio*n of different actors (in contrast to e.g. initiatives for improved sustainability within a single company or long-standing farmer cooperative)?

Additionally, there also had to be sufficient information on *outcomes* and general *context* of the collaborative. Different from Larsson (1993), who established a quantitative criterion of "at least two pages" for the sufficiency of information, here sufficiency of information was assumed if a variety of aspects of the criteria above were described, independently of the amount of text dedicated to this task.

Out of the 50 identified relevant and usable cases, a random sample of 30 cases was drawn that was analyzed in the subsequent research steps (Table E1).

2. Coding scheme

The coding scheme contains precise and operable definitions of the key concepts to be analyzed and consists of six parts. In the first part, *general information* about the case and the available publications describing the case is captured. This part mainly includes case quality variables as suggested by Lucas (1974) and Larsson (1993). These variables are introduced to allow controlling for effects of e.g. amount of available information, kinds of publications, and time period in which the cases took place. Controlling for these effects is deemed preferable to excluding cases *ex-ante*. In the second part, information *characterizing the case* is gathered, such as the level at which the collaborative was located, the way it was initiated, actors that were involved etc. This is followed by a third part asking for the environmental, economic, and social *goals of the intervention* and rating the ambitiousness of the goals of each of these areas.

The fourth part of the coding scheme contains the *independent variables*. Thus, the variables in this part ask for the presence of *success factors.* They were retrieved in two ways: On the one hand, all factors suggested in the reviewed literature to have an impact on the success of collaborative efforts were transformed into variables and included in the coding scheme. In order to evaluate the impact of factors that can have differing presence and influence on collaborative performance at different stages were translated into two variables, one evaluating the presence of the factor at the outset of a collaborative, the other variable doing the same at the latest known point in time.

The fifth part of the coding scheme contains the *dependent variables*. Here, the *success of the analyzed collaborative* is evaluated by assessing how a collaborative performed regarding the different success criteria.

Table A1 Overview over the analyzed cases

Case name	Country	Start year	Level	Description	Goals
Alce Nero	Italy	1977	Sub-national (region)	Initiative for the production and processing of organic wheat in the Marche region.	Organic production, "living in harmony with nature", job creation, preservation of rural and agricultural values and traditions, reversing large-scale out-migration, strengthening rural identity.
Allmende Kontor Tempelhof	Germany	2010	Sub-municipality	Community garden on a former airport in the city of Berlin.	Creation of a networking site for urban gardening initiatives, raising awareness about how food is grown, generating opportunities for urban residents to partake in this process, participative involvement of citizens in issues of climate protection, biodiversity, urban ecology, and city planning.
Altmühltaler Lamm	Germany	1996	Landscape	Multi-stakeholder initiative for the establishment of a label for regional sheep products from the valley of River Altmühl.	Landscape preservation, nature and biodiversity conservation, ecological grazing, better income for shepherds, regional marketing, preservation of cultural heritage, strengthening regional identity, better life-quality for shepherds.
AOC Beaufort cheese collective promotion system	France	1965	Landscape	Collective of milk and cheese producers in the Beaufortain and Tarentaise regions in Savoie county.	Marketing and promotion of Beaufort cheese, control and improvement of product and processing quality, added value, assure price stability, landscape conservation, local development, support of mountain agriculture, strengthening local identity.
Associazione Crocus Maremma	Italy	2002	Cross-municipality	Farmer association for saffron cultivation in the Maremma region.	Re-introducing and cultivating saffron as an alternative agricultural product, strengthening local identity, attracting rural tourists and their money, leaving behind conventional agriculture, new economic outlet, getting together like in the past.

bergisch pur	Germany	1996	Landscape	Multi-stakeholder initiative for the establishment of a regional brand in the Bergisches Land region.	Ecologically friendly farming, reduced resource use, high product quality, increased income of farmers, establishment of a regional marketing system and with that short and low-cost transportation ways, rural development of regional cultural landscapes, provision of sustainable products to consumers.
Biobourgogne Viandes	France	1994	Subnational (administrative region)	Initiative of organic cattle breeders in the Burgundy region.	Organic farming, natural breeding methods, organizing a regional supply chain, collecting and marketing members' animals, higher prices for farmers, creation of jobs, close contact with customers, intensifying the network of regional food chain stakeholders.
Biomelk Flanders	Belgium	2001	Cross-subnational (regions)	Organic milk dairy cooperative in the region of Flanders.	Maintaining organic dairy farming with relatively high standards for animal production of the national organic label, guaranteeing the collection rounds of organic milk in the region, providing a price premium for the producers, having control over the marketing and use of the members' milk, rural development, strengthening small-scale farms.
BioPlus Berlin-Brandenburg	Germany	1990	Sub-national (state)	Regional branch of a national organic farmer association founded after German reunification in the re-integrated East German states of Berlin and Brandenburg.	Support of sustainable forms of cultivation, especially organic farming; strengthening members economically; strengthening of the region.
Bioregion Moorbad Harbach	Austria	1990	Cross-municipality	Limited liability company founded by a local entrepreneur, farmers and municipalities for the restoration of the local cultural landscape in the region around Moorbad Harbach.	Conservation of the cultural landscape, organic farming, use of local species for crops and livestock, high quality processing, support of regional economy (tourism), ensuring farmers' income and livelihood, local rural development.

Dartmoor Farming Futures	UK	2009	Landscape	Multi-stakeholder pilot project for the management of public environmental benefits of the Dartmoor's moorland.	Managment of natural habitats and biodiversity, protection of watercourses, management of archaeological sites, increasing the delivery of outcomes on commons land and with that economic benefits for farmers, active participation of local farmers in land management, greater and common understanding of the idea of ecosystem services and agri-environmental schemes (AES).
De Hoeve Pork	The Netherlands	1996	Cross-subnational (provinces)	Pig meat supply chain covering various Dutch provinces.	Sustainable pork production, development of a robust chain concept for sustainable pig meat production, reconnecting regional pig farming with society and rural landscapes, creation of room for manoeuvre in standardized governmental environmental regulation for alternative approaches for the realization of sustainability goals.
De Westhoek Hoeveproducten	Belgium	1993	Cross-county	Farmer initiative for direct sale and promotion of farm products under a common label in the Westhoek region.	Environment-friendly production, regional direct selling and promotion of farm products, higher sales, improvement of product quality, strengthening of regional identity, improving farmer's livelihood, rural development.
Gailtal Alp Cheese	Austria	1989	County	Government induced multi-stakeholder activity groups and networks for the establishment of a Protected Nomination of Origin (PDO) for local cheese of the alpine valley Gailtal.	Halting the decline of farms and dairies of the Gailtal, enhancing the incomes of farmers and other food producers, protection of a traditional, extensive way of livestock rearing and cheese production.
Graig Farm Network	UK	1988	Cross-county	Farmer network for organic livestock production in mid-Wales.	Small ecological footprint through organic farming, fair prices for producers, ensuring markets for famers to sell their meat, production of high quality meat which offers benefits for consumers, transparency.

Het Groene Woud	The Netherlands	2006	Landscape	Farmer driven initiative for regional branding in the National Landscape Het Groene Woud.	Preserving and increasing landscape quality, regional branding to strengthen regional economy, creation of future perspectives for the agricultural sector, high quality products, collective action among rural entrepreneurs, rural development.
Hirschbach Bergräuter-genossenschaft	Austria	1986	Landscape	Cooperative for the production of mountain herbs in the Mühlviertel region.	Organic instead of conventional production, securing income of the members to ensure their full-time farming jobs, production of high quality goods, preservation of local farms, transparency for consumers.
MangioCarneBio	Italy	2004	Subnational (region)	Farmer initiative for the marketing of organic meat in the Emilia-Romagna Region.	Organic farming, animal welfare, finding regional markets for and promotion of organic beef, higher and stable prices, strengthening local identity, establishment of direct producer-consumer relations.
Northern Friesian Woodlands cooperative - Black-tailed Godwit protection	The Netherlands	1990	Landscape	Collective of regional cooperatives for the integration of farming with bird protection in the Northern Friesian Woodlands.	Bird protection in terms of optimizing the breeding success of the Black-tailed Godwit, reduction of nitrogen losses and ammonia emissions, farming in accordance with policy targets, strengthening the sense of local identity, preserving historical landscape.
Palermo Organic Farmers Market	Italy	2006	Municipality	Multi-stakeholder initiative for setting up an organic farmers market in the city of Palermo.	Support of organic farming, direct sale / short supply chains, close consumer-producer relations, provision of local and organic food to the citizens of Palermo.
Parish Grasslands Project	UK	2001	Cross-municipality	Community network of local residents, farmers, and smallholders in the communities of Brockweire, Hewelsfield, and St Briavels to manage and maintain their fields for biodiversity benefits	Restoring and maintaining the biodiversity of grasslands and the intactness of the ecosystem, enabling financial support of activities of smallholders, especially their management for biodiversity benefits, arousing interest for and increasing knowledge of the surrounding landscape.

Pistoia Mountains Raw Sheep Milk Cheese	Italy	2000	County	Multi-stakeholder initiative for the preservation of the Pistoia Mountains Raw Sheep Milk Cheese in Pistoia province in Tuscany.	Raw milk cheese production in compliance with the hygienic requirements, preserving traditional landscape, preserving the quality and traditional characteristics of the Pistoia Mountains Raw Sheep Milk Cheese and its production process, opening new markets for local products, improvement of farmers' livelihoods, giving producers a chance to survive in the long term, rural development.
Pontbren Group	UK	1997	Landscape	Farmer-led project to integrate woodland management and upland livestock farming in mid-Wales.	Delivering environmental services as part of productive upland livestock farming, environmentally friendly livestock farming, creation of wildlife habitats, restoring woodland and hedges, improved livestock shelter, cost-effective integration of agriculture and woodland management, cost reduction, add value to products, development of a more financially sustainable supply-chain, improvement of prospects for the next generation on family farms, collective action.
Qualität aus Brandenburg	Germany	1992	Subnational (state)	Regional union (multi-stakeholder) for organic farming in the state of Brandenburg	Welfare-oriented animal husbandry, environmentally friendly soil cultivation, preservation of agricultural holdings in Brandenburg, competitive marketing of agricultural products, high product quality, rural development.
Regionalwert AG	Germany	2006	Cross-county	Citizen shareholder corporation that supports the development of organic agriculture and the establishment of a local sustainable food supply chain in the region around the city of Freiburg.	Organic farming, regional sustainable food supply chain, facilitating the entrance of young farmers, maintaining existing farms, engaging in research on indicators for an assessment of socio-ecological norms, establishing a regional network of stakeholders, maintaining the agriculture of the region, regional development

Tablehurst and Plaw Hatch Community Farms	UK	1995	Municipality	Two farm businesses in the county of East Sussex that realize biodynamic farming and are owned by a co-operation of citizens of the local community	Biodynamic farming, local food production and consumption, little transport, self-determined prices for products, self-sustaining farms, community participation, close relations between producers and consumers.
Tradice Bílých Karpat	Czech Republic	1990	Landscape	Civic association of farmers and ENGOs for the preservation of the diversity of natural and cultural heritage in the White-Carpathian mountains.	Reviving traditional products; re-localization of production; building of trust-based relations between producers and consumers; preservation of the regional identity; support of the operations of small-scale fruit-tree growers, other farmers, and craftsmen; maintenance and development of the diversity of natural and cultural heritage.
Upländer Farmer Dairy	Germany	1986	Cross-county	Organic milk dairy cooperative in the Upland region.	Use of local resources, avoidance of “food miles”, no support of globalized structures, improvement of the sustainability and the livability of the rural areas; strengthening new institutional forms like farmers co-operatives; consumer involvement, “food citizenship”, raising regional attractiveness and supporting tourism; fair distribution of value added to the actors of the chain; support of the rural economy.
Waddengroup Foundation	The Netherlands	1994	Landscape	Multi-stakeholder initiative for the production of regional, sustainable products in the Wadden region.	Developing collective capacity in producing primary products, processing, distribution and sales, production and marketing of ecologically friendly and regionally specific high quality products, creating synergy within the Wadden Sea community.
Zeeuwse Vlegel	The Netherlands	1983	Sub-national (province)	Multi-stakeholder initiative for the sustainable production of quality baking wheat in the province of Zeeland.	Sustainable and profitable cultivation of high quality baking wheat; reduction of the distance between producers and consumers.

The variables in the coding scheme are questions that are asked about a case and are answered usually with a numeric code. Answers are mostly expressed on a metric scale from 0 to 4, similar to a five-point Likert-scale. In the descriptions of the variables themselves, only the endpoints of these scales are labeled. Nevertheless, in an introductory part of the coding scheme that explains the coding rules, all points of the response scale are labeled with general labels (e.g. "2 corresponds to 41 to 60 percent ('applies to a medium extent')"). The coding scheme also includes a number of binary, nominal, ordinal and qualitative variables. Most variables also allow for answers of "n/a" if the question does not apply to the case and "NIL" if available information is not sufficient to make at least an informed guess. Additionally, the coding scheme requires for all variables a code expressing the degree of reliability of information on which the answer is based, with codes ranging from 0 meaning 'insufficient information available' to 3 meaning 'explicit, detailed and reliable information available'.

Furthermore, the coding scheme included two features to allow for more openness and adaptability to the nature of the studied cases. To this end, after coding the first 15 cases the coding scheme was updated regarding two aspects: On the one hand, the coding scheme contained a qualitative variable OTHER FACTORS, where factors that had not been included in the coding scheme but that were decisive for the performance of an analyzed collaborative could be coded openly. The factors mentioned under this variable were checked for novelty and repeated appearance. Two factors met these criteria: MEDIA ATTENTION and NATURAL CONDITIONS. Thus, these factors were included in the coding scheme and coded retroactively for the already coded cases. On the other hand, for some variables an actor typology was needed, for example to code relational characteristics such as trust among involved actors. In order to determine an appropriate actor typology, actor types were coded openly in the first 15 cases, thus creating an individual actor typology for each case. Based on these different actor typologies, a general actor typology was developed, included in the coding scheme and used for the subsequent cases. Also the actor typologies and related variables of the already coded cases were transformed into this general actor typology. As a rule for this transformation, if two actor types were subsumed under one actor type in the new, general actor typology and if these two actors had received different codes for a certain variable, the higher code was adopted for the variables under the new actor typology, in order to capture the action potential for this new actor type.

In the last version of the coding scheme, which includes these updates, 271 main variables were included. Eleven of the main variables use the actor typology mentioned above to characterize individual actor groups that were involved in a collaborative and the relations among them. Consequently, these eleven variables split up into 225 sub-variables, leading to altogether 496 variables.

3. Coding procedure

The coding scheme was pre-tested on two case studies by the first author, a researcher who was well-acquainted and experienced with the case survey method and a researcher who was unfamiliar with this method. Necessary changes identified in this pre-test were implemented.

The actual coding was realized by the first author and a student assistant. The case studies were mainly coded by one of the coders. However, following Lucas's (1974) recommendation that more than one coder should code at least some of the case studies, three case studies were coded by both coders as well as every fifth case study after that. When cases were coded by both coders, coding results were compared and strong deviations (i.e. usually a difference of more than +/- 1 between the codes) were

discussed and possibly adjusted (consensus approach (Larsson 1993)). Afterwards, both code lists were consolidated into one code list by using the weighted means of the codes, using the reliability values as weights.

Also for the cases coded by one coder, steps were taken to increase reliability of the codes: First, delineation of the scope of each case was always done by both coders. For this purpose, after reading the case material and before starting to code the case, the responsible coder proposed an actor typology (for the first 15 cases) or, respectively, suggested how the different involved actors fit into the general actor typology (for the last 15 cases) and provided the other researcher with the text passages on which she based her classification of the actors. Both coders then discussed and agreed upon an appropriate actor typology. Second, when coding was completed the other coder cross-checked the codes and asked the responsible coder for clarification and, if necessary, adjustment. The provision of text passages on involved actors as well as of a summary of the whole case in the coding scheme itself enabled the other coder to judge the meaningfulness of the codes.

Moreover, interrater agreement was determined with an average r_{wg} value (James et al. 1984) of 0.86 across all variables (standard deviation 0.17). With that, interrater agreement was at an appropriate level, indicating a high degree of agreement.

4. Data analysis

The aim of our analysis was to determine which of the independent variables (representing success factors) have decisive effects on which dependent variables (representing success criteria).

We applied a stepwise exploratory approach to reduce complexity and arrive at robust and interpretable results, which started with some steps for data preparation for the statistical analysis were realized: First, all qualitative variables were removed as their primary role was to explicate the codes. Second, for those variables based on the actor typology, different values were calculated and used for further analysis instead of using the whole range of their sub-variables. The calculated values were:

- for all variables based on the actor typology:
    - overall average;
- additionally for the variables evaluating relational characteristics:
    - average value for the most involved actors (those actor types whose degree of involvement was coded with a 4) ,
    - average value for the initiators (those actor types that were coded as initiators),
    - overall minimum value,
    - overall maximum value.

Third, for those factors that were evaluated both at the outset of the collaborative and at the latest known point in time, the difference between the initial and final value was calculated.

Fourth, in order to aggregate variables a principal component analysis (PCA) on conceptually close variable subsets within the success factor sub-clusters with oblique rotation (promax) was performed. For each PCA, an initial analysis without rotation was run to obtain eigenvalues for each component in the data. As criterion for the decision on how many factors should be extracted, mainly the scree plot /

broken stick criterion was applied. If the scree plot was ambiguous, the number of factors where the scree plot converged with Kaiser's criterion (eigenvalue greater 1) was used. All analyses were evaluated using Kaiser-Meyer-Olkin measures for sampling adequacy and Bartlett's test of sphericity, which for all analyses yielded acceptable results. All resulting constructs have acceptable reliability, with Cronbach's Alpha of at least 0.74 (for more information see ESM 5).

Fifth, all variables with less than 5 observations were removed. Also all values with a reliability of less than 1 were taken out, which was possible for the cases coded by two coders if one of the coders coded a reliability of 1, the other a reliability of 0, as well as for the values calculated out of the variables based on the actor typology if their average reliability was less than 1. Last but not least, one outlier case had to be treated to avoid skewed results. The case in question is Palermo Organic Farmers Market, which was the only rather unsuccessful case in our sample. The values of the dependent variables of this case were substituted by the next higher value plus 1 (Field et al. 2012). With these preparatory steps, the number of variables was reduced from 271/496 to 189.

Next, we mapped potential relations between dependent and independent variables by means of correlation analyses. For this purpose, correlations of all case quality, case type and independent variables with the dependent variables were calculated using Spearman's rho. Those case quality and case type variables that showed a significant correlation ($p<0.1$) with any of the dependent variables were potential confounders. These variables were used for a robustness test through the calculation of partial correlations. Thus, robustness of the correlations was tested against:

- *Publication quality:* at least one of the sources was peer-reviewed; at least one of the sources was an officially published source (with ISBN, ISSN etc.); at least one of the authors of the used publications was involved in the collaborative as organizer or facilitator.
- *Temporal aspects:* year in which the collaborative was initiated; year of latest information on the collaborative; development stage of the collaborative when it was reported.
- *Case type:* area over which the collaborative extended; ambitiousness of its environmental, economic, and social goals (only for the dependent variables that were not calculated based on the ambitiousness of the goals of the collaboratives).

Finally, we performed multiple regression in order to assess which of the selected success factors impact on which success criteria. For the regression models, all independent variables were considered that proved to have a significant and robust relation with one of the dependent variables. These independent variables were checked for missing values and in order to obtain complete samples of sufficient size ($n\geq19$) variables with many missing values were removed. The removed variables were preferentially the ones showing a low correlation with the dependent variable. Due to the small sample size, models were restricted to a maximum of four variables. Therefore, we assessed different models with varying combinations of variables from at least two of the major clusters. We evaluated the regression models regarding the assumptions of normality, linearity, multicollinearity, and homoscedasticity to evaluate their generalizability. We finally selected those models with the smallest value of the Akaike information criterion (AIC).

Online Resource 1.2 - Overview over the identified case studies

Table A2 List of all identified usable cases of collaboratives for a more sustainable agriculture with references and information whether or not they were included in the case survey

Case		Country	References	Included in the case survey?
1	Alce Nero	Italy	Antonelli et al. 2004; Schmid et al. 2004	Yes
2	Allmende Kontor Tempelhof	Germany	Wunder 2013; Münnich 2014	Yes
3	Altmühltaler Lamm	Germany	Perner and Thöne 2005; Knickel et al. 2003; Revermann and Petermann 2001; Blümlein and Popp 1999; Kullmann 2007	Yes
4	AOC Beaufort cheese collective promotion system	France	Assouline 2007; Dubeuf 1996; Vivier 1992; Agranier et al.	Yes
5	Associazione Crocus Maremm	Italy	Sonnino 2007	Yes
6	bergisch pur	Germany	Schmidt 2010; Knickel et al. 2003; Bischoff and Wagner 2011; Kullmann 2007	Yes
7	BERSTA producer-consumer co-operative	Austria	Petrovics et al. 2010; Rohrmoser 2004	No
8	Bioalpin	Austria	Schermer 2008; Steinlechner and Schermer 2010; Schermer et al. 2006; Schermer and Furtschegger 2013	No
9	Biobauern Sulzberg	Austria	Schermer et al. 2004; Gleirscher 2002; Schmid et al. 2004	No
10	Biobourgogne Viandes	France	Auersalmi et al. 2004; Schmid et al. 2004	Yes
11	Biomelk Flanders	Belgium	Vercauteren 2005; Simoncini 2006; Vuylsteke et al. 2008	Yes
12	BioPlus Berlin-Brandenburg	Germany	Segert and Zierke 2004a, 2004b	Yes
13	Bioregion Moorbad Harbach	Austria	Kratochvil 2004; Offenzeller 2009	Yes
14	Brucker Land	Germany	Brand 2005; Kullmann 2007; Brand 1998; Gothe and Schoene 2002; Blümlein and Popp 1999; Schöll 2007	No
15	Consortium Vacche Rosse and Reggiana Cow Breeders	Italy	Montanari and Roest 2013	No
16	Cooperativa Agricola Firenzuola	Italy	Simoncini 2006; Brunori et al. 2005a; Vuylsteke et al. 2008	No
17	Crisoperla Association	Italy	Brunori et al. 2013	No
18	Dartmore Farming Futures	UK	Waldon 2011; Mills 2012	Yes
19	De Hoeve Pork	The Netherlands	Brandsma et al. 2005; Wiskerke and Roep 2007; Roep and Wiskerke 2012a; Nijhoff-Savvaki et al. 2009,	Yes

			2012; Roep and Wiskerke 2012b; Vuylsteke et al. 2008	
20	De Westhoek Hoeveproducten	Belgium	Vuylsteke and van Huylenbroeck; Simoncini 2006	Yes
21	Duurzaam Boer Blijven	The Netherlands	Hermans et al. 2013	No
22	EVI producer-consumer co-operative	Austria	Petrovics et al. 2010; Rohrmoser 2004	No
23	Fuchsia Brands Ltd.	Ireland	O'Reilly 2001; Crowley 2004; McCutcheon 2002	No
24	Gailtal Alp Cheese	Austria	Rytkönen and Gratzer 2010; Gratzer 2013; Borg and Gratzer 2013	Yes
25	Graig Farm Network	UK	Marsden and Smith 2005; Kirwan et al.	Yes
26	Grassland Project MAB Rhön	Germany	Jedicke 2007, 2008; Jedicke et al. 2010, 2006, n/d	No
27	Het Groene Woud	The Netherlands	Horlings 2012; Oostindie et al. 2007	Yes
28	Hirschbach Bergkräutergenossenschaft	Austria	Gleirscher 2002; Hofer 2006	Yes
29	La Terra e il Cielo	Italy	Schmid et al. 2004; Antonelli et al. 2004	No
30	Manchester Food Futures	UK	Psarikidou and Szerszynski 2012a, 2012b; Levidow et al. 2010	No
31	MangioCarneBio	Italy	Roest et al. 2007; Cerruti 2008	Yes
32	Northern Friesian Woodlands cooperative - Black-tailed Godwit protection	The Netherlands	Swagemakers and Wiskerke 2010; Swagemakers et al. 2009	Yes
33	Norwich Eostre Organics	UK	Hargreaves et al. 2013; Hargreaves et al. 2011; Seyfang 2004b, 2004a, 2006b, 2006a, 2006c, 2007b, 2007a, 2008, 2009; Kirwan et al.	No
34	Ökomodell Achental	Germany	Voll 2009; Verein Ökomodell Achental e.V. 2002; Knickel et al. 2003; Offenzeller 2009; Neumeier 2012	No
35	Palermo Organic Farmers Market	Italy	Orlando 2011	Yes
36	Parish Grasslands Project	UK	Ingram et al. 2008; Peterken 2010, 2013	Yes
37	Pistoia Mountains Raw Sheep Milk Cheese	Italy	Brunori et al. 2005b; Brunori and Cerruti 2008; Simoncini 2006	Yes
38	Pontbren Group	UK	Wales Rural Observatory 2013	Yes
39	Preiļi Organic Farmers Network	Latvia	Tisenkopfs et al. 2011; Kalnina et al. 2007	No
40	Qualität aus Brandenburg	Germany	Segert and Zierke 2004a, 2004b	Yes
41	Redfern Grove Estate community garden	UK	Bell and Cerulli 2012	No
42	Regionalwert AG	Germany	Volz 2011; Hiß 2009, 2014	Yes

43	Sandwell Community Agriculture	UK	Davis et al. 1999; Davis and Middleton 2012	No
44	Tablehurst and Plaw Hatch Community Farms	UK	Ravenscroft and Hanney 2011; Ravenscroft et al. 2013; Pilley	Yes
45	Thise dairy	Denmark	Noe 2007	No
46	Tradice Bílých Karpat	Czech Republic	Tisenkopfs et al. 2011; Kučerová et al. 2007	Yes
47	Upländer Farmer Dairy	Germany	Strauch et al.; Knickel et al. 2003; Staub 2008	Yes
48	VEL and VANLA nutrient management project	The Netherlands	Reijs et al. 2004; van der Ploeg et al. 2006; Stuiver et al. 2003	No
49	Waddengroup Foundation	The Netherlands	Moreno and van der Ploeg 2011; Moreno 2014; Marsden and Smith 2005; Roep 2002	Yes
50	Zeeuwse Vlegel	fnether	Wiskerke and Oerlemans 2004; Wiskerke 2003; Oerlemans and Assouline 2004; Boef, de 2000; Wiskerke 1995; Jongerden 2000; Jongerden and Ruivenkamp 2008	Yes

Online Resource 1.3 - Summary of variable aggregation with PCA of variables of the coding scheme for case studies of collaboratives for a more sustainable agriculture

Table A3 Summary of principal component analysis for variables expressing characteristics of the issue addressed by the collaborative for a more sustainable agriculture (N=30)

Item	**Promax rotated factor loadings** *ISSUE CHARACTERISTICS*
ISSUE STORAGE	0.85
ISSUE PUBGOOD	-0.81
ISSUE IMPORTANCE	0.76
ISSUE COPROD	-0.7
Eigenvalue	2.44
% of variance	61
KMO overall	0.75, middling
KMO single items	>.74
Bartlett test	33.85, p<.001
Cronbach's Alpha	0.76*
Determinant of the R-Matrix	0.28

** For the calculation of Cronbach's Alpha the sign of the negatively loading variables was inverted.*

Table A4 Summary of principal component analysis for variables related to commitment and motivation of the actors involved in a collaborative for a more sustainable agriculture (N=30)

Item	**Promax rotated factor loadings** *DEVOTEDNESS END*
LOYALTY	0.80
COMMITMENT COLLABORATION END	0.78
MOTIVATION END	0.77
SATISFACTION	0.74
VALUES ENVIRON END	0.52
Eigenvalue	2.68
% of variance	54
KMO overall	0.72, middling
KMO single items	>0.62
Bartlett test	37.96, p<.001
Cronbach's Alpha	0.77
Determinant of the R-Matrix	0.24

Table A5 Summary of first principal component analysis for variables related to characteristics of the objectives of a collaborative for a more sustainable agriculture (N=30)

Item	**Promax rotated factor loadings** *INITIATIVE ATTRACTIVENESS*
INCENTIVE FOR OBJECTIVE	0.9
OBJECTIVES RELEVANCE	0.88
INCENTIVE FOR COLLABORATION	0.83
OBJECTIVES BALANCE	-0.82
OBJECTIVES RANGE	-0.66
Eigenvalue	3.38
% of variance	68
KMO overall	0.87, meritorious
KMO single items	>0.83
Bartlett test	74.41, p<.001
Cronbach's Alpha	0.87*
Determinant of the R-Matrix	0.07

** For the calculation of Cronbach's Alpha the sign of the negatively loading variables was inverted.*

Table A6 Summary of principal component analysis for variables related to the characteristics of the products of a collaborative for a more sustainable agriculture (N=25)

Item	**Promax rotated factor loadings** *PRODUCT IDENTITY QUALITY*
PRODUCT UNIQUENESS	0.94
PRODUCT NAME LOCAL	0.83
PRODUCT QUALITY	0.77
Eigenvalue	2.16
% of variance	72
KMO overall	0.56, miserable
KMO single items	>0.54
Bartlett test	34.97, p<.001
Cronbach's Alpha	0.74
Determinant of the R-Matrix	0.28

Table A7 Summary of principal component analysis for variables related to management and marketing of a collaborative for a more sustainable agriculture (N=25); factor loadings above criterion level of 0.3 appear in bold

Item	**Promax rotated factor loadings**	
	BUSINESS PROFESSIONALITY	*TARGETED CUSTOMERS**
MARKETING COMPETENCY	**0.94**	0.05
BUSINESS MANAGEMENT	**0.93**	0.11
TARGETED CUSTOMERS	0.20	**1.00**
MULTIPLE MARKETS	**0.42**	**-0.62**
Eigenvalue	1.93	1.36
% of variance	48	34
KMO overall	0.62, mediocre	
KMO single items	>0.53	
Bartlett test	34.08, p<.001	
Cronbach's Alpha	0.78	0.65
Determinant of the R-Matrix	0.28	

**This variable was not included in the regression analysis.*

Online Resource 1.4 – Overview over the values of the relevant variables

Table A8 Frequency, mean, and standard deviation for the relevant variables of the coding scheme for case studies of collaboratives for a more sustainable agriculture

Var.no.	Variable Name	frequency	mean	standard dev
D.I1	ISSUE PUBGOOD	30	0.93	1.28
D.I2	ISSUE COPROD	30	2.08	1.16
D.I10	ISSUE STORAGE	29	2.24	0.77
D.I11	ISSUE IMPORTANCE	30	2.30	1.21
D.IV.4	PRODUCT DEMAND END	25	3.14	0.89
E.I.a2i	KNOWLEDGE ISSUE FARMERS	21	2.99	0.79
E.I.a2ii	KNOWLEDGE ISSUE FARMER ASSOC	11	3.12	0.73
E.I.a2iii	KNOWLEDGE ISSUE PROCESSORS	5	2.90	1.02
E.I.a2iv	KNOWLEDGE ISSUE PRIV OTH	5	2.92	0.91
E.I.a2v	KNOWLEDGE ISSUE GEN ADMIN	8	2.50	0.76
E.I.a2vi	KNOWLEDGE ISSUE SPECIAL TASK	6	3.17	0.75
E.I.a2vii	KNOWLEDGE ISSUE CIV	10	3.21	0.83
E.I.a2viii	KNOWLEDGE ISSUE RES EDU	1	3.00	#DIV/0!
E.I.a2ix	KNOWLEDGE ISSUE CIT	5	2.30	0.45
E.I.b4	VALUES ENVIRON END	28	3.01	0.66
E.I.b7	COMMITENT COLLABORATION END	30	3.14	0.97
E.I.b9	MOTIVATION END	28	3.11	0.73
E.I.b10	SATISFACTION	30	2.94	0.62
E.I.b11	LOYALTY	30	3.42	0.79
E.II.c1i	EXT REL FARMERS	23	2.19	1.19
E.II.c1ii	EXT REL FARMERS_FARMER ASSOC	6	1.67	1.03
E.II.c1iii	EXT REL FARMERS_PROCESSORS	5	1.67	1.18
E.II.c1iv	EXT REL FARMERS_PRIV OTH	4	1.25	0.50
E.II.c1v	EXT REL FARMERS_GEN ADMIN	2	0.50	0.71
E.II.c1vi	EXT REL FARMERS_SPECIAL TASKS	4	1.38	0.95
E.II.c1vii	EXT REL FARMERS_CIV	7	1.31	0.92
E.II.c1viii	EXT REL FARMERS_RES EDU	1	0.00	#DIV/0!
E.II.c1ix	EXT REL FARMERS_CIT	2	2.50	0.71
E.II.c1x	EXT REL FARMER ASSOC	11	2.62	0.82
E.II.c1xi	EXT REL FARMER ASSOC_PROCESSORS	3	2.00	1.00
E.II.c1xii	EXT REL FARMER ASSOC_PRIV OTH	2	1.17	1.18
E.II.c1xiii	EXT REL FARMER ASSOC_GEN ADMIN	4	1.00	1.41
E.II.c1xiv	EXT REL FARMER ASSOC_SPECIAL TASKS	3	1.33	1.53
E.II.c1xv	EXT REL FARMER ASSOC_CIV	5	1.10	1.14
E.II.c1xvi	EXT REL FARMER ASSOC_RES EDU	1	0.00	#DIV/0!
E.II.c1xvii	EXT REL FARMER ASSOC_CIT	1	0.00	#DIV/0!
E.II.c1xviii	EXT REL PROCESSORS	7	0.79	0.81

Var.no.	Variable Name	frequency	mean	standard dev
E.II.c1xix	EXT REL PROCESSORS_PRIV OTH	2	1.17	1.18
E.II.c1xx	EXT REL PROCESSORS_GEN ADMIN	2	0.00	0.00
E.II.c1xxi	EXT REL PROCESSORS_SPECIAL TASKS	2	0.50	0.71
E.II.c1xxii	EXT REL PROCESSORS_CIV	4	0.63	0.48
E.II.c1xxiii	EXT REL PROCESSORS_RES EDU	1	0.00	#DIV/0!
E.II.c1xxiv	EXT REL PROCESSORS_CIT	0	#DIV/0!	#DIV/0!
E.II.c1xxv	EXT REL PRIV OTH	4	1.75	0.96
E.II.c1xxvi	EXT REL PRIV OTH_GEN ADMIN	2	1.50	0.71
E.II.c1xxvii	EXT REL PRIV OTH_SPECIAL TASKS	0	#DIV/0!	#DIV/0!
E.II.c1xxviii	EXT REL PRIV OTH_CIV	2	0.50	0.71
E.II.c1xxix	EXT REL PRIV OTH_RES EDU	0	#DIV/0!	#DIV/0!
E.II.c1xxx	EXT REL PRIV OTH_CIT	1	1.00	#DIV/0!
E.II.c1xxxi	EXT REL GEN ADMIN	5	2.00	0.71
E.II.c1xxxii	EXT REL GEN ADMIN_SPECIAL TASKS	3	3.67	0.58
E.II.c1xxxiii	EXT REL GEN ADMIN_CIV	2	1.50	0.71
E.II.c1xxxiv	EXT REL GEN ADMIN_RES EDU	0	#DIV/0!	#DIV/0!
E.II.c1xxxv	EXT REL GEN ADMIN_CIT	3	1.00	0.00
E.II.c1xxxvi	EXT REL SPECIAL TASKS	1	2.00	#DIV/0!
E.II.c1xxxvii	EXT REL SPECIAL TASKS_CIV	3	1.00	1.00
E.II.c1xxxviii	EXT REL SPECIAL TASKS_RES EDU	0	#DIV/0!	#DIV/0!
E.II.c1xxxix	EXT REL SPECIAL TASKS_CIT	0	#DIV/0!	#DIV/0!
E.II.c1xl	EXT REL CIV	8	2.54	0.84
E.II.c1xli	EXT REL CIV_RES EDU	0	#DIV/0!	#DIV/0!
E.II.c1xlii	EXT REL CIV_CIT	4	1.00	0.00
E.II.c1xliii	EXT REL RES EDU	2	2.00	1.41
E.II.c1xliv	EXT REL RES EDU_CIT	1	2.00	#DIV/0!
E.III.c2	NETWORK DENSITY INIT	27	2.49	1.26
E.III.c3	NETWORK DENSITY END	29	2.42	0.81
E.II.c1xlv	EXT REL CIT	5	1.20	0.45
E.II.c6i	TRUST END FARMERS	23	2.77	0.99
E.II.c6ii	TRUST END FARMERS_FARMER ASSOC	7	2.41	1.16
E.II.c6iii	TRUST END FARMERS_PROCESSORS	6	3.00	0.89
E.II.c6iv	TRUST END FARMERS_PRIV OTH	5	2.30	0.67
E.II.c6v	TRUST END FARMERS_GEN ADMIN	5	2.00	0.00
E.II.c6vi	TRUST END FARMERS_SPECIAL TASKS	4	2.63	0.48
E.II.c6vii	TRUST END FARMERS_CIV	6	3.43	0.59
E.II.c6viii	TRUST END FARMERS_RES EDU	1	3.00	#DIV/0!
E.II.c6ix	TRUST END FARMERS_CIT	3	3.22	0.69
E.II.c6x	TRUST END FARMER ASSOC	10	3.45	0.50
E.II.c6xi	TRUST END FARMER ASSOC_PROCESSORS	5	2.72	1.22
E.II.c6xii	TRUST END FARMER ASSOC_PRIV OTH	2	3.38	0.53
E.II.c6xiii	TRUST END FARMER ASSOC_GEN ADMIN	6	2.67	0.75
E.II.c6xiv	TRUST END FARMER ASSOC_SPECIAL TASKS	4	1.75	0.96

Var.no.	Variable Name	frequency	mean	standard dev
E.II.c6xv	TRUST END FARMER ASSOC_CIV	5	3.20	0.76
E.II.c6xvi	TRUST END FARMER ASSOC_RES EDU	1	3.00	#DIV/0!
E.II.c6xvii	TRUST END FARMER ASSOC_CIT	2	3.75	0.35
E.II.c6xviii	TRUST END PROCESSORS	7	2.75	1.42
E.II.c6xix	TRUST END PROCESSORS_PRIV OTH	2	3.50	0.71
E.II.c6xx	TRUST END PROCESSORS_GEN ADMIN	2	2.50	0.71
E.II.c6xxi	TRUST END PROCESSORS_SPECIAL TASKS	2	1.50	2.12
E.II.c6xxii	TRUST END PROCESSORS_CIV	2	2.50	0.71
E.II.c6xxiii	TRUST END PROCESSORS_RES EDU	1	3.00	#DIV/0!
E.II.c6xxiv	TRUST END PROCESSORS_CIT	0	#DIV/0!	#DIV/0!
E.II.c6xxv	TRUST END PRIV OTH	5	3.10	1.02
E.II.c6xxvi	TRUST END PRIV OTH_GEN ADMIN	2	2.00	0.00
E.II.c6xxvii	TRUST END PRIV OTH_SPECIAL TASKS	1	2.00	#DIV/0!
E.II.c6xxviii	TRUST END PRIV OTH_CIV	2	2.25	0.35
E.II.c6xxix	TRUST END PRIV OTH_RES EDU	0	#DIV/0!	#DIV/0!
E.II.c6xxx	TRUST END PRIV OTH_CIT	1	2.00	#DIV/0!
E.II.c6xxxi	TRUST END GEN ADMIN	4	2.00	0.82
E.II.c6xxxii	TRUST END GEN ADMIN_SPECIAL TASKS	4	2.92	0.83
E.II.c6xxxiii	TRUST END GEN ADMIN_CIV	4	2.88	0.63
E.II.c6xxxiv	TRUST END GEN ADMIN_RES EDU	0	#DIV/0!	#DIV/0!
E.II.c6xxxv	TRUST END GEN ADMIN_CIT	2	3.00	1.41
E.II.c6xxxvi	TRUST END SPECIAL TASKS	0	#DIV/0!	#DIV/0!
E.II.c6xxxvii	TRUST END SPECIAL TASKS_CIV	3	2.83	0.29
E.II.c6xxxviii	TRUST END SPECIAL TASKS_RES EDU	0	#DIV/0!	#DIV/0!
E.II.c6xxxix	TRUST END SPECIAL TASKS_CIT	0	#DIV/0!	#DIV/0!
E.II.c6xl	TRUST END CIV	7	3.00	0.61
E.II.c6xli	TRUST END CIV_RES EDU	0	#DIV/0!	#DIV/0!
E.II.c6xlii	TRUST END CIV_CIT	4	2.92	0.83
E.II.c6xliii	TRUST END RES EDU	2	2.00	#DIV/0!
E.II.c6xliv	TRUST END RES EDU_CIT	1	#DIV/0!	#DIV/0!
E.II.c6xlv	TRUST END CIT	4	3.00	0.82
E.II.d3	CONFLICT END	29	0.62	0.81
E.III.b3	INCENTIVE FOR OBJECTIVE	30	2.52	1.15
E.III.b4	OBJECTIVES RANGE	30	2.19	0.87
E.III.b5	OBJECTIVES RELEVANCE	30	2.84	1.04
E.III.b7	OBJECTIVES BALANCE	30	-0.03	1.47
E.III.c1	INCENTIVE FOR COLLABORATION	30	3.05	0.85
E.III.j1	FINANCIAL RESOURCES INIT	28	2.83	1.06
E.III.j2	FINANCIAL RESOURCES END	28	3.23	0.83
E.IV.a1	PRODUCT QUALITY	25	3.46	0.51
E.IV.a3	PRODUCT UNIQUENESS	25	2.78	1.16
E.IV.a5	PRODUCT NAME LOCAL	25	2.71	1.54
E.IV.d1	MARKETING COMPETENCY	25	2.64	1.13
E.IV.d4	MULTIPLE MARKETS	24	2.03	1.25

Var.no.	Variable Name	frequency	mean	standard dev
E.IV.d5	BUSINESS MANAGEMENT	24	2.15	1.28
E.IV.e2	INVESTMENTS	24	1.66	0.99
F2	ACHIEVEMENT ENVIRONMENTAL GOALS (g_{1i})	30	2.99	0.94
F3	ACHIEVEMENT ECONOMIC GOALS (g_{2i})	30	2.90	1.19
F4	ACHIEVEMENT SOCIAL GOALS (g_{3i})	30	2.93	0.79
F6	DURABILITY OF GOAL ACHIEVEMENT (D_i)	30	3.19	0.93
F23	ACCEPTANCE (Aci)	30	3.03	0.83

Table A9 Values of the success measures for all analyzed case studies

Case	Achievement of goals			Durability	Acceptance
	env	econ	social		
Alce Nero	3	3	2	3	2
Allmende Kontor Tempelhof	4	0	3	1	4
Altmühltaler Lamm	2	4	3	3	3
AOC Beaufort cheese collective promotion system	1	4	3	3	3
Associazione Crocus Maremma	4	4	3	3	3
bergisch pur	3	3	3	3	4
Biobourgogne Viandes	3	4	3	2	3
Biomelk Flanders	4	4	2	3	3
BioPlus Berlin-Brandenburg	2	1	2	4	3
Bioregion Moorbad Harbach	3	4	4	4	4
Dartmoor Farming Futures	2	1	4	3	2
De Hoeve Pork	3.6	3.5	2.4	3	2
De Westhoek Hoeveproducten	1	3	3	4	3
Gailtal Alp Cheese	4	4	4	4	4
Graig Farm Network	2	3	4	4	3
Het Groene Woud	2	1	3	3	2
Hirschbach Bergkräutergenossenschaft	4	3.6	3.3	3.6	3.3
MangioCarneBio	3	3	2	3	3
Northern Friesian Woodlands cooperative - Black-tailed Godwit protection	4	3	3	3	3
Palermo Organic Farmers Market	1.5	1	1	0	0.5
Parish Grasslands Project	3	3	4	4	3
Pistoia Mountains Raw Sheep Milk Cheese	4	4	3	4	3
Pontbren Group	4	1	3	3	4
Qualität aus Brandenburg	4	4	3	4	4
Regionalwert AG	3	3	3	4	4
Tablehurst and Plaw Hatch Community Farms	4	3	3	3	3
Tradice Bílých Karpat	3	2.5	3.5	4	2
Upländer Farmer Dairy	3	3.5	3.6	3.5	2.5
Waddengroup Foundation	3	4	3	4	4
Zeeuwse Vlegel	2.5	2	1	2.5	3.6

Online Resource 1.5 - Results of the check of assumptions of the regression models

Achievement of social goals

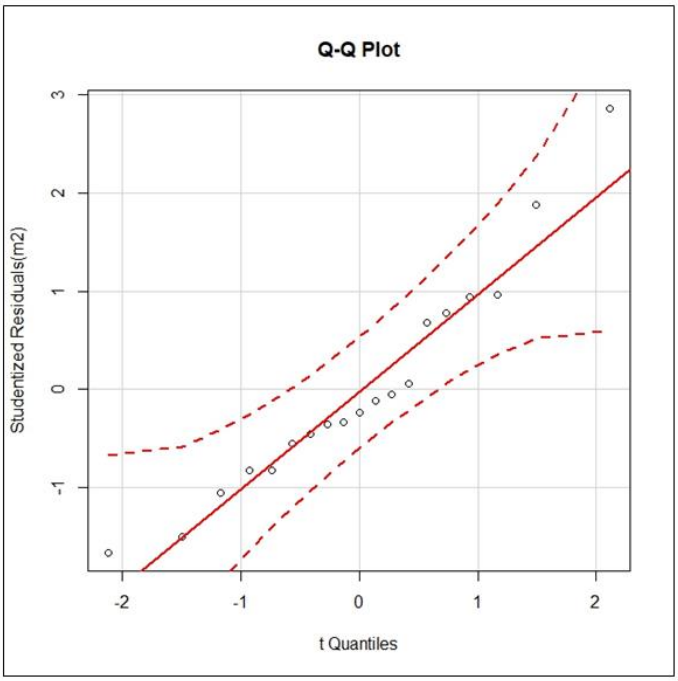

Figure A1: Check for normality: Q-Q plot with confidence interval for the model explaining the achievement of social goals

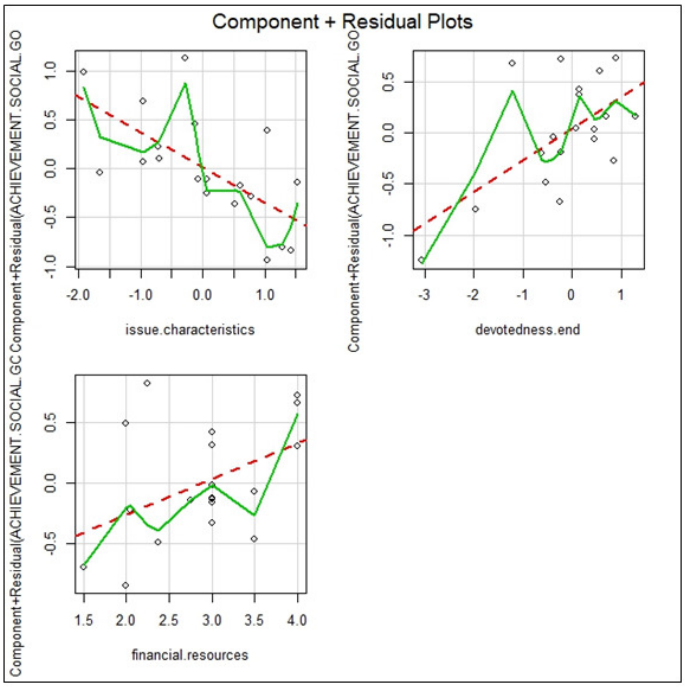

Figure A2: Check for linearity: Component + residual plots for the model explaining the achievement of social goals

- Check for multicollinearity:

```
> vif(m2)
issue.characteristics       devotedness.end   financial.resources
             1.115564              1.073594              1.051905
```

- Check for homoscedasticity:

```
Non-constant Variance Score Test
Variance formula: ~ fitted.values
Chisquare = 0.6387941    Df = 1     p = 0.4241478
```

Achievement of environmental goals

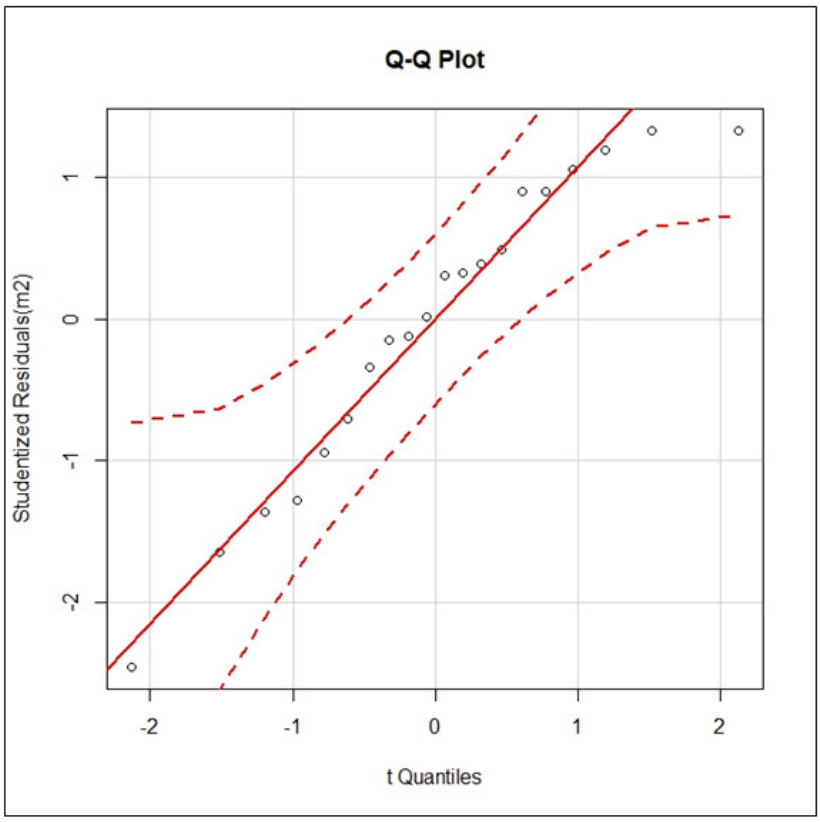

Figure A3: Check for normality: Q-Q plot with confidence interval for the model explaining the achievement of environmental goals

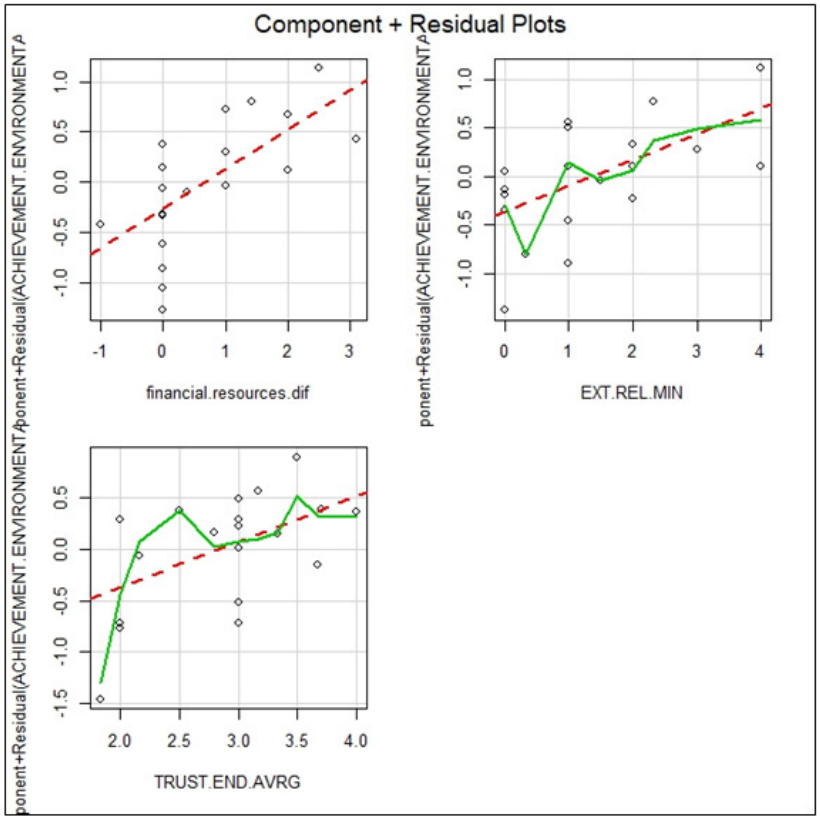

Figure A4: Check for linearity: Component + residual plots for the model explaining the achievement of environmental goals

- Check for multicollinearity:

```
> vif(m2)
financial.resources.dif             EXT.REL.MIN           TRUST.END.AVRG
               1.154463                1.048975                1.179951
```

- Check for homoscedasticity:

```
Non-constant Variance Score Test
Variance formula: ~ fitted.values
Chisquare = 1.325423    Df = 1     p = 0.2496211
```

Achievement of economic goals

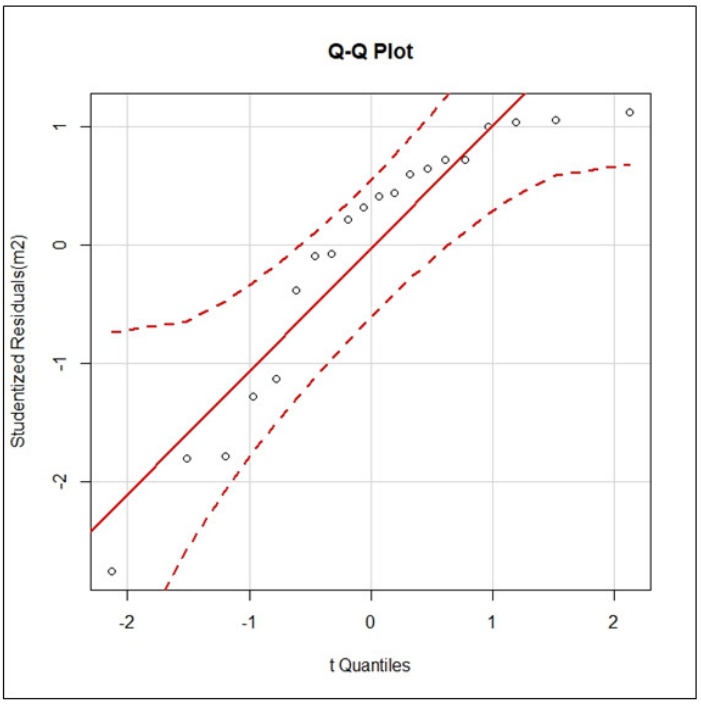

Figure A5: Check for normality: Q-Q plot with confidence interval for the model explaining the achievement of economic goals

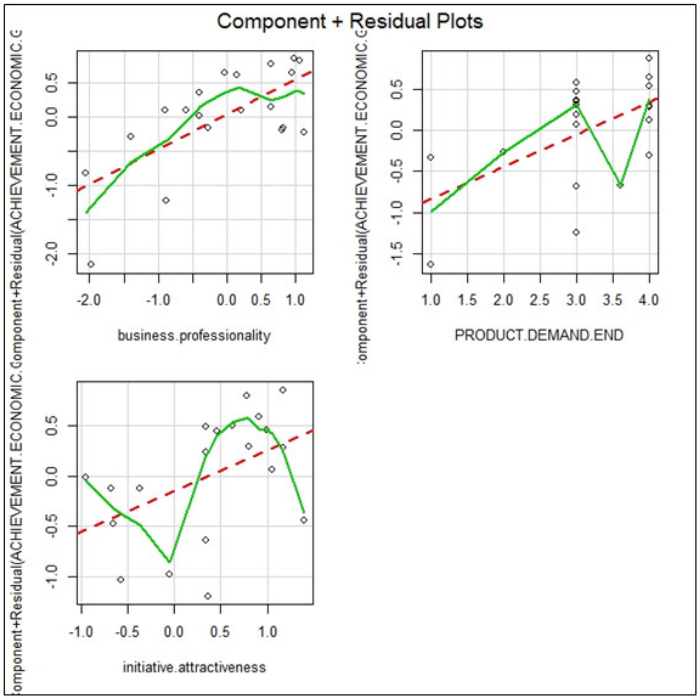

Figure E6: Check for linearity: Component + residual plots for the model explaining the achievement of economic goals

- Check for multicollinearity:

```
> vif(m2)
 business.professionality        PRODUCT.DEMAND.END initiative.attractiveness
                 1.023066                  1.051016                  1.039007
```

- Check for homoscedasticity:

```
Non-constant Variance Score Test
Variance formula: ~ fitted.values
Chisquare = 1.252135    Df = 1     p = 0.2631452
```

Durability

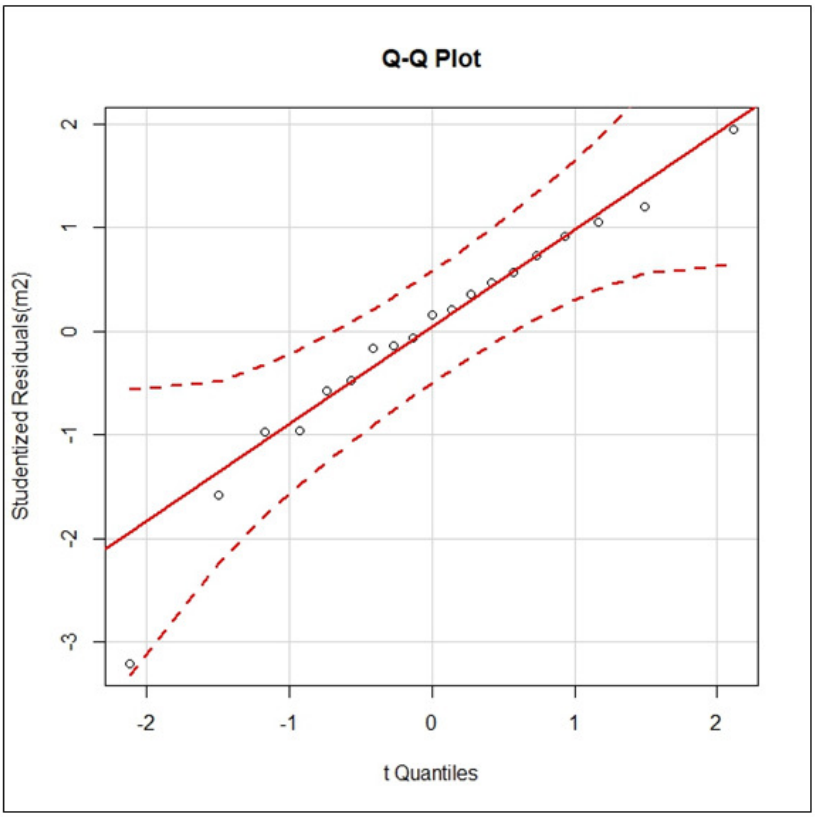

Figure A7: Check for normality: Q-Q plot with confidence interval for the second model explaining durability

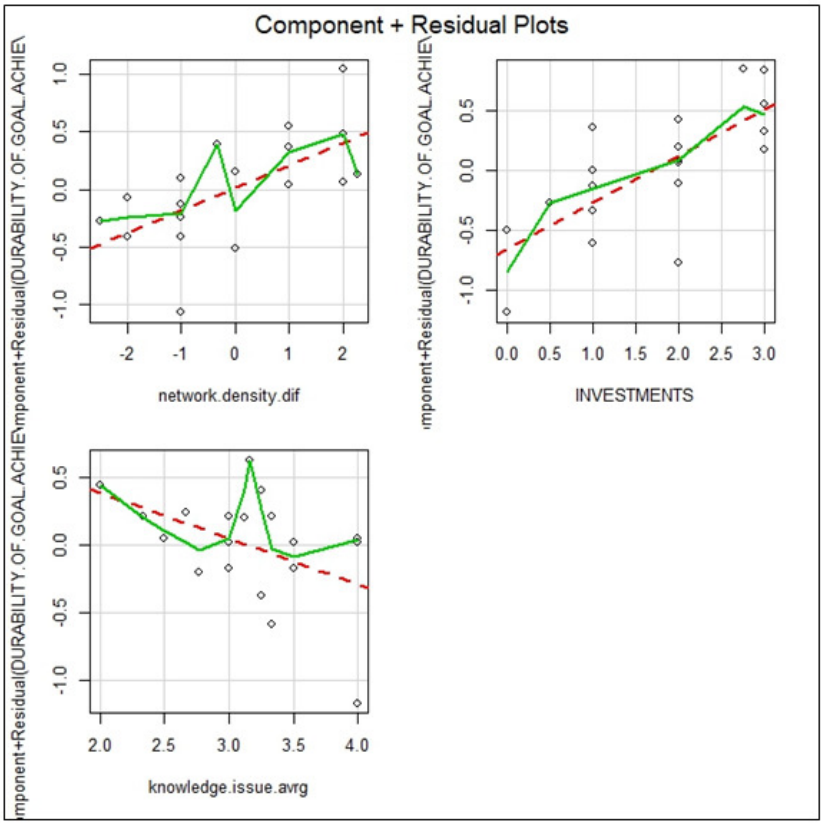

Figure A8: Check for linearity: Component + residual plots for the second model explaining durability

- Check for multicollinearity of the second model:

```
> vif(m2)
 network.density.dif          INVESTMENTS knowledge.issue.avrg
            1.027425             1.018668             1.034156
```

- Check for homoscedasticity of the second model:

```
Non-constant Variance Score Test
Variance formula: ~ fitted.values
Chisquare = 0.4927551    Df = 1     p = 0.4827009
```

Acceptance

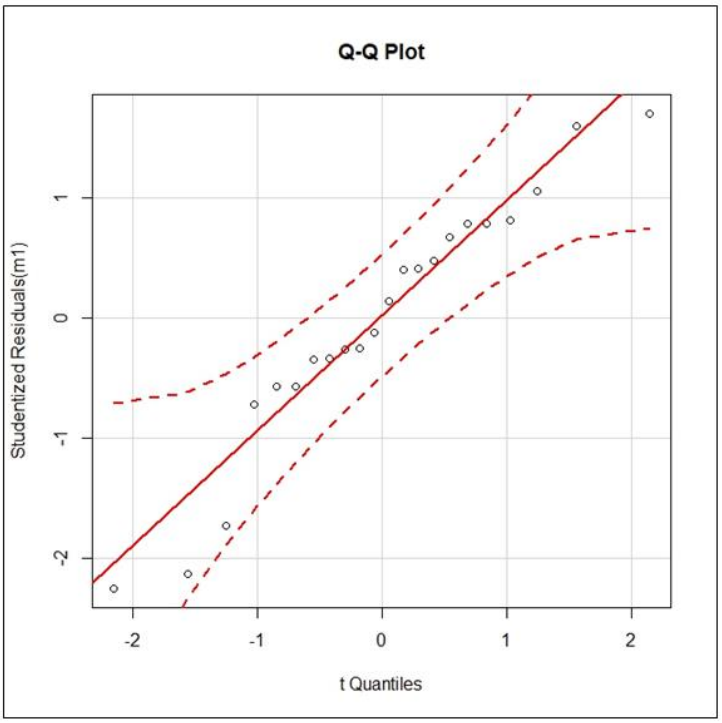

Figure A9: Check for normality: Q-Q plot with confidence interval for the model explaining acceptance

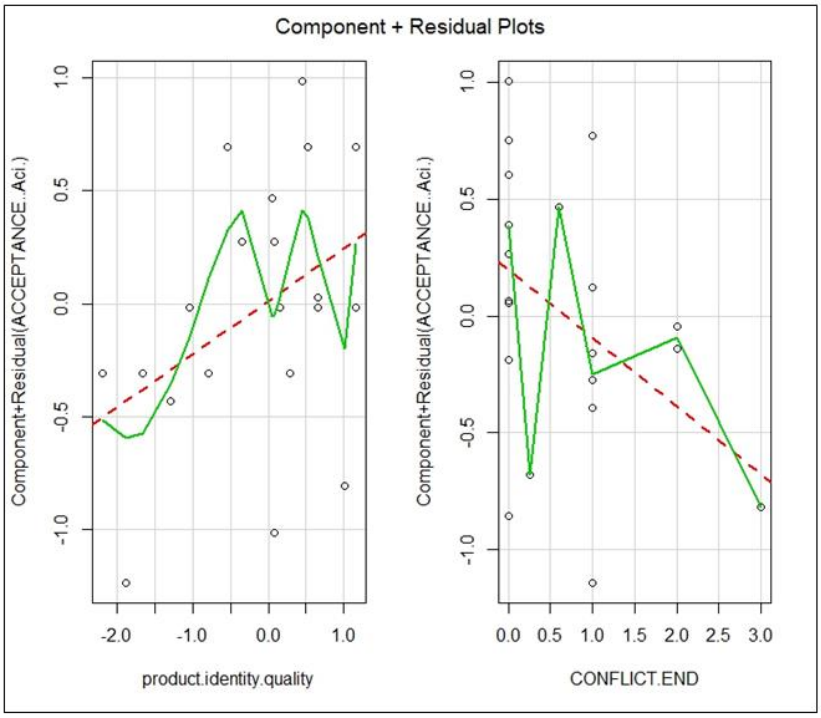

Figure A10: Check for linearity: Component + residual plots for the model explaining acceptance

- Check for multicollinearity:

```
> vif(ml)
product.identity.quality             CONFLICT.END
                1.006235                 1.006235
```

- Check for homoscedasticity:

```
Non-constant Variance Score Test
Variance formula: ~ fitted.values
Chisquare = 0.7790501    Df = 1     p = 0.3774318
```

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Online Resource 2 to Velten, Sarah, Jager, Nicolas W., Newig, Jens: Success of Collaboration for Sustainable Agriculture: a Case Study Meta-Analysis; *Environment, Development and Sustainability*
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Online Resource 2 - Coding Scheme for Case Studies of Collaborative Interventions for a more Sustainable Agriculture on the Local or Regional Level

The purpose of this coding scheme is the assessment of a range of cases of interventions in Europe that attempted to improve the sustainability of agriculture in a region or locality in order to evaluate in which cases which factors are most crucial for success or failure of such an intervention. For this analysis, a case is defined as follows: fragmentation

A case is defined as *an intervention (initiative, project, putting a legislation into practice etc.) which is realized on the local or regional level (i.e. any level above farm-level and below national level), which aims at improving the sustainability of agriculture in the concerned locality or region and is carried out in any EU country in collaboration of several actors.*

Thus, aside from collaboratives with ambitious objectives and the intention to realize genuine sustainable agriculture we also include collaboratives that seek incremental improvements. To be considered a relevant case for our case meta-analysis, a collaborative may focus on only part of the sustainability dimensions but still needs to pursue its objectives in a way that benefits or at least does not worsen the situation of the remaining, non-focal areas. Key selection criterion is whether there is some evidence that interventions actually aim at sustainability improvements. Cases in which such aims were obviously merely symbolic and not sincere were not included.

The analytical scheme comprises seven parts:

A. **General Information**
B. **Case Type**
C. **Goals of the intervention**
D. **External Factors supporting or hindering the success of the intervention:**
    I. Characteristics of the issue
    II. Characteristics of the policies to be complied with (where applicable)
    III. Factors of external conditions and support
    IV. Market-related factors (where applicable)
E. **Internal Factors supporting or hindering the success of the intervention:**
    Actor-related:
    I. Characteristics of the individual involved actors
    II. Characteristics of the group of involved actors

Related to organization & management of the intervention:

III. Structure and organization of the intervention
IV. Business performance of the intervention (where applicable)
V. Others (open coding of additional factors)

F. Success of the intervention

Coding rules

- All variables have to be coded with the value of the variable and a value for the reliability (only for the variables A1-A5 and the variables that are calculated automatically no value for the reliability of the information does not need to be given).
- For variable values of the semi-quantitative variables, mostly a 5 level scale from 0 to 4 in steps of 1 is used. The steps can be interpreted as follows:
  - 0 corresponds to 0 to 20 per cent ("does not apply");
  - 1 corresponds to 21 to 40 per cent ("applies to a low extent");
  - 2 corresponds to 41 to 60 per cent ("applies to a medium extend");
  - 3 corresponds to 61 to 80 per cent ("applies to a high extend");
  - 4 corresponds to 81 to 100 per cent ("applies to a very high extend")

  whereas 100 per cent corresponds to a theoretical maximum that could be expected under realistic optimal conditions.
  - If a there is no information available for a variable, the variable is coded "NIL".
  - If a variable cannot be coded because it would logically not make sense, the variable is coded "n/a". However, code as little variables "n/a" as possible.
  - There are certain variables that cannot be coded neither "NIL" nor "n/a". This is signaled by "~~NIL~~" and "~~n/a~~" in the column informing the code type of the variable.
- Coding is to be based on the evidence from the text(s) describing the case. Only for the variables INTERVENTION AREA (B3) and ISSUE AREAS (D.I4) it is allowed to obtain information from external sources if sufficient information cannot be found in the text(s).
- The reliability value states the amount of information available on each variable. The values range from 0 to 3 and can be interpreted as follows:
  - 0 = insufficient information available (the variable value is coded NIL in this case);
  - 3 = explicit, detailed and reliable information available.

  Variables coded "n/a" do not require a reliability value.
- During coding, make deliberate use of the comment function of EXCEL to explain the coding of those variables for which your choice of the code might not be obvious at first sight.

Code types

bin [0/1]	Binary values; code 1 for "yes"/"true"/"present" and 0 for "no"/"false"/"absent"
number	Code a fitting number
qual	Text; code one of the options provided in the description of the variable
Nominal, ordinal, or metric	Code discrete numbers according to the description of the variable. Scale possible codes [0..4] → 0; 1; 2; 3; 4 [-4..4] → -4; -3; -2; -1; 0; 1; 2; 3; 4 [0..7] → 0; 1; 2; 3; 4; 5; 6; 7 [0..10] → 0; 1; 2; 3; 4; 5; 6; 7; 8; 9; 10
text	Free text

Glossary

Active involvement Actors are actively involved in the intervention, actively pursue or actively contribute to the achievement of the goals of the intervention, i.e. they invest resources (time, money etc.) in order to achieve the goals of the intervention. One example of actors that do have a stake in the intervention but are not actively involved in it are consumers who merely buy the products produced in the context of an intervention without any further engagement with the intervention itself. Another example are authorities whose only contribution is the granting of necessary permits or from which funds for the realization of the intervention are obtained but who do not further intervene in or interact with the intervention.

Actor Actors are individuals (individual actors) or organizations (collective actors) that are either directly involved in the intervention or that are in other ways relevant to the intervention.

Citizens Non-organised individuals (e.g. consumers, residents, etc.); also includes citizens in their function as shareholders/ investors.

Civil society actors "A collection of entities and groups that are organised (institutionalised), non-governmental, non-profit, self-governing, and voluntary (e.g. NGOs, churches, unions)." (Newig et al., 2013) This actor category may also comprise citizen initiatives, non-governmental foundations and trusts.

Concerned authorities (CA) Comprises both governmental actors actively involved in the intervention and governmental actors that have the competency to decide on issues relevant to the intervention but are not actively involved in the intervention (see also "active involvement").

Governmental actors "All governmental actors and organisations at various levels engaged in the formulation of policies and their execution …, including quasi-governmental organization fulfilling functions of government." (Newig et al., 2013) In this analysis, governmental actors are subdivided into two categories:

- **General administration:**
  Actors of the general political administration, e.g. counties, municipalities, local administration.
- **public bodies with special tasks**:
  Actors that are exclusively or predominantly state-owned and are dedicated to specific tasks, e.g. extension service, chamber of agriculture, Nature Park.

Member Members are individuals directly involved in the intervention (either as individual actors or as representatives of collective actors).

Private actors "All for-profit organisations that are owned or operated by private individuals, and companies engaged in the supply of goods and services (i.e. productive private enterprises, farmers, industry, etc.), including umbrella organisations representing industry, and state-owned enterprises that are mandated to return a profit from their commercial activity." (Newig et al., 2013). In this analysis, the private actors are further subdivided into:

- **Individual farmers**:
  Individual farmers in both the sense of a person and single farm businesses. Includes all types of agricultural producers, e.g. also shepherds, orchard owners etc.
- **Farmer associations**:
  All types of collective actors in which agricultural producers of all kinds self-organize (e.g. organic farming association, farmer co-operative etc.). Also includes collective actors that are ideologically close to agricultural producer associations, such as rural women associations.
- **Processors:**
  All types actors that process agricultural produce, e.g. butchers, millers, food industry.
- **Other private businesses:**
  All types of private businesses that do not fit into any of the other private business categories

Research & Education actors Individuals or organizations of both public and private character which are involved in research and/or education.

No.	Variable Name	Description	References	Values
A. General Information				
A1	CODER NAME	First and family name of the person who coded this case		Text
A2	CASE NAME	Assigned name of the case	Newig et al., 2013	Text
A3	COUNTRY	Country in which the case took place	Newig et al., 2013	Text
A4	REFERENCES	References of the publications used for the coding of the case	Newig et al., 2013	Text
A5	SUMMARY	Short summary of the case (max. 200 words)	Newig et al., 2013	Text
A6	WORD COUNT	Estimate of the amount of information available on the case. Estimate the number of words by counting pages dealing with the case, and number of words per page. Illustrations are counted as though the space they occupy was filled with words. Count all pages (in all publications) that are used for coding this particular case.	Newig et al., 2013	Number
A7	SOURCE PEER	Are there peer-reviewed publications among the publications used for coding this case? Decisions-criteria: Is the publication in question listed in Scopus?	Newig et al., 2013	Bin [1/0]
A8	SOURCE PUBL	Are there commercially published, yet not peer-reviewed publications among the publications used for coding this case? Decision-criteria: Does the publication in question have an ISBN or ISSN?	Newig et al., 2013	Bin [1/0]
A9	SOURCE GREY	Are there any other types of publications among the publications used for coding this case? (e.g. theses, reports, conference contributions)	Newig et al., 2013	Bin [1/0]
A10	AUTH ORG	Were any of the authors of the publications used for coding involved in the intervention as organizer and/or facilitator?	Newig et al., 2013	Bin [1/0]
A11	AUTH ACTIVE	Were any of the authors of the publications used for coding actively involved in the intervention in any other way?	Newig et al., 2013	Bin [1/0]
A12	AUTHOR NEUTRAL	Were any of the authors of the publications used for coding neutral observers of the intervention?	Newig et al., 2013	Bin [1/0]
A13	CASE START YEAR	Year in which the intervention started, i.e. when first events leading to the intervention took place. In case of a legislation: year when its implementation was initiated.	Newig et al., 2013	Number

A14	CASE END YEAR	Year in which the intervention ended, e.g. when a program which initiated the intervention ended, when the activities at the core of the intervention ceased to be carried out etc. If the intervention was ongoing or had not ended, code n/a.	Newig et al., 2013	Number
A15	LATEST DATA	Year for which the latest information on the case is available. In case of doubt, enter the publication year of the latest publication reporting on the case.	Newig et al., 2013	Number
B. Case Type				
B1	ISSUE DESCRIPTION	Describe shortly the issue addressed by the intervention.	Newig et al., 2013	Text
B2	LEVEL	Level at which the intervention took place. In case of doubt (e.g. if a city is at the same time a county or a state), choose the highest code. 0 = sub-municipality 1 = municipality 2 = cross-municipality 3 = county (or equivalent) 4 = cross-county 5 = landscape / watershed (ecologically/geographically defined rather than administratively defined) 6 = subnational 7 = cross-subnational	Newig et al., 2013	nominal [0..7]
B3	INTERVENTION AREA	Approximate size of the area in which the intervention took place in km^2 (For this variable, external sources can be used, if necessary)	Newig et al., 2013	Number
B4	POLICY	Did the intervention consist in or include the compliance to one or more policies?		Bin [0/1]
B5	POLICY NAME	If POLICY = 1, provide the names of the policies. If POLICY = 0, code n/a.		Text

B6	POLICY LEVEL	If POLICY = 1, specify the administrative level of the policies. If policies have different levels, code the policy with the highest level: 0 = municipality 1 = cross-municipality 2 = county (or equivalent) 3 = cross-county 4 = sub-national 5 = cross-sub-national 6 = national 7 = cross-national within the EU 8 = EU 9 = cross-national with non-EU countries 10 = international If POLICY = 0, code n/a.	Newig et al., 2013	nominal [0..10]
B7	MARKETING	Did the intervention include the selling and/or marketing of agricultural products?		Bin [0/1]
B8	INITIATION TYPE	Specify how the intervention was initiated: 0 = pure bottom-up initiation through non-state actor(s) or lower-level governmental body/bodies 4 = pure top-down initiation through higher level governmental body/bodies.	Horlings, 1994; Ingram et al., 2008; Measham and Lumbasi, 2013	metric [0..4]
B9	INITIATORS	Indicate whether the following actor types were among the initiating actors.	Newig et al., 2013	Bin [0/1]
B9i	INITIATOR FARMERS	Individual farmers		
B9ii	INITIATOR FARMER ASSOC	Farmer associations		
B9iii	INITIATOR PROCESSORS	Processors		
B9iv	INITIATOR PRIV OTH	Other private businesses		

B9v	INITIATOR GEN ADMIN	Governmental actors of the general administration		
B9vi	INITIATOR SPECIAL TASK	Public bodies with special tasks		
B9vii	INITIATOR CIV	Civil society actors		
B9viii	INITIATOR RES EDU	Research & education actors		
B9ix	INITIATOR CIT	Citizens		
B10	ACTORS QUAL	Insert the names of the single involved actors of the following actor types. If appropriate, summarize actor groups, e.g. “organic farmers” instead of giving the names of all farmers or “commons associations” instead of giving the names of all involved commons associations.		Text
B10i	ACTOR QUAL FARMERS	Individual farmers		
B10ii	ACTOR QUAL FARMER ASSOC	Farmer associations		
B10iii	ACTOR QUAL PROCESSORS	Processors		
B10iv	ACTOR QUAL PRIV OTH	Other private businesses		
B10v	ACTOR QUAL GEN ADMIN	Governmental actors of the general administration		
B10vi	ACTOR QUAL SPECIAL TASK	Public bodies with special tasks		
B10vii	ACTOR QUAL CIV	Civil society actors		
B10viii	ACTOR QUAL RES EDU	Research & education actors		
B10ix	ACTOR QUAL CIT	Citizens		

B11	ACTORS	Indicate the degree of active involvement the following types of actors. If there are several actors of one type that are actively involved in the intervention, consider the most involved one: 0 = Actors of the type in question were not involved or only to a very low degree. 4 = Actors of the type in question were involved or contributed to a high degree.	Newig et al., 2013	metric [0..4]
B11i	ACTOR FARMERS	Individual farmers		
B11ii	ACTOR FARMER ASSOC	Farmer associations		
B11iii	ACTOR PROCESSORS	Processors		
B11iv	ACTOR PRIV OTH	Other private businesses		
B11v	ACTOR GEN ADMIN	Governmental actors of the general administration		
B11vi	ACTOR SPECIAL TASK	Public bodies with special tasks		
B11vii	ACTOR CIV	Civil society actors		
B11viii	ACTOR RES EDU	Research & education actors		
B11ix	ACTOR CIT	Citizens		
The following variables classify the case by determining which 'fields of action' (FOA) of the sustainable agriculture framework (Velten, 2014) the intervention sought to address.				
B12	FOA AGRIFOOD SYSTEM: PRODUCTION	Did the intervention seek to address the field of action of the organization of the agrifood system by seeking changes in production patterns, e.g. to realize a more diverse production, to produce more, or less etc.?		Bin [0/1]
B13	FOA AGRIFOOD SYSTEM: SUPPLY CHAIN	Did the intervention seek to address the field of action of the organization of the agrifood system by seeking changes in post-harvest handling, processing, distribution, and marketing?		Bin [0/1]
B14	FOA AGRIFOOD SYSTEM: CONSUMPTION	Did the intervention seek to address the field of action of the organization of the agrifood system by seeking changes in in consumption patterns?		Bin [0/1]

B15	FOA MANAGEMENT & TECHNOLOGICAL SOLUTIONS: CROPS & LIVESTOCK	Did the intervention address the field of action of specific management approaches, practices or technologies through the use of new or better species or breeds of crops or livestock?		Bin [0/1]
B16	FOA MANAGEMENT & TECHNOLOGICAL SOLUTIONS: MANAGEMENT TOOLS	Did the intervention address the field of action of specific management approaches, practices or technologies through the use of systematic decision-supporting tools (indicators, models etc.)?		Bin [0/1]
B17	FOA MANAGEMENT & TECHNOLOGICAL SOLUTIONS: RESOURCE USE	Did the intervention address the field of action of specific management approaches, practices or technologies through changes in the kinds or quantities of resources used?		Bin [0/1]
B18	FOA MANAGEMENT & TECHNOLOGICAL SOLUTIONS: TECHNOLOGIES & PRACTICES	Did the intervention address the field of action of specific management approaches, practices or technologies through the application of different agricultural practices or technologies?		Bin [0/1]
B19	FOA SOCIAL & ENVIRONMENTAL CHALLENGES: EMISSION-REDUCTION	Did the intervention seek to address the field of action of current social or environmental challenges by seeking to reduce harmful emissions?		Bin [0/1]
B20	FOA SOCIAL & ENVIRONMENTAL CHALLENGES: GLOBAL TRENDS	Did the intervention seek to address the field of action of current social or environmental challenges by seeking to adapt to or mitigate trends such as climate change, urbanization, population growth?		Bin [0/1]
B21	FOA SOCIAL & HUMAN CAPITAL: KNOWLEDGE, EDUCATION, SKILLS	Did the intervention seek to address the field of action of social or human capital by improving knowledge, education, and/or skills of stakeholders (human capital)?		Bin [0/1]
B22	FOA SOCIAL & HUMAN CAPITAL: ORGANIZATION	Did the intervention seek to address the field of action of social or human capital by improving the organization of stakeholders?		Bin [0/1]

B23	FOA SOCIAL & HUMAN CAPITAL: RESEARCH & DEVELOPMENT	Did the intervention seek to address the field of action of social or human capital by engaging in research and development activities?		Bin [0/1]
B24	FOA SOCIAL, POLITICAL & ECONOMIC ENVIRONMENT: ACCESSIBILITY	Did the intervention seek to address issues in the field of action of the societal, political or economic context by improving access for everybody to food, water, production means, or marketing channels?		Bin [0/1]
B25	FOA SOCIAL, POLITICAL & ECONOMIC ENVIRONMENT: ECONOMIC SYSTEM	Did the intervention seek to address issues in the field of action of the societal, political or economic context through changes in the valuation of goods and services and in the way economic activities are carried out?		Bin [0/1]
B26	FOA SOCIAL, POLITICAL & ECONOMIC ENVIRONMENT: INFRASTRUCTURE	Did the intervention seek to address issues in the field of action of the societal, political or economic context through the improvement of infrastructure?		Bin [0/1]
B27	FOA SOCIAL, POLITICAL & ECONOMIC ENVIRONMENT: INVESTMENT	Did the intervention seek to address issues in the field of action of the societal, political or economic context through changes and improvements in investment in agriculture?		Bin [0/1]
B28	FOA SOCIAL, POLITICAL & ECONOMIC ENVIRONMENT: POLICY & INSTITUTIONS	Did the intervention seek to address issues in the field of action of the societal, political or economic context through changes of or new policies and institutions?		Bin [0/1]

B29	FOA SOCIAL, POLITICAL & ECONOMIC ENVIRONMENT: SOCIETY	Did the intervention seek to address issues in the field of action of the societal, political or economic context through attempts to change the values, organization, thinking etc. of society?		Bin [0/1]
C. Goals of the intervention				
C1	GOALS DESCRIPTION	Describe shortly what the intervention attempted to achieve.		Text ~~NIL~~ ~~n/a~~
C2	AMBITIOUSNESS ENVIRONMENTAL GOALS (a_{1i})	How varied and fundamental were the improvements of environmental aspects the intervention aimed at? 0 = The intervention did not aim at environmental improvements or aimed at unambitious environmental improvements. 4 = The intervention intended to achieve ambitious environmental improvements.		metric [0..4] ~~NIL~~ ~~n/a~~
C3	AMBITIOUSNESS ECONOMIC GOALS (a_{2i})	How varied and fundamental were the improvements of economic aspects the intervention aimed at? 0 = The intervention did not aim at economic improvements or aimed at unambitious economic improvements. 4 = The intervention intended to achieve ambitious economic improvements.		metric [0..4] ~~NIL~~ ~~n/a~~
C4	AMBITIOUSNESS SOCIAL GOALS (a_{3i})	How varied and fundamental were the improvements of social aspects the intervention aimed at? 0 = The intervention did not aim at social improvements or aimed at unambitious social improvements. 4 = The intervention intended to achieve ambitious social improvements.		metric [0..4] ~~NIL~~ ~~n/a~~
C5	AMBITIOUSNESS OF GOALS TOTAL (A_i)	Calculates the average ambitiousness of the goals of the intervention: $A_i = \frac{\sum_{j=1}^{3} a_{j_i}}{3}$		Number

D. External factors supporting or hindering success of the intervention				
D.I Characteristics of the issue				
D.I1	ISSUE PUBGOOD	Could the issue be characterized as a public good problem? Public goods are characterized by their non-excludability and non-rivalry, i.e. it is hardly possible to exclude somebody from the use of this good (non-excludability) and, at the same time, the use and benefit of the good by one individual does not preclude that of other individuals (non-rivalry) (Ayer, 1997). Examples for public goods are clean air or the beauty of landscapes. 0 = The issue did not have public good characteristics. 4 = The issue clearly was a public good problem.	Ayer, 1997	metric [0..4]
D.I2	ISSUE COPROD	Could the issue be characterized as a problem of co-production of benefits? An example for co-production would be the implementation of new management practices which at the same time lead to an increase agricultural productivity (individual benefit for the farmer) and to an increase in biodiversity and ecosystem services (collective benefit). 0 = The issue was not a problem of co-production. 4 = The issue clearly was a problem of co-production.	Ayer, 1997	metric [0..4]
D.I3	ISSUE PRISONERDIL	Could the issue be characterized as a 'prisoner dilemma'? In situations of prisoner dilemma character a lack of communication between concerned actors leads to individually and collectively sub-optimal outcomes. Or, vice-versa, through communication between concerned actors, individually and collectively optimal outcomes become possible. 0 = The issue was not of prisoner dilemma character. 4 = The issue clearly was of prisoner dilemma character.	Ayer, 1997	metric [0..4]

D.I4	ISSUE AREA	If one of the issues addressed by the intervention was a specific environmental and/or resource problem (e.g. a polluted lake, extraction of groundwater in a certain area etc.), what was the approximate area of this issue in km^2? (for this variable, external sources can be used, if necessary)	Agrawal, 2001; Markelova and Mwangi, 2010	Number
D.I5	ISSUE BOUNDARIES	If one of the issues addressed by the intervention was a specific environmental and/or resource problem, did it have well-defined boundaries? 0 = The boundaries of the issues could not or hardly be defined. 4 = The boundaries of the issue were or could possibly be clearly defined.	Agrawal, 2001; Markelova and Mwangi, 2010	metric [0..4]
D.I6	ISSUE MOBILITY	If one of the issues addressed by the intervention was a specific environmental and/or resource problem, how mobile was it, i.e. how often and how much did it change its location? 0 = The issue was of low mobility, it never changed its location significantly. 4 = The issue was of high mobility, it often changed its location significantly.	Agrawal, 2001; Markelova and Mwangi, 2010	metric [0..4]
D.I7	RESOURCE DEMAND	If one of the issues addressed by the intervention was a specific resource problem, how high was the demand for the resource itself or for its benefits? 0 = There was a low demand for the resource or its benefits. 4 = There was a high demand for the resource or its benefits.	Agrawal, 2001; Totin et al., 2014	metric [0..4]
D.I8	ISSUE PREDICATBILITY	If one of the issues addressed by the intervention was a specific environmental and/or resource problem, how predictable was its behavior in a 'business as usual' development, i.e. without any intervention? 0 = The issue was not or hardly predictable. 4 = The issue was well-predictable.	Agrawal, 2001; Markelova and Mwangi, 2010	metric [0..4]

D.I9	ISSUE LOCATION	If one of the issues addressed by the intervention was a specific environmental and/or resource problem, was there an overlap between the location of the issue and the location of the actors involved with the issue? 0 = There was no overlap between the location of the issue and the location of the involved actors. 4 = The location of the involved actors and the issue were identical or the location/area of the issue enclosed the location/area of the involved actors or the location/area of the involved actors and the location/area of the issue.	Agrawal, 2001; Burandt et al., 2013	metric [0..4]
D.I10	ISSUE BENEFITS STORAGE	If the issue was related to the generation of any kind of benefits (e.g. agricultural produce, biodiversity, beautiful landscapes etc.), how well could these benefits be stored? (for instance, beautiful landscape and biodiversity could not be stored, easily perishable agricultural produce could be stored to some degree, hardly perishable produce could be easily stored) 0 = The benefits could not or hardly be stored. 4 = The benefits could be easily stored.	Agrawal, 2001; Markelova and Mwangi, 2010	metric [0..4]
D.I11	ISSUE IMPORTANCE	To which degree were the involved actors dependent on the (solution of) the issue? 0 = The involved actors were mostly not dependent on the (solution of) the issue. 4 = The involved actors were mostly dependent on the (solution of) the issue.	Agrawal, 2001	metric [0..4]
D.II Characteristics of the policies to be implemented or complied with Code the variables of the following section only if the intervention consisted in or included implementation of or compliance with one or more policies (POLICY = 1). In all other cases (POLICY = 0), code all variables of this section n/a.				
D.II1	POLICY COMMAND-AND-CONTROL	To which extent did the policies rely on command-and-control measures (e.g. threshold values for pollutants, minimum sizes for conservation areas)?	Cocklin et al., 2007; Newig et al., 2013	metric [0..4]

		0 = The policies did not include command-and-control mechanisms. 4 = The policies made ample use of command-and-control mechanisms.		
D.II2	POLICY ECNOMIC	Did the policy / policies include economic or financial measures (e.g. taxes, subsidies)?	Cocklin et al., 2007; Newig et al., 2013	Bin [0/1]
D.II3	POLICY OTHER	Did the policy / policies include any other types of instruments? If so, shortly describe these other policy instruments. Else, code n/a.	Cocklin et al., 2007	Text
D.II4	POLICY FORMULATION INVOLVEMENT	Were the stakeholders involved in the formulation of the policies the intervention sought to comply with? 0 = No or very little stakeholder involvement in policy-making had taken place. 4 = There had been a high level of stakeholder involvement in the formulation of the concerning policies.	Horlings, 1994; Cocklin et al., 2007	metric [0..4]
D.II5	POLICY ACCEPTABILITY	To which degree did stakeholders accept the main issues of the policies? 0 = Most of the stakeholders opposed the main issues of the policies. 4 = Most of the stakeholders accepted and supported the main issues of the policies.	Horlings, 1994	metric [0..4]
D.II6	POLICY FAIRNESS	Did the policies treat all affected actors equitably and fair? E.g. in case of non-obligatory policies, could all actors addressed by the policies (e.g. all farmers) participate in the schemes proposed by the policies? 0 = The policies treated the affected actors inequitably. 4 = The policies treated the affected actors equitably.	Cocklin et al., 2007	metric [0..4]
D.II7	POLICY LONG-TERM	Did the policies present a long-term commitment to certain programs, strategies and/or forms of support? 0 = Duration of the commitment was not-defined or only short-term. 4 = Duration of the commitment was long-term.	Cocklin et al., 2007	metric [0..4]
D.II8	POLICY SPECIFICITY	How specific were the prescriptions of the policies to the conditions of the area in which the case takes place?	Prager et al., 2011	metric [0..4]

		0 = The prescriptions were mostly unspecific to local conditions, e.g. they were uniform for the whole EU or a whole country. 4 = The prescriptions were very specific to conditions the individual conditions in a locality or a region.		
D.II9	POLICY CLARITY	Were the rules of the policies clear and simple for the involved actors? 0 = The rules of the policies were rather complex and hard to understand. 4 = (Almost) all rules of the policies were clear, simple, and easy to understand.	Cocklin et al., 2007	metric [0..4]
D.II10	POLICY PRECISION	How precise were the policies, i.e. how well did they define what had to be done and which measures had to be taken? 0 = The policies were mostly imprecise, e.g. they referred to very broad terms such as “good state of the soil” or “application of good agricultural practice”. 4 = The policies were precise and clearly defined measures to be taken and/or threshold values that needed to be complied with.	Prager et al., 2011	metric [0..4]
D.II11	POLICY FLEXIBILITY	How flexible were the rules of the policies? A flexible policy is not too prescriptive so the policy-addressees who have to implement them can search for solutions appropriate to their conditions (e.g. the policy only prescribes long-term goals rather than means to achieve them). 0 = The rules were rather inflexible and prescriptive. 4 = The rules were flexible.	Horlings, 1994; Lamprinopoulou et al., 2006; Cocklin et al., 2007; Prager, 2015	metric [0..4]
D.II12	POLICY PRACTICABILITY	Were the policy requirements easy to put into practice? 0 = It was hard or complicated for the policy-addressees to put the policy requirements into practice. 4 = For (almost) all policy requirements it was easy for the policy-addressees to put them into practice.	Cocklin et al., 2007	metric [0..4]

D.II13	POLICY ADMINISTRATIVE EFFORT	How much administrative work and effort (e.g. in terms of paperwork) did compliance with the policies cause the policy-addressees? 0 = The policies were little administratively onerous. 4 = The policies were very administratively onerous.	Cocklin et al., 2007	metric [0..4]
D.II14	POLICY INTERNALIZATION	Did the policies internalize external costs and/or benefits? 0 = The policies did not internalize external costs or benefits. 4 = The policies internalized external costs / benefits to a great extent.	Horlings, 1994	metric [0..4]
D.II15	POLICY LEARNING	Did the policies stimulate learning processes and/or were they linked to education and training? 0 = The policies did not stimulate learning processes and/or were linked to education and training. 4 = The policies explicitly stimulated learning processes and/or included substantial education and training.	Horlings, 1994; Cocklin et al., 2007	metric [0..4]
D.II16	POLICY INCENTIVES QUALITY	Were incentives / rewards accruing from the policies not only tied to quantity but also to quality (e.g. of a protected resource)? 0 = Incentives / rewards rewarded mainly quantities provided and did not reward quality. 4 = Incentives / rewards rewarded quality to a great extent.	Cocklin et al., 2007	metric [0..4]
D.II17	POLICY INCENTIVES PERFORMANCE	Were incentives / rewards accruing from the policies equitable in the sense that they rewarded actual performance (instead of being merely tied to the size of the farm, number of animals etc.)? 0 = Incentives / rewards were not tied to actual performance. 4 = Incentives / rewards were mostly tied to actual performance.	Cocklin et al., 2007	metric [0..4]

D.II18	POLICY PRIOR WORK	Did incentives / rewards accruing from the policies consider and reward relevant beneficial work that had been done by policy-addressees before the introduction of the policies? 0 = Incentives / rewards did not reward prior work. 4 = Incentives / rewards (almost) fully rewarded prior work.	Cocklin et al., 2007	metric [0..4]
D.II19	POLICY INCENTIVES ENVIRONMENT	Were incentives / rewards tied to a stewardship ethic and did they target environmental outcomes? 0 = Incentives / rewards were not tied to a stewardship ethic or environmental outcomes. 4 = Incentives / rewards were strongly tied to a stewardship ethic or environmental outcomes.	Cocklin et al., 2007	metric [0..4]
D.II20	POLICY INCENTIVES PAYMENT	In case of issues that created benefits that accrued to a community beyond the local/regional stakeholders, were the incentives / rewards paid by a broader community (and not only by the local community)? For example measures to store CO_2 can be carried out on the local or regional level but are beneficial to people in all places of the world. 0 = Incentives / rewards were not paid by a wider community. 4 = Incentives / rewards were mostly paid by a wider community.	Cocklin et al., 2007	metric [0..4]
D.II21	POLICY ENFORCEMENT	Was compliance with the requirements of the policies monitored and enforced? 0 = Compliance was not or hardly monitored and enforced. 4 = Compliance was strongly monitored and enforced.	Cocklin et al., 2007; Prager et al., 2011	metric [0..4]
D.II22	POLICY MONITORING LOCAL	Was monitoring and control of compliance with the policies carried out by local groups or a local management rather than through government agencies? 0 = Monitoring was not carried out by local groups or a local management. 4 = Monitoring was mainly carried out by local groups or a local management.	Cocklin et al., 2007; Ingram et al., 2008	metric [0..4]

D.III Factors of external conditions and support				
D.III.a Political environment				
D.III.a1	INTERVENTION LEGAL SECURITY	Were there doubts as to the legal feasibility of the intervention (and its implications)?	Carlberg et al., 2003; Burandt et al., 2013	Bin [0/1]
D.III.a2	INTERVENTION POLICY SUPPORT INIT	At the outset of the intervention, to which degree did the concerned authorities and existing policies support, encourage and stimulate such types of interventions like the one in this case, i.e. did the concerned authorities and/or the regulatory framework not only allow for such interventions but also promote them? -4 = Interventions as in this case were clearly discouraged and impeded by the concerned authorities and/or the regulatory framework. 0 = Interventions as in this case were neither supported nor impeded by the concerned authorities and the regulatory framework. 4 = Interventions as in this case were clearly supported and encouraged by the concerned authorities and/or the regulatory framework.	Horlings, 1994; Schlager, 1995; Carlberg et al., 2003; Lamprinopoulou et al., 2006; Mburu and Wale, 2006; Shiferaw et al., 2011; Burandt et al., 2013; Dyer et al., 2013; Ramdwar et al., 2013	metric [-4..4]
D.III.a3	INTERVENTION POLICY SUPPORT END	At the end of the intervention or at the latest known point in time, to which degree did the concerned authorities and existing policies support, encourage and stimulate such types of interventions like the one in this case? -4 = Interventions as in this case were clearly discouraged and impeded by the concerned authorities and/or the regulatory framework. 0 = Interventions as in this case were neither supported nor impeded by the concerned authorities and the regulatory framework. 4 = Interventions as in this case were clearly supported and encouraged by the concerned authorities and/or the regulatory framework.	Horlings, 1994; Schlager, 1995; Carlberg et al., 2003; Lamprinopoulou et al., 2006; Mburu and Wale, 2006; Shiferaw et al., 2011; Burandt et al., 2013; Dyer et al., 2013; Ramdwar et al., 2013	metric [-4..4]

D.III.b Forms of support				
D.III.b1	EXTERNAL FUNDING AVAILABILITY	To which degree was financial support made available for this intervention from concerned authorities or from other not-actively involved actors? 0 = No or very little external funds were available. 4 = A high amount of funds was available.	Carlberg et al., 2003; Ingram et al., 2008; Ramdwar et al., 2013; Prager, 2015	metric [0..4]
D.III.b2	EXTERNAL FUNDING ADEQUACY	Was the external financial support available for the intervention adequate? -4 = There were far too little external funds; the intervention would have needed much more external financial support. 0 = The level of external funding was adequate. 4 = There was far too much external financial support (which undermined the capacity of the intervention to become self-sustaining).	Agrawal, 2001; Shiferaw et al., 2011; Dyer et al., 2013; Measham and Lumbasi, 2013	metric [-4..4]
D.III.b3	TECHNICAL SUPPORT AVAILABILITY	To which degree was technical support made available for this intervention from concerned authorities or from other not-actively involved actors? Technical support refers to expert knowledge and/or skills relevant to the issue of the intervention. 0 = No or very little technical support were available. 4 = A high amount of technical support was available.	Carlberg et al., 2003; Shiferaw et al., 2011; Prager, 2015	metric [0..4]
D.III.b4	TECHNICAL SUPPORT ADEQUACY	Was the external technical support available for the intervention adequate? -4 = There was far too little external technical support; the intervention would have needed much more technical support. 0 = The level of technical support was adequate. 4 = There was far too much external technical support (which undermined the capacity of the intervention to become self-sustaining).	Agrawal, 2001; Lamprinopoulou et al., 2006; Shiferaw et al., 2011	metric [-4..4]

D.III.b5	FACILITATION AVAILABILITY	To which degree was the intervention supported by external facilitators? "A facilitator is a specialist who helps people design effective meetings and problem-solving sessions, and acts as the meeting leader on behalf of the group. A facilitator does not have the authority to make substantive decisions, but may have a say in how the meetings is run, and will consult with the group about major process decisions, such as a significant change in agenda or meeting procedures." (Newig et al., 2013, p. 36) 0 = The intervention did not include facilitation / was not supported by external facilitators. 4 = The intervention was strongly supported by external facilitators.	Carlberg et al., 2003; Oerlemans and Assouline, 2004; Ingram et al., 2008; Markelova and Mwangi; Mills et al., 2011; Burandt et al., 2013; Measham and Lumbasi, 2013; Prager, 2015	metric [0..4]
D.III.b6	FACILITATION INTERVENTION	Were support and intervention by external facilitators adequate? -4 = There was far too little support and intervention by external facilitators; the initiative would have needed much more facilitation and/or intervention by external facilitators. 0 = The level of support and intervention by external facilitators was adequate. 4 = There was far too much support and intervention by external facilitators (which undermined the capacity of the involved actors to develop their own capacities to manage group processes).	Shiferaw et al., 2011	metric [-4..4]
D.III.b7	FACILITATOR COMPETENCY	How competent were the external facilitators supporting the intervention? (Did the facilitator(s) have an appropriate personality? Were the facilitators trained in group work? Were they able to earn the respect of the involved actors and to enter into a dialogue with them? etc.) 0 = The facilitator(s) had a low level of competency. 4 = The facilitator(s) had a high level of competency.	Mills et al., 2011; Ramdwar et al., 2013	metric [-4..4]

D.III.b8	FACILITATOR LOCAL	Were/was the facilitator(s) from the same region or locality in which the intervention was realized? 0 = None of the facilitators were from the region or locality of the intervention. 4 = All of the facilitators were from the region or locality of the intervention.	Mills et al., 2011	metric [0..4]
D.III.c Other external factors				
D. III.c1	EXTERNAL EVENTS	Did there occur any external event on which the actors involved in the intervention had no influence and that posed a great challenge for the intervention?	Ramdwar et al., 2013	Bin [0/1]
D. III.c2	EXTERNAL EVENTS TYPE	If EXTERNAL EVENTS=1, describe these/this external event(s) shortly. If EXTERNAL EVENTS=0, code n/a.		Text
D. III.c3	REGIONAL PLANNING COORDINATION	Were the activities of the intervention coordinated with regional planning? 0 = There was no coordination of the activities of the intervention with regional planning. 4 = Most of the activities of the intervention were coordinated with regional planning.	Burandt et al., 2013	metric [0..4]
D. III.c4	EARLY ACHIEVEMENTS	Were there achievements and successes in early phases of the realization of the intervention?	Burandt et al., 2013	Bin [0/1]
D.IV Market-related factors Only code these variables if the intervention included the marketing of products and/or services (MARKETING = 1). In all other cases (MARKETING = 0), code all variables of this section n/a.				
D.IV.1	PRICE STABILITY	How stable were prices for inputs and outputs of the intervention? 0 = Prices were rather volatile and unstable. 4 = Prices were rather stable.	Carlberg et al., 2003	metric [0..4]
D. IV.2	PRICE LEVEL	How fair and favorable were the market prices for inputs and outputs of the intervention? -4 = Input prices were far too high and/or output market prices were far too low. 0 = Input and/or output prices were at an adequate level. 4 = Input prices were very low and/or output market prices were very high.	Horlings, 1994; Mburu and Wale, 2006	metric [-4..4]

D. IV.3	PRODUCT DEMAND INIT	At the outset of the intervention, what was the level of demand for its products / services? 0 = There was low demand for the products / services of the intervention. 4 = There was high demand form (almost) all products and services of the intervention.	Carlberg et al., 2003; Mburu and Wale, 2006	metric [0..4]
D. IV.4	PRODUCT DEMAND END	At the end of the intervention or at the latest known point in time, what was the level of demand for the products / services of the intervention? 0 = There was low demand for the products / services of the intervention. 4 = There was high demand form (almost) all products and services of the intervention.	Carlberg et al., 2003; Mburu and Wale, 2006	metric [0..4]
D. IV.5	ECONOMIC CLIMATE INIT	How was the general economic climate at the outset of the intervention? 0 = The general economic climate was rather depressive and/ or there was a recession. 4 = The general economic climate was rather positive and/or there was a boom.	Carlberg et al., 2003	metric [0..4]
D. IV.6	ECONOMIC CLIMATE END	How was the general economic climate at the end of the intervention or at the latest point in time? 0 = The general economic climate was rather depressive and/ or there was a recession. 4 = The general economic climate was rather positive and/or there was a boom.	Carlberg et al., 2003	metric [0..4]
D. IV.7	COMPETITOR NUMBER	How many competitors did the intervention have for the sales of its products / services? 0 = There were few competitors. 4 = There were many competitors.	Carlberg et al., 2003	metric [0..4]
D IV.8	COMPETITOR PRICES	Considering the price-performance ratio, were the prices of the competitors for their products/services more or less attractive than the prices of the intervention?	Carlberg et al., 2003	metric [-4..4]

		-4 = The prices of the competitors were much less attractive. 0 = The prices of the competitors were approximately equally attractive as the prices of the intervention. 4 = The prices of the competitors were much more attractive than the prices of the intervention.		
D. IV.9	MARKET DOMINATION	Were there any competitors that dominated the market?	Lamprinopoulou et al., 2006	Bin [0/1]
E. Internal factors supporting or hindering success of the intervention				
ACTOR-RELATED				
E.I Characteristics of the individual involved actors				
E.I.a Knowledge and skills				
E.I.a1	ACTOR EDUCATION	Indicate the degree of formal education of the involved actors: 0 = All involved actors had a low level of formal education (e.g. they went to school only for few years or had very basic school education). 4 = All involved actors had a high level of formal education (e.g. university degree, advanced professional training)	Lubell and Fulton, 2007	metric [0..4]
E.I.a2	KNOWLEDGE ISSUE	Indicate the degree to which the involved actors of the following actor types had knowledge about and relevant to the issue at the heart of the intervention (as defined in the variable ISSUE DESCRIPTION). If there are several actors of one type, consider the one with the highest level of knowledge: 0 = Actors of the concerning actor group had very little knowledge about and relevant to the issue. 4 = (Almost) all actors of the concerning actor group had good knowledge about and relevant to the issue.	Newig: personal communication (introduction of this variable was based on the experience with the coding scheme SCAPE (Newig et al., 2013), which lacked such a variable but would have needed it)	metric [0..4]
E.I.a2i	KNOWLEDGE ISSUE FARMERS	Individual farmers		
E.I.a2ii	KNOWLEDGE ISSUE FARMER ASSOC	Farmer associations		

E.I.a2iii	KNOWLEDGE ISSUE PROCESSORS	Processors		
E.I.a2iv	KNOWLEDGE ISSUE PRIV OTH	Other private businesses		
E.I.a2v	KNOWLEDGE ISSUE GEN ADMIN	Governmental actors of the general administration		
E.I.a2vi	KNOWLEDGE ISSUE SPECIAL TASK	Public bodies with special tasks		
E.I.a2vii	KNOWLEDGE ISSUE CIV	Civil society actors		
E.I.a2viii	KNOWLEDGE ISSUE RES EDU	Research & education actors		
E.I.a2ix	KNOWLEDGE ISSUE CIT	Citizens		
E.I.a3	ACTOR KNOWL COLLAB PRINCIPLES	Indicate the degree to which the involved actors of the following types knew of and understood principles of cooperation and collective action at the outset of the intervention (e.g. from their professional background, former experiences etc.). If there are several actors of one type, consider the one with the highest level of knowledge: 0 = Actors of the concerning actor group were not or hardly familiar with principles of cooperation and collective action. 4 = (Almost) all actors of the concerning actor group were very familiar with principles of cooperation and collective action.	Bhuyan, 2007; Azadi et al., 2010	metric [0..4]
E.I.a3i	KNOWL COLLAB PRINCIPLES FARMERS	Individual farmers		

E.I.a3ii	KNOWL COLLAB PRINCIPLES FARMER ASSOC	Farmer associations		
E.I.a3iii	KNOWL COLLAB PRINCIPLES PROCESSORS	Processors		
E.I.a3iv	KNOWL COLLAB PRINCIPLES PRIV OTH	Other private businesses		
E.I.a3v	KNOWL COLLAB PRINCIPLES GEN ADMIN	Governmental actors of the general administration		
E.I.a3vi	KNOWL COLLAB PRINCIPLES SPECIAL TASK	Public bodies with special tasks		
E.I.a3vii	KNOWL COLLAB PRINCIPLES CIV	Civil society actors		
E.I.a3viii	KNOWL COLLAB PRINCIPLES RES EDU	Research & education actors		
E.I.a3ix	KNOWL COLLAB PRINCIPLES CIT	Citizens		
E.I.a4	ACTOR COLLAB SKILLS	Indicate the degree to which the involved actors of the following types had already had experience with collaboration with other actors for joint activities and had therefore had the opportunity to improve their skills needed for such activities. If there are several actors of one type, consider the one with the highest level of skills: 0 = No or very few actors of the concerning actor group were experienced in collaboration and collective action. 4 = Most or all actors of the concerning actor group were experienced in in collaboration and collective action.	Oerlemans and Assouline, 2004; Mburu and Wale, 2006; Shiferaw et al., 2011	metric [0..4]
E.I.a4i	COLLAB SKILLS FARMERS	Individual farmers		

E.I.a4ii	COLLAB SKILLS FARMER ASSOC	Farmer associations		
E.I.a4iii	COLLAB SKILLS PROCESSORS	Processors		
E.I.a4iv	COLLAB SKILLS PRIV OTH	Other private businesses		
E.I.a4v	COLLABO SKILLS GEN ADMIN	Governmental actors of the general administration		
E.I.a4vi	COLLAB SKILLS SPECIAL TASK	Public bodies with special tasks		
E.I.a4vii	COLLAB SKILLS CIV	Civil society actors		
E.I.a4viii	COLLAB SKILLS RES EDU	Research & education actors		
E.I.a4ix	COLLAB SKILLS CIT	Citizens		
E.I.a5	CAPACITY-BUILDING	Did the intervention include efforts to enhance the skills of the involved actors (e.g. monitoring techniques, technical skills, organizational skills) in order to enhance their capacities and/or to close non-financial resource gaps? 0 = The intervention did not include capacity-building efforts. 4 = capacity-building played a crucial role in the realization of the intervention.	Shiferaw et al., 2011; Gyau et al., 2012; Burandt et al., 2013; Dyer et al., 2013; Measham and Lumbasi, 2013; Prager, 2015	metric [0..4]
D.III.b Attitudes				
E.I.b1	AWARE PROBLEM INIT	Indicate the degree to which the involved actors were aware of the problem(s) at the heart of the intervention at its outset: 0 = None or very few of the involved actors were aware of the problem(s). 4 = (Almost) all of the involved actors were aware of the problem(s).	Lubell and Fulton, 2007; Prager, 2015	metric [0..4]

E.I.b2	AWARE PROBLEM END	Indicate the degree to which the involved actors were aware of the problem(s) at the heart of the intervention at its end or at the latest known point in time: 0 = None or very few of the involved actors were aware of the problem(s). 4 = (Almost) all of the involved actors were aware of the problem(s).	Lubell and Fulton, 2007; Prager, 2015	metric [0..4]
E.I.b3	VALUES ENVIRON INIT	Indicate the strength of environmental values held by the involved actors at the outset of the intervention: 0 = Conservation of environmental values was of low importance to all or most of the involved actors. 4 = Conservation of environmental values was of great importance to all or most of the involved actors.	Lubell and Fulton, 2007	metric [0..4]
E.I.b4	VALUES ENVIRON END	Indicate the strength of environmental values held by the involved actors at the end of the intervention or at the latest known point in time: 0 = Conservation of environmental values was of low importance to all or most of the involved actors. 4 = Conservation of environmental values was of great importance to all or most of the involved actors.	Lubell and Fulton, 2007	metric [0..4]
E.I.b5	PAST EXPERIENCE	Did the involved actors have positive/successful or negative/unsuccessful past experiences with collaboration? -4 = All or most of the actors had negative/unsuccessful past experiences with collaboration. 0 = The involved actors did not have any past experiences with collaboration or past experiences of the involved actors were mixed and were to more or less equal parts positive and negative. 4 = All or most of the actors had positive/successful past experiences with collaboration.	Agrawal, 2001; Lamprinopoulou et al., 2006	metric [-4..4]
E.I.b6	COMMITMENT COLLABORATION INIT	Indicate the degree to which the involved actors had faith in and were committed to collaborative principles at the outset of the intervention:	Wadsworth, 2001; Oerlemans and Assouline, 2004; Lamprinopoulou et al., 2006;	metric [-4..4]

		-4 = All or most of the involved actors doubted the effectiveness of collaboration and collective action. 0 = The involved actors were neither convinced of principles of collaboration and collective action nor did they doubt them or attitudes towards collaboration were mixed with more or less equal parts of actors being convinced of and actors doubting the effectiveness of collaboration and collective action. 4 = All or most of the involved actors were convinced of and committed to principles of collaboration and collective action.	Azadi et al., 2010	
E.I.b7	COMMITMENT COLLABORATION END	Indicate the degree to which the involved actors had faith in and were committed to collaborative principles at the end of the intervention or at the latest known point in time: -4 = All or most of the involved actors doubted the effectiveness of collaboration and collective action. 0 = The involved actors were neither convinced of principles of collaboration and collective action nor did they doubt them or attitudes towards collaboration were mixed with more or less equal parts of actors being convinced of and actors doubting the effectiveness of collaboration and collective action. 4 = All or most of the involved actors were convinced of and committed to principles of collaboration and collective action.	Wadsworth, 2001; Oerlemans and Assouline, 2004; Lamprinopoulou et al., 2006; Ingram et al., 2008; Azadi et al., 2010	metric [-4..4]
E.I.b8	MOTIVATION INIT	Indicate the degree to which the involved actors were motivated to achieve something together and participate actively in the realization of the intervention at its outset: 0 = All or most of the involved actors were little motivated to achieve something together and/or refused to participate actively. 4 = All or most of the involved actors were very motivated to achieve something together and participate actively.	Wadsworth, 2001; Clark, 2006; Bhuyan, 2007; Azadi et al., 2010; Burandt et al., 2013; Dyer et al., 2013; Ramdwar et al., 2013	metric [0..4]

E.I.b9	MOTIVATION END	Indicate the degree to which the involved actors were motivated to achieve something together and participate actively in the realization of the intervention at its end or at the latest known point in time: 0 = All or most of the involved actors were little motivated to achieve something together and/or refused to participate actively. 4 = All or most of the involved actors were very motivated to achieve something together and participate actively.	Wadsworth, 2001; Clark, 2006; Bhuyan, 2007; Azadi et al., 2010; Burandt et al., 2013; Dyer et al., 2013; Ramdwar et al., 2013	metric [0..4]
E.I.b10	SATISFACTION	How satisfied were the involved actors with the intervention? 0 = The involved actors were unsatisfied. 4 = Most of the involved actors were very satisfied.	Azadi et al., 2010	metric [0..4]
E.I.b11	LOYALTY	How loyal were the involved actors to the intervention? For example did all the involved actors/members sell all of their produce to the cooperative or to other buyers? Or did a noteworthy number of actively involved actors decide to quit their membership/commitment in the intervention? 0 = The involved members were hardly loyal. 4 = (Almost) all involved actors were loyal to the intervention.	Bhuyan, 2007	metric [0..4]
E.I.c Economic assets of non-state actors				
E.I.c1	NON-STATE ACTOR ECONOMIC SITUATION	What was the financial situation of the involved non-state actors at the outset of the intervention? -4 = All or most involved non-state actors were very poor and/or had economically inviable businesses. 0 = All or most involved non-state actors had a stable financial situation (they were neither rich nor poor) and/or had economically stable but not very profitable businesses or there were more or less equal parts of rich and poor actors. 4 = All or most involved non-state actors were financially well-situated and/or had profitable businesses.	Agrawal, 2001; Carlberg et al., 2003; Lubell and Fulton, 2007	metric [-4..4]

E.I.c2	NON-STATE ACTOR FINANCIAL RESOURCES	Indicate the degree to which involved non-state actors themselves were able to provide financial resources for the realization of the intervention: 0 = The involved non-state actors were able to provide no or few financial resources. 4 = The involved non-state actors were able to provide substantial financial resources.	Dyer et al., 2013	metric [0..4]
E.II Characteristics of the group of involved actors				
E.II.a Group size and composition				
E.II.a1	GROUP SIZE INIT	Inform the number of actively involved actors at the outset of the intervention. If no exact number is available, estimate the number. Include all actors whose involvement was coded greater than 0 in variables B14 to B18.	Schlager, 1995; Ayer, 1997; Agrawal, 2001; Bhuyan, 2007; Mills et al., 2011; Ramdwar et al., 2013; Totin et al., 2014; Prager, 2015	Number
E.II.a2	GROUP SIZE END	Inform the number of actively involved actors at the end of the intervention or the latest known point in time. If no exact number is available, estimate the number. Include all actors whose involvement was coded greater than 0 in variables B14 to B18.	Schlager, 1995; Ayer, 1997; Agrawal, 2001; Bhuyan, 2007; Mills et al., 2011; Ramdwar et al., 2013; Totin et al., 2014; Prager, 2015	Number
E.II.a3	GROUP DIVERSITY INIT	Indicate the degree of diversity and heterogeneity of the attributes of the involved individuals (e.g. regarding their age, gender, education, profession, experience, financial situation etc.) at the outset of the intervention: 0 = The group was quite homogeneous. 4 = The group was heterogeneous with regard to many attributes.	Agrawal, 2001; Newman and Dale, 2007; Azadi et al., 2010; Markelova and Mwangi, 2010; Shiferaw et al., 2011; Isaac, 2012; Dyer et al., 2013; Ramdwar et al., 2013; Totin et al., 2014	metric [0..4]
E.II.a4	GROUP DIVERSITY END	Indicate the degree of diversity and heterogeneity of the attributes of the involved individuals (e.g. regarding their age, gender, education, profession, experience, financial situation etc.) at the end of the intervention or at the latest known point in time: 0 = The group was quite homogeneous. 4 = The group was heterogeneous with regard to many attributes.	Agrawal, 2001; Newman and Dale, 2007; Azadi et al., 2010; Markelova and Mwangi, 2010; Shiferaw et al., 2011; Isaac, 2012; Dyer et al., 2013; Ramdwar et al., 2013; Totin et al., 2014	metric [0..4]

E.II.a5	INCLUSIVENESS	Indicate the degree to which all parties that were interested in participating and/or for whom participation was feasible were represented in the group: 0 = The group was highly exclusive. 4 = The group was inclusive, i.e. all parties that were interested and/or that could be involved were represented.	Shiferaw et al., 2011; Dyer et al., 2013	metric [0..4]
E.II.a6	ACTOR RESOURCE COMPLEMENTARITY	Indicate to which degree the non-financial resources of the involved actors (e.g. skills, knowledge, experience, contacts) complemented each other so all non-financial resources necessary for the intervention were available: 0 = Non-financial resource of the involved actors did not complement each other or did so only to a very low degree. 4 = Actors complemented each other with their non-financial resources (almost) perfectly.	Dyer et al., 2013	metric [0..4]
E.II.a7	POWERFUL INDIVIDUALS	Did the group involve influential and powerful individuals who could use their influence and power in favor of the intervention? Examples of such individuals: influential politician, owner of a big company, local champion, NGO leader etc.	Burandt et al., 2013	Bin [0/1]
E.II.a8	POWERFUL INDIVIDUAL TYPES	Indicate to which actor group(s) the powerful and influential individual(s) pertained (see variable D.III.a4). If POWERFUL INDIVIDUALS = 0, code n/a.		Qual
E.II.a9	ACTOR RENEWAL	Were actors that dropped out of the group realizing the intervention intentionally substituted by new actors?	Newman and Dale, 2007	Bin [0/1]
E.II.a10	MEMBERSHIP ELIGIBILITY	Were there clear criteria to decide if an actor was eligible to be involved in the intervention? 0 = There were no criteria that defined if an actor was eligible to be involved in the intervention. 4 = There were clear criteria that defined if an actor was eligible to be involved in the intervention.	Agrawal, 2001	metric [0..4]

E.II.b Social Capital: Shared norms, objectives, and perceptions				
E.II.b1	SHARED GOALS INIT	Indicate the degree to which the involved actors had the same interests and objectives at the outset of the intervention: 0 = The involved actors had no or very few common interests and objectives. 4 = The involved actors were very similar in their interests and goals.	Agrawal, 2001; Oerlemans and Assouline, 2004; Lamprinopoulou et al., 2006; Mills et al., 2011; Dyer et al., 2013; Ramdwar et al., 2013; Prager, 2015	metric [0..4]
E.II.b2	SHARED NORMS INIT	Indicate the degree to which the involved actors had the same norms, values and beliefs at the outset of the intervention: 0 = The involved actors had no or very few values, norms and beliefs in common. 4 = The involved actors had very similar norms, values and beliefs.	Schlager, 1995; Agrawal, 2001; Oerlemans and Assouline, 2004; Markelova and Mwangi, 2010; Mills et al., 2011; Dyer et al., 2013; Prager, 2015	metric [0..4]
E.II.b3	SHARED PERCEPTIONS INIT	Indicate to which degree the involved actors agreed about the nature of the issue and its causes at the outset of the intervention: 0 = The involved actors' perceptions of the issue and its causes diverged. 4 = The involved actors agreed mostly or completely on the issue and its causes.	Schlager, 1995; Lamprinopoulou et al., 2006; Prager, 2015	metric [0..4]
E.II.b4	SHARED PROCEDURES INIT	Indicate the degree to which the involved actors agreed on approach and procedures for the realization of the intervention at its outset: 0 = The involved actors disagreed about approach and procedures. 4 = The involved actors agreed mostly or completely on approach and procedures.	Oerlemans and Assouline, 2004	metric [0..4]
E.II.b5	SHARED GOALS END	Indicate the degree to which the involved actors had the same interests and objectives at the end of the intervention or at the latest known point in time:	Agrawal, 2001; Oerlemans and Assouline, 2004; Lamprinopoulou et al., 2006;	metric [0..4]

		0 = The involved actors had no or very few common interests and objectives. 4 = The involved actors were very similar in their interests and goals.	Mills et al., 2011; Dyer et al., 2013; Ramdwar et al., 2013; Prager, 2015	
E.II.b6	SHARED NORMS END	Indicate the degree to which the involved actors had the same norms, values and beliefs at the end of the intervention or at the latest known point in time: 0 = The involved actors had no or very few values, norms and beliefs in common. 4 = The involved actors had very similar norms, values and beliefs.	Schlager, 1995; Agrawal, 2001; Oerlemans and Assouline, 2004; Markelova and Mwangi, 2010; Mills et al., 2011; Dyer et al., 2013; Prager, 2015	metric [0..4]
E.II.b7	SHARED PERCEPTIONS END	Indicate to which degree the involved actors agreed about the nature of the issue and its causes at the end of the intervention or at the latest known point in time: 0 = The involved actors' perceptions of the issue and its causes diverged. 4 = The involved actors agreed mostly or completely on the issue and its causes.	Schlager, 1995; Lamprinopoulou et al., 2006; Prager, 2015	metric [0..4]
E.II.b8	SHARED PROCEDURES END	Indicate the degree to which the involved actors agreed on approach and procedures for the realization of the intervention at the end of the intervention or at the latest known point in time: 0 = The involved actors disagreed about approach and procedures. 4 = The involved actors agreed mostly or completely on approach and procedures.	Oerlemans and Assouline, 2004	metric [0..4]

E.II.b9	SOCIAL LEARNING	Did social learning (about technical issues, about group processes etc.) occur among the actors involved in the intervention? Social learning requires that 1) there is a change in understanding of the involved individuals; 2) there is a "change or understanding that goes beyond individuals or small groups to become situated within wider social units", i.e. "the ideas and attitudes learned by members of the small group must diffuse to members of the wider social units or communities of practice to which they belong"; 3) learning occurs through social interaction of members of a network (Reed et al., 2010). 0 = No significant social learning occurred in the context of the intervention. 4 = High levels of social learning occurred in the context of the intervention.	Oerlemans and Assouline, 2004; Lubell and Fulton, 2007	metric [0..4]
E.II.c Social Capital: relations and trust				
E.II.c1	EXT REL	Indicate to which degree the involved actors already had direct relations to each other as a result of prior interactions of any kind (e.g. from former common projects, through informal relations etc.). If there are several actors of one type, consider the one with the highest degree of pre-existing relations: 0 = The involved actors did not have any direct relations to each other. 4 = All involved actors had strong relations to each other, i.e. their prior interaction was of high intensity. Please code whether relations existed both within the actor groups and between the actor groups.	Lamprinopoulou et al., 2006; Ingram et al., 2008; Mills et al., 2011; Prager, 2015	metric [0..4]

	Individual farmers								
Individual farmers	E.II.c1i	*Farmer associations*							
Farmer associations	E.II.c1ii	E.II.c1x	*Processors*						
Processors	E.II.c1iii	E.II.c1xi	E.II.c1xviii	*Other private businesses*					
Other private businesses	E.II.c1iv	E.II.c1xii	E.II.c1xix	E.II.c1xxv	*Governmental actors of the general administration*				
Governmental actors of the general administration	E.II.c1v	E.II.c1xiii	E.II.c1xx	E.II.c1xxvi	E.II.c1xxxi	*Public bodies with special tasks*			
Public bodies with special tasks	E.II.c1vi	E.II.c1xiv	E.II.c1xxi	E.II.c1xxvii	E.II.c1xxxii	E.II.c1xxxvi	*Civil society actors*		
Civil society actors	E.II.c1vii	E.II.c1xv	E.II.c1xxii	E.II.c1xxviii	E.II.c1xxxiii	E.II.c1xxxvii	E.II.c1xl	*Research & education actors*	
Research & education actors	E.II.c1viii	E.II.c1xvi	E.II.c1xxiii	E.II.c1xxix	E.II.c1xxxiv	E.II.c1xxxviii	E.II.c1xli	E.II.c1xliii	*Citizens*
Citizens	E.II.c1ix	E.II.c1xvii	E.II.c1xxiv	E.II.c1xxx	E.II.c1xxxv	E.II.c1xxxix	E.II.c1xlii	E.II.c1xliv	E.II.c1xlv

E.III.c2	NETWORK DENSITY INIT	Indicate the density of relations among the actively involved actors at the outset of the intervention. Network density is a "measure of existing ties as a percentage of all possible ties" (Isaac, 2012, p. 10) between the actors that are involved in the intervention in its initial phase. A "tie" is a direct relation between two actors.	Isaac, 2012	metric [0..4]

		0 = Network density was very low; there existed only few direct relations between the actors. 4 = Network density was high; all or most of the actors had direct relations to many of the other actors.		
E.III.c3	NETWORK DENSITY END	Indicate the density of relations among the actively involved actors at the end of the intervention or at the latest known point in time. 0 = Network density was very low; there existed only few direct relations between the actors. 4 = Network density was high; all or most of the actors had direct relations to many of the other actors.	Isaac, 2012	metric [0..4]
E.II.c4	COMMON IDENTITIES	Indicate the degree to which the involved actors had a common identity. Were they part of the same or very different cultures? Did they have very similar or different professional backgrounds? Did they come from similar or different places? etc. 0 = The involved actors came from very different backgrounds and had very different identities. 4 = All or most of the involved actors came from similar backgrounds and had similar identities.	Mills et al., 2011; Burandt et al., 2013	metric [0..4]
E.II.c5	TRUST INIT	Indicate the degree of trust among the involved actors at the outset of the intervention. “Trust is the willingness to accept vulnerability based on positive expectations about another’s intentions or behaviors” (McEvily et al., 2003). “Levels of trust likely depend on the existence of a prehistory of either antagonism or cooperation among [involved actors]. Where there is no prehistory of interaction, there is possibly (but not necessarily) neither trust nor distrust among the parties.” (Newig et al., 2013) If there are several actors of one type, consider the one with the highest level of trust:	Schlager, 1995; Mburu and Wale, 2006; Azadi et al., 2010; Shiferaw et al., 2011; Dyer et al., 2013; Prager, 2015	metric [-4..4]

		-4 = There was a high level of distrust among the involved actors. 0 = There was neither trust nor distrust among the involved actors. 4 = There was a high level of trust among the involved actors. Please code the level of trust for both within the actor groups and between the actor groups (see variable D.IV.c1).		
E.II.c6	TRUST END	Indicate the degree of trust among the involved actors at the end of the intervention or at the latest known point in time. If there are several actors of one type, consider the one with the highest level of trust: -4 = There was a high level of distrust among the involved actors. 0 = There was neither trust nor distrust among the involved actors. 4 = There was a high level of trust among the involved actors. Please code the level of trust for both within the actor groups and between the actor groups (see variable D.IV.c1).	Mburu and Wale, 2006; Lubell and Fulton, 2007; Newman and Dale, 2007; Ingram et al., 2008; Azadi et al., 2010; Mills et al., 2011; Shiferaw et al., 2011; Dyer et al., 2013; Ramdwar et al., 2013; Prager, 2015	metric [-4..4]
E.II.d Competition and conflict				
E.II.d1	ACTOR COMPETITION	Indicate the degree to which actors actively involved with the intervention competed with each other (in economic and other terms): 0 = There was no or only a very low level of competition among the involved actors. 4 = There was strong competition among many of the involved actors.	Lamprinopoulou et al., 2006; Azadi et al., 2010; Ramdwar et al., 2013	metric [0..4]
E.II.d2	CONFLICT INIT	Indicate the degree to which there was any kind of conflict between the involved actors at the outset of the intervention:	Ramdwar et al., 2013	metric [0..4]

		0 = There was (almost) no conflict of any sort between involved actors. 4 = There were high levels of conflict between involved actors.		
E.II.d3	CONFLICT END	Indicate the degree to which there was any kind of conflict between the involved actors at the end of the intervention or at the latest known point in time: 0 = There was (almost) no conflict of any sort between involved actors. 4 = There were high levels of conflict between involved actors.	Ramdwar et al., 2013	metric [0..4]
E.II.e Group dysfunctions				
E.II.e1	POWER IMBALANCE	Did all involved actors have an equal say in the realization of the intervention or did some actors have privileges and more influence in the realization of the intervention. 0 = All involved actors had more or less the same influence on the realization of the intervention. 4 = Some of the involved actors had much more influence on the way the intervention was realized than others.	Dyer et al., 2013; Ramdwar et al., 2013; Totin et al., 2014	metric [0..4]
E.II.e2	TAKE OVER	Did any individual actors try to or succeed in taking over the intervention to promote their own interests? 0 = No attempts to take over the intervention for the promotion of own interests was made. 4 = Individual actors were able to (almost) completely take over the intervention and use it for their own purposes.	Shiferaw et al., 2011; Ramdwar et al., 2013	metric [0..4]
E.II.e3	CORRUPTION	Did corruption occur among the involved actors?	Shiferaw et al., 2011	Bin [1/0]
RELATED TO ORGANIZATION & MANAGEMENT				
E.III Structure and organization of the intervention				
D.III.a Group formation				
E.III.a1	KEY INITIATING ACTOR	Was there an individual or a nucleus of initiators who could be characterized as skilled, determined and pro-active?	Lamprinopoulou et al., 2006; Burandt et al., 2013; Prager, 2015	Bin [1/0]

E.III.a2	FEASIBILITY STUDY	Was a feasibility study carried out before the actual initiation of the intervention?	Carlberg et al., 2003	Bin [1/0]
E.III *b Tasks and objectives*				
E.III.b1	DEFINED OBJECTIVES	Indicate to which degree the tasks and objectives of the intervention were clearly defined: 0 = At no point in time, the tasks and objectives of the intervention were clearly and explicitly defined. 4 = All tasks and objectives were explicitly and clearly defined.	Dyer et al., 2013; Measham and Lumbasi, 2013	metric [0..4]
E.III.b2	ACTOR AWARE OBJECTIVES	Where all involved actors aware of the objectives of the intervention? 0 = Few involved actors were aware of the actual objectives of the intervention. 4 = (Almost) all involved actors knew and were aware of (almost) all objectives of the intervention.	Clark, 2006	metric [0..4]
E.III.b3	INCENTIVE FOR OBJECTIVE	Did the objectives of the intervention provide economic and/or other kinds of positive benefits relative to other options, i.e. were the benefits potentially derived from or paid for pursuing the objectives of the intervention higher than the opportunity costs for the involved actors? -4 = There was very little incentive to pursue the objectives of the intervention because opportunity costs were much higher than potential benefits. 0 = The potential benefits and opportunity costs of pursuing the objectives of the intervention were more or less equal. 4 = There was high incentive to pursue the objectives of the intervention because opportunity costs were much lower than potential benefits.	Measham and Lumbasi, 2013; Prager, 2015	metric [-4..4]
E.III.b4	OBJECTIVES RANGE	How many objectives did the intervention pursue and how varied were these objectives?	Bhuyan, 2007; Newman and Dale, 2007; Shiferaw et al., 2011	metric [0..4]

		0 = The intervention concentrated on few tasks and objectives of similar character. 4 = The intervention pursued a great range of varied objectives.		
E.III.b5	OBJECTIVES RELEVANCE	How relevant are the objectives of the intervention to the needs of the stakeholders and especially to the involved actors? 0 = The objectives are of low relevance to stakeholders. 4 = The objectives are highly relevant to the stakeholders.	Dyer et al., 2013; Measham and Lumbasi, 2013	metric [0..4]
E.III.b6	OBJECTIVES COMPATIBILITY	Are the objectives and activities of the intervention compatible with existing livelihoods and/or usual activities of the involved actors (e.g. are they able to carry out the activities without having to change much about their land-use)? 0 = The objectives and activities of the intervention are highly incompatible with existing livelihoods of the involved actors (e.g. they require the involved actors to fundamentally change their income-generating activities). 4 = The objectives and activities are mostly compatible with the livelihoods of (almost) all involved actors (e.g. they do not change much about their income-generating activities).	Measham and Lumbasi, 2013	metric [0..4]
E.III.b7	OBJECTIVES BALANCE	Indicate to which extend there is a balance between individual goals of the involved actors and collective goals in the goals of the intervention: -4 = The goals are very unbalanced and strongly favor individual goals over collective goals. 0 = The objectives of the intervention are more or less balanced between individual and collective goals. 4 = The goals are very unbalanced and strongly favor collective goals over individual goals	Oerlemans and Assouline, 2004	metric [-4..4]

E.III.b8	OBJECTIVES COMPLEXITY	Indicate the degree to which the objectives of the intervention were complex, i.e. difficult to understand, requiring much knowledge and many different skills, and challenging in organizational terms: 0 = The objectives of the intervention were of low complexity. 4 = The objectives of the intervention were of high complexity.	Newman and Dale, 2007	metric [0..4]
E.III.b9	OBJECTIVES REALISTIC	Indicate the degree to which the objectives of the intervention were achievable given all circumstances of the intervention: 0 = The objectives of the intervention could hardly be achieved. 4 = (Almost) all of the objectives were well achievable.	Mburu and Wale, 2006	metric [0..4]
E.III.b10	OBJECTIVES TIME	Was the time allotted for the introduction of and adaptation to new practices, the achievement of the objectives, etc. sufficient? 0 = Even without any major problems or delays, the time allotted was too short. 4 = The allotted time was sufficient.	Agrawal, 2001; Dyer et al., 2013	metric [0..4]
E.III.c Enabling Collaboration				
E.III.c1	INCENTIVE FOR COLLABORATION	Did the intervention provide economic and/or other kinds of positive benefits for collaboration, i.e. were the benefits expected with collaboration higher than the benefits expected with individual action? Examples for such incentives for collaboration are: • Actors involved in the intervention get exclusive benefits (financial or non-financial) which not-involved actors do not get. • A threat of top-down government regulation can be averted by collaborative action. • The group is a source of social capital for the involved actors etc.	Schlager, 1995; Ayer, 1997; Newman and Dale, 2007; Ingram et al., 2008; Shiferaw et al., 2011; Burandt et al., 2013; Dyer et al., 2013; Prager, 2015	metric [-4..4]

		-4 = There was very little incentive to collaborate because expected benefits from individual action were much higher than benefits expected from collaborative action. 0 = The expected benefits from collaborative action and from individual action were more or less equal. 4 = There was high incentive to collaborate because expected benefits from individual action were much lower than benefits expected from collaborative action.		
E.III.c2	COLLABORATION TRANSACTION COSTS	How much monetary and non-monetary transaction costs for participating in the intervention did the involved actors have to face (i.e. information, transformation, and enforcement costs)? 0 = Transaction costs for collaboration were low. 4 = Transaction costs for collaboration were high.	Schlager, 1995; Prager, 2015	metric [0..4]
E.III.d Communication and interaction				
E.III.d1	COM INTENS	Indicate how frequently and substantively communication occurred among the involved actors. If there are several actors of one type, consider the one with the highest communication intensity: 0 = Information was rarely distributed and/or the involved actors rarely communicated with each other and/or the information/the topics are of low relevance to the intervention. 4 = Information was frequently distributed and/or the involved actors communicated with each other frequently and/or the provided information/the topics were of high relevance to the intervention. Please code communication intensity for both within the actor groups and between the actor groups (see variable D.IV.c1).	Ayer, 1997; Wadsworth, 2001; Carlberg et al., 2003; Clark, 2006; Bhuyan, 2007; Burandt et al., 2013; Dyer et al., 2013; Ramdwar et al., 2013; Prager, 2015	metric [0..4]
E.III.d2	COMMUNICATION CHANNEL VARIETY	Were activities and communication related to the intervention conducted in a variety of diverse but interacting forms (physical meetings, planned tours, newsletters, online chat rooms etc.)?	Wadsworth, 2001; Newman and Dale, 2007	metric [0..4]

		0 = Very few different forms of communication and interaction were used. 4 = Many different forms of communication and interaction were used		
E.III.d3	FACE-TO-FACE	How often did the involved actors interact in face-to-face settings? 0 = The actors never or very rarely met face-to-face and/or only single actors interacted face-to-face with each other. 4 = There were frequent face-to-face meetings with (almost) all actors.	Wadsworth, 2001; Clark, 2006; Lubell and Fulton, 2007; Burandt et al., 2013	metric [0..4]
E.III.d4	ACTOR INTERDEPENDENCE	Indicate the degree to which the involved actors needed each other to be able to carry out activities related to the intervention. If the actors were dependent on each other to varying degrees, consider the highest existing degree of interdependence: 0 = The involved actors were rather independent from each other, e.g. they mainly acted on their own and only exchanged some relevant information with each other. 4 = The involved actors needed each other's knowledge, skills, decisions, support etc. for most of the activities they carried out or they had to coordinate most of their activities with other involved actors.	Agrawal, 2001; Dyer et al., 2013	metric [0..4]
E.III.d5	CORE GROUP	Was there a central committee of few actors where the main interaction occurred with each of the actors of this committee communicating with a further group of actors in a certain locality, of a certain profession etc.?	Ayer, 1997; Clark, 2006; Mills et al., 2011	Bin [1/0]
E.III.e Distribution of benefits				
E.III.e1	IDENT BENEFITS	Could individuals who benefitted from the activities of the intervention clearly be identified? 0 = Individuals benefiting from the activities of the intervention could hardly be identified. 4 = (Almost) all individuals benefiting from the activities of the intervention could be clearly identified.	Schlager, 1995	metric [0..4]

E.III.e2	BENEFITS DISTRIBUTION	Were benefits derived from the intervention distributed in a fair and equitable way (e.g. benefits were distributed proportionally to the contribution each actor made to the activities or the achievement of the objectives of the intervention)? 0 = The distribution of benefits was hardly fair and equitable. 4 = The distribution of benefits was very fair and equitable.	Schlager, 1995; Agrawal, 2001; Ramdwar et al., 2013	metric [0..4]
E.III.f Internal decision-making and participation				
E.III.f1	EARLY PARTICIPATION	How broad was the range of actors that participated in important decisions concerning the intervention since the beginnings of the intervention and therefore had influence on the nature of the intervention? 0 = Very few of the involved actors participated in and influenced decisions about the nature of the intervention at its outset. 4 = Most of the involved actors participated in and influenced decisions about the nature of the intervention at its outset.	Dyer et al., 2013	metric [0..4]
E.III.f2	DECISION-MAKING MODE	Indicate which mode of decision-making was mainly used for important internal decisions of the intervention: 0 = autocratic decisions (i.e. one individual or one actor decides). 1 = minority decisions (i.e. a small group of actors decides). 2 = majority vote (i.e. a majority of the involved actors agrees to the decision). 3 = relatively broad consensus (i.e. as many involved actors as possible agree on the decision). 4 = unanimity (i.e. every involved actor has the right to veto). (adapted from Newig et al., 2013)	Schlager, 1995; Oerlemans and Assouline, 2004; Mburu and Wale, 2006; Newman and Dale, 2007; Shiferaw et al., 2011	ordinal [0..4]
E.III.f3	PARTICIPATION COMMUNICATION	For major decisions concerning the intervention, to which degree were involved actors provided with or granted access to information relevant to such a decision by those actors who had control over this information?	Schlager, 1995; Oerlemans and Assouline, 2004; Mburu and Wale, 2006; Newman and Dale, 2007; Shiferaw et al., 2011	metric [0..4]

		0 = The majority of the involved actors were not provided with or did not have access to information. 4 = (Almost) all involved actors were provided with or had access to all relevant information. (adapted from Newig et al., 2013)		
E.III.f4	PARTICIPATION CONSULTATION	For important decisions concerning the intervention, to which degree could involved actors provide all the input they considered relevant for such a decision to those actors preparing or taking the decision? 0 = The involved actors could not provide input or only to a negligible degree. 4 = (Almost) all involved actors had the possibility to provide (almost) all the input they considered relevant. (adapted from Newig et al., 2013)	Schlager, 1995; Oerlemans and Assouline, 2004; Mburu and Wale, 2006; Newman and Dale, 2007; Shiferaw et al., 2011	metric [0..4]
E.III.f5	PARTICIPATION DIALOGUE	For important decisions concerning the intervention, to which degree could involved actors engage in dialogue about knowledge and opinions relevant to such a decision with each other and/or with the actors preparing or taking the decision? Dialogue goes beyond the one-way participation of communication and consultation and requires a two-way exchange of information. 0 = There was a low degree of information flow between the involved actors. 4 = There was intense information flow between (almost) all of the involved actors. (adapted from Newig et al., 2013)	Schlager, 1995; Oerlemans and Assouline, 2004; Mburu and Wale, 2006; Newman and Dale, 2007; Shiferaw et al., 2011	metric [0..4]
E.III.f6	INFLUENCE	For important decisions concerning the intervention, to which degree did the needs and wants expressed by the broad range of involved actors usually determine the final decision?	Bhuyan, 2007	metric [0..4]

		0 = The final decision was usually determined by the needs and wants of the broad range of involved actors only to a low degree. 4 = The final decision was usually determined by the needs and wants of the broad range of involved actors to a high degree.		
E.III.f7	PARTICIPATION MODE SKILL CONTRIBUTION	Did the usual mode of participation allow the involved actors to contribute all of their relevant skills and expertise? 0 = With the usual mode of participation, the involved actors could hardly contribute their relevant skills and expertise. 4 = (Almost) all involved actors could contribute (almost) all of their relevant skills and expertise.	Dyer et al., 2013	metric [0..4]
E.III.g Internal rules & enforcement				
E.III.g1	RULES EXISTENCE	Does the intervention have clear, stable and standardized rules, procedures and structures? 0 = The intervention had no or very few explicit rules. 4 = The intervention had and adequate system of clear and standardized rules, procedures, and structures.	Oerlemans and Assouline, 2004; Markelova and Mwangi, 2010; Shiferaw et al., 2011	metric [0..4]
E.III.g2	RULES SIMPLICITY	Were the rules simple and easy to understand? 0 = The rules of the intervention were very complex and hard to understand. 4 = Most of the rules of the intervention were simple and easy to understand.	Agrawal, 2001	metric [0..4]
E.III.g3	RULES LOCAL	Were the rules, procedures and structures of the intervention devised locally/ by the involved actors or imposed by external actors (e.g. government agencies)? 0 = All or most of the rules were imposed by external actors. 4 = The rules were (almost) completely devised by the involved actors.	Agrawal, 2001; Shiferaw et al., 2011	metric [0..4]
E.III.g4	RULES ADAPTED	Were the rules, procedures and structures of the intervention adapted to the individual conditions of the locality where the intervention was realized?	Shiferaw et al., 2011	metric [0..4]

		0 = The rules were rather generic and not adapted to the individual conditions. 4 = The rules were greatly adapted to the individual conditions.		
E.III.g5	RULES ADJUST	Could the involved actors decide to change and adjust the rules if necessary? 0 = The involved actors had no possibility to change and adapt the rules once they were adopted. 4 = The involved actors were completely free to change and adapt the rules if necessary.	Oerlemans and Assouline, 2004; Ramdwar et al., 2013	metric [0..4]
E.III.g6	RULES ENFORCABILITY	Indicate the degree to which the rules of the intervention were enforceable. Aside from the existence of enforcement mechanisms (sanctions and rewards, see variable ENFORCEMENT MECHANISMS), this includes that the rules have prescribed, explicit targets/limits and that it is possible to monitor/verify compliance. 0 = Rules were hardly enforceable. 4 = (Almost) all rules were enforceable.	Agrawal, 2001	metric [0..4]
E.III.g7	ENFORCEMENT MECHANISMS	Does the intervention have effective mechanisms to enforce its internal rules? 0 = No mechanisms to enforce the rules of the intervention had been devised. 4 = There are effective enforcement mechanisms for (almost) all binding rules of the intervention.	Carlberg et al., 2003; Lamprinopoulou et al., 2006; Ingram et al., 2008; Markelova and Mwangi, 2010; Shiferaw et al., 2011; Totin et al., 2014	metric [0..4]
E.III.g8	GRADUATED SANCTIONS	Are the sanctions graduated so different levels of sanctions can be imposed according to the graveness of rule violation? 0 = Sanctions are not graduated. 4 = (Almost) all sanctions are graduated.	Schlager, 1995; Agrawal, 2001	metric [0..4]
E.III.g9	ENFORCEMENT INTERNAL	Is monitoring for compliance and enforcement carried out by actors actively involved in the intervention themselves (rather than by external bodies)?	Schlager, 1995; Ayer, 1997; Mills et al., 2011	metric [0..4]

		0 = Enforcement is not carried out by actors involved in the intervention. 4 = Enforcement is mostly carried out by actors involved in the intervention.		
E.III.g10	EXTERNAL ADJUDICATION	Do the actors actively involved in the intervention have access to low-cost local adjudication to resolve conflicts that cannot be resolved internally? 0 = The involved actors do not have access to adjudication. 4 = The involved actors have access to low-cost local adjudication.	Schlager, 1995; Agrawal, 2001	metric [0..4]
E.III.h Monitoring & accountability				
E.III.h1	MONITORING	Does the intervention include regular and transparent monitoring and evaluation of the activities and expenses occurring in relation to the intervention? 0 = The intervention is (almost) never monitored and evaluated. 4= All relevant aspects of the intervention are monitored on a regular basis.	Schlager, 1995; Oerlemans and Assouline, 2004; Shiferaw et al., 2011; Prager, 2015	metric [0..4]
E.III.h2	FEEDBACK	To which degree are the results of the monitoring efforts made available to all involved actors? 0 = Monitoring results were usually not made available. 4 = All monitoring results were made available to the involved actors.	Prager, 2015	metric [0..4]
E.III.h3	ACCOUNTABILITY	To which degree do leaders and managers of the intervention assume responsibility for the activities, expenses, and consequences arising from them? 0 = Leaders and managers did not assume responsibility for any activities or consequences. 4 = (Almost) all leaders and managers assumed responsibility for activities and consequences.	Schlager, 1995; Agrawal, 2001; Markelova and Mwangi, 2010; Shiferaw et al., 2011; Ramdwar et al., 2013	metric [0..4]

		Note: This variable can be attributed a code greater than 0 even if no monitoring was conducted because it also refers to the assumption of responsibility for (positive and negative) consequences, which can become apparent even without monitoring.		
E.III.i Leader characteristics				
E.III.i1	LEADERS AGE	How old was/were the leader(s)? 0 = The leader(s) was/were under 50 years old. 1 = In case of a group of leaders: Ages of the leaders were mixed, there were both individuals of less and individuals of more than 50 years of age. 2 = The leader(s) was/were over 50 years old.	Agrawal, 2001	nominal [0..2]
E.III.i2	LEADERS EDUCATION	Indicate the level of formal education of the leader(s): 0 = All leaders had a low level of formal education (e.g. they went to school only for few years or had very basic school education). 4 = All leaders had a high level of formal education (e.g. university degree, advanced professional training)	Azadi et al., 2010	metric [0..4]
E.III.i3	LEADERS KNOWLEDGE COLLABORATIVE PRINCIPLES	Indicate the degree to which the leaders knew of and understood principles of cooperation and collective action (e.g. from their professional background, former experiences etc.) 0 = The leaders were not familiar with principles of cooperation and collective action. 4 = (Almost) all leaders were very familiar with principles of cooperation and collective action.	Azadi et al., 2010	metric [0..4]
E.III.i4	LEADERS COMMITMENT COLLABORATION	Indicate the degree to which the leader(s) had faith in and was/were committed to collaborative principles: -4 = All or most of the leaders doubted the effectiveness of collaboration and collective action. 0 = The leaders were neither convinced of principles of collaboration and collective action nor did they doubt them or attitudes towards collaboration were mixed with more or less equal parts of leaders being	Azadi et al., 2010; Burandt et al., 2013; Prager, 2015	metric [-4..4]

		convinced of and leaders doubting the effectiveness of collaboration and collective action. 4 = All or most of the leaders were convinced of and committed to principles of collaboration and collective action.		
E.III.i5	LEADERS MANAGEMENT SKILLS	Did the leader(s) have appropriate management skills? Management skills include • *technical skills*: "Ability to use methods, procedures, processes, tools, techniques, and specialized knowledge to perform specific tasks", • *analytic skills*: "Ability to identify key variables, see how they are interrelated, and decide which ones should receive the most attention", • *decision-making skills*: "Ability to choose effective solutions from among alternatives", • *human skills*: "Ability to work cooperatively with others, to communicate effectively, to motivate and train others, to resolve conflicts, and to be a team player", • *communication skills*: "Ability to send and receive information, thoughts, and feelings, which create common understanding and meaning", • *interpersonal skills* : "Ability to develop and maintain a trusting and open relationship with superiors, subordinates and peers to facilitate the free exchange of information and provide a productive work setting", • *conceptual skills* "Ability to see the organization as a whole and to solve problems from a systemic point of view", • *diagnostic skills*: "Ability to determine the probable cause of a problem from examining the symptoms which are observed by the manager",	Azadi et al., 2010; Shiferaw et al., 2011; Burandt et al., 2013; Prager, 2015	metric [0..4]

		• *flexible skills*: "Ability to deal with ambiguous and complex situations and rapidly changing demands", • *administrative skills*: "Ability to follow policies and procedures, process paper work in an orderly manner, and manage expenditures within the limits set by budgets" (Peterson and van Fleet, 2004, p. 1303) 0 = The leaders have a low level of management skills. 4 = (Almost) all leaders have a high level of management skills.		
E.III.i6	LEADERS TECHNICAL KNOWLEDGE	How much technical knowledge relevant to the issue(s) at the heart of the intervention did the leader(s) have? 0 = The leaders had a low level of knowledge relevant to the issue. 4 = (Almost) all leaders had a high level of technical knowledge relevant to the issue.	Carlberg et al., 2003; Azadi et al., 2010; Burandt et al., 2013	metric [0..4]
E.III.i7	LEADERS DIVERSITY	In case of a group of leaders: How heterogeneous were the leaders in their individual characteristics? 0 = The group of leaders is quite homogeneous. 4 = The group of leaders is heterogeneous with regard to many attributes. If only one leader existed, code 0.	Azadi et al., 2010	metric [0..4]
E.III.i8	LEADERS STATE ACTORS DEGREE	To which degree did state actors carry out leadership, organization and management of the intervention? 0 = The intervention was mainly self-organizing, i.e. involved non-state actors took on all or most of the organization and management of the intervention. If state actors were actively involved, they interfered sparsely or acted as partners equal to the non-state actors. 4 = The intervention was rather state-led, i.e. (some of the) state actors took on and carried out most of the leadership and management and acted as superiors to the involved non-state actors and other state actors.	Horlings, 1994; Agrawal, 2001; Oerlemans and Assouline, 2004; Lamprinopoulou et al., 2006; Newman and Dale, 2007; Ingram et al., 2008; Mills et al., 2011; Shiferaw et al., 2011; Dyer et al., 2013; Measham and Lumbasi, 2013; Ramdwar et al., 2013; Prager, 2015	metric [0..4]
E.III.i9	LEADERS STATE ACTORS ADEQUACY	Did state actors take on too much, too little, or the right amount of leadership and management in this intervention?	Agrawal, 2001; Lamprinopoulou et al., 2006; Ingram et al., 2008;	metric [-4..4]

		-4 = State actors carried out far too little leadership and management tasks, a much greater involvement of state actors in leadership and management of the intervention would have been beneficial. 0 = The level to which state actors took on and carried out leadership and management of the intervention was adequate. 4 = State actors carried out far too much leadership and management tasks, a much lower involvement of the state actors in leadership and management of the intervention would have been beneficial. Code n/a if no state-actors were actively involved.	Shiferaw et al., 2011; Dyer et al., 2013	
E.III.i10	LEADERS LOCAL CHAMPION	Were/ was the leader(s) local champion(s) at the outset of the intervention? A local champion is an individual which is highly regarded by many other individuals and actors in the concerning locality or region. 0 = None of the leaders is a local champion. 4 = All or most of the leaders are local champions.	Carlberg et al., 2003	metric [0..4]
E.III.i11	LEADERS NETWORK	Did the leader(s) possess intensive external network relations, especially to relevant external actors? 0 = The leaders had few external network relations to relevant actors. 4 = The leaders had many external network relations to relevant actors.	Agrawal, 2001; Clark, 2006	metric [0..4]
E.III.i12	LEADERS AGREEMENT	Was there agreement among the involved actors about who should be the leader(s)? 0 = There was little agreement about who should be the leader(s). 4 = Most involved actors agreed about who should be the leader(s).	Ramdwar et al., 2013	metric [0..4]
E.III.i13	LEADERS TRUST	Did the involved actors trust in the leader(s)? 0 = The involved actors had little trust in the leaders 4 = Most of the involved actors had trust in (almost) all the leaders.	Shiferaw et al., 2011; Ramdwar et al., 2013	metric [0..4]

E.III.i14	LEADERSHIP CONTINUITY	Was the leadership of the intervention continuous or did the leaders change with high frequency? 0 = The individuals in the position of the leader(s) changed quite often. 4 = There was (nearly) no change in leadership.	Carlberg et al., 2003	metric [0..4]
E.III.i15	LEADERSHIP ROTATION	In the cases where leadership changed, was this due to a planned rotation of the position of the leader(s)? If no significant change of leadership occurred, code 0.	Newman and Dale, 2007	Bin [0/1]
D.V.i16	LEADERS PAID	Did the main leader(s) have a paid position dedicated to leading the intervention?	Carlberg et al., 2003	Bin [0/1]
D.V.i17	LEADERS TRAINING	Did the leader(s) receive ongoing managerial training? 0 = The leaders did not receive noteworthy ongoing managerial training. 4 = (Almost) all the leaders received ongoing managerial training.	Carlberg et al., 2003	metric [0..4]
E.III.j Financial resources				
E.III.j1	FINANCIAL RESOURCES INIT	At its outset, did the intervention have overall sufficient financial resources for its realization? 0 = The financial resources of the intervention were clearly insufficient. 4 = The financial resources of the intervention were sufficient.	Azadi et al., 2010; Burandt et al., 2013	metric [0..4]
E.III.j2	FINANCIAL RESOURCES END	At its end or at the latest known point in time, did the intervention have overall sufficient financial resources for its realization? 0 = The financial resources of the intervention were clearly insufficient. 4 = The financial resources of the intervention were sufficient.	Azadi et al., 2010; Burandt et al., 2013	metric [0..4]
E.III.j3	DEBT	Did the intervention become indebted? 0 = The intervention had no significant debts. 4 = The intervention was severely indebted with little probability of paying back the debts.	Azadi et al., 2010	metric [0..4]

E.III.j 4	MEMBER CREDITS	Did the intervention provide adequate and timely credit facilities to the actors involved in it? 0 = The intervention did not provide noteworthy credit facilities to the involved actors. 4 = The intervention provided many adequate credit facilities to the involved actors.	Azadi et al., 2010	metric [0..4]
E.III.k Human resources				
E.III.k1	HUMAN RESOURCES AVAILABILITY	Did the intervention have sufficient labor force available (of both involved actors contributing labor and (possibly existing) paid employees)? 0 = The available manpower was insufficient. 4 = The available manpower was sufficient.	Prager et al., 2011; Burandt et al., 2013	metric [0..4]
E.III.k2	HUMAN RESOURCES QUALITY	What was the quality of the labor force of the intervention, i.e. did the employees and the actors contributing labor have the necessary knowledge, skills and capacities for the tasks they had to carry out? 0 = The labor force was of low quality. 4 = The labor force was of high quality.	Carlberg et al., 2003	metric [0..4]
E.III.l Relations to external actors				
E.III.l1	PERSONAL EXT CONTACTS	Did the involved actors (including the leaders) have any personal, rather informal contacts to individuals of not-actively involved actors that were important for the intervention (e.g. authorities, business partners)? 0 = No personal contacts to individuals of important external actors existed. 4 = Many personal contacts to individuals of important external actors existed	Isaac, 2012	metric [0..4]
E.III.l2	CONTACT OTHER COLLAB	Did the actors involved in this intervention have any kind of contact to actors involved in other, similar (successful) interventions? 0 = There was no contact to other interventions. 4 = There was intensive contact to other interventions.	Carlberg et al., 2003	metric [0..4]
E.III.l3	ALLIANCES	Did this intervention have an alliance or partnership with other not-actively involved actors or organizations?	Carlberg et al., 2003	metric [0..4]

		0 = There were no alliances with other actors or organizations. 4 = There were strong alliances to important other actors or organizations.		
E.III.m Other organizational factors				
E.III.m1	FORMALIZATION	Was the intervention given a legal form (e.g. in order to be able to have access to subsidies, to become a legitimate business partner etc.)?	Oerlemans and Assouline, 2004; Burandt et al., 2013	Bin [0/1]
E.III.m2	SELF-SUSTENANCE	According to the latest information available, to which degree had the intervention become self-sustaining or to which degree would it potentially become self-sustaining, i.e. were the tasks and functions of the intervention carried out even without external or public support such as funding, technical support, facilitation? 0 = The intervention (potentially or actually) ceased to exist or to actively carrying out its tasks and functions or the intervention continued but remained greatly dependent on external or public support. 4 = The intervention (potentially or actually) had become mostly self-sustaining	Prager et al., 2011; Ramdwar et al., 2013	metric [0..4]
E.III.m3	APPLICATION COSTS	If the intervention included an application for a general scheme that would provide financial and other forms of support to the intervention (e.g. the scheme of protected denominations of origin, PDO), did the involved actors have to face high costs of any type in order to realize the application? 0 = The application for the scheme caused low costs and/or the costs for the application could easily be covered. 4 = The application for the scheme caused very high costs and/or it was not or only hardly possible to cover the costs for the application.	Prager, 2015	metric [0..4]

E.IV Business performance of the intervention Only code these variables if the intervention included the marketing of products and/or services (MARKETING = 1). In all other cases (MARKETING = 0), code all variables of this section n/a.				
E.IV.a Competitiveness				
E.IV.a1	PRODUCT QUALITY	Were the marketed products and/or services of high quality? 0 = Products and/or services were of low quality. 4 = Products and/or services were of high quality.	Carlberg et al., 2003; Azadi et al., 2010; Burandt et al., 2013	metric [0..4]
E.IV.a2	PRODUCT RANGE	How competitive was the range of products and/or services offered by the intervention? -4 = The range of products/services was too small and not diverse enough 0 = The range of products/services was competitive. 4 = The range of products/services was too large and diverse.	Shiferaw et al., 2011; Burandt et al., 2013	metric [-4..4]
E.IV.a3	PRODUCT UNIQUENESS	Were the products and/or services offered by or through the intervention easy to differentiate and recognize? 0 = The products / services were of low uniqueness and recognizability. 4 = The products / services were of high uniqueness and recognizability.	Carlberg et al., 2003; Lamprinopoulou et al., 2006	metric [0..4]
E.IV.a4	PRODUCT PRICE	Was the price-performance ratio of the products and/or services of the intervention favorable? -4 = The price was far too low for the performance and quality of the products / services. 0 = The price of the products / services was adequate for their performance and quality. 4 = The price of the products / services was too high for their performance and quality.	Burandt et al., 2013	metric [-4..4]
E.IV.a5	PRODUCT NAME LOCAL	Did the names of the products / services feature the name of the locality or region of its origin in any way?	Burandt et al., 2013	metric [0..4]

		0 = The names of the products/services did not feature the names of the localities/regions of their origin. 4 = (Almost) all of the names of the products/services featured the names of the localities/regions of their origin.		
E.IV.a6	REPUTATION	Did the intervention itself have a good reputation? 0 = The intervention had no or a low reputation. 4 = The intervention had a good reputation.	Carlberg et al., 2003	metric [0..4]
E.IV.b Market integration				
E.IV.b1	MARKET INTEGRATION	To which degree was the intervention integrated into the wider economy, i.e. to which degree were costs, prices, demands etc. determined by national and global markets and conditions rather than only by local and regional markets and conditions? 0 = Market integration was low, i.e. the intervention was rather detached from conditions and events of the national and global markets. 4 = Market integration was high, i.e. the intervention was greatly dependent on and influenced by conditions and events of the national and global markets.	Agrawal, 2001; Shiferaw et al., 2011	metric [0..4]
E.IV.b2	VERTICAL INTEGRATION	To which degree was the intervention vertically integrated in the supply chain, i.e. to which degree did it have linkages to wholesalers, processors, exporters, supermarkets etc. and exchanges information with its partners along the supply chain? 0 = The intervention was hardly vertically integrated. 4 = The intervention was strongly vertically integrated.	Carlberg et al., 2003; Shiferaw et al., 2011; Burandt et al., 2013	metric [0..4]

E.IV.c Logistics				
E.IV.c1	CLOSENESS INPUTS	How close was the region / locality of the intervention located to the origin of the inputs necessary for its products /services? 0 = The region / locality of the intervention was far away from the origin of most of its inputs. 4 = The region / locality of the intervention was close to the origin of most of its inputs Use the codes as appropriate to the case. For example, in some cases a distance of 100 km from the origin of inputs is far if no means for transportation are available.	Carlberg et al., 2003	metric [0..4]
E.IV.c2	INFRASTRUCTURE INIT	At its outset, did the intervention have a good infrastructure for processing, transportation, distribution and, storage etc.? 0 = The intervention had little infrastructure for transportation, distribution and storage. 4 = The intervention was well-equipped with infrastructure for transportation, distribution and storage.	Carlberg et al., 2003; Burandt et al., 2013	metric [0..4]
E.IV.c3	INFRASTRUCTURE END	At its end or at the latest known point in time, did the intervention have a good infrastructure for processing, transportation, distribution and, storage etc.? 0 = The intervention had little infrastructure for transportation, distribution and storage. 4 = The intervention was well-equipped with infrastructure for transportation, distribution and storage.	Carlberg et al., 2003; Burandt et al., 2013	metric [0..4]
E.IV.c4	CLOSENESS CUSTOMERS	How close was the region / locality of the intervention located to the customers of the intervention (depending on the marketing channels used by the intervention this can be the final consumers as well as wholesalers, processors, supermarkets etc.)? 0 = The region / locality of the intervention was far away from the customers. 4 = The region / locality of the intervention was close to the customers.	Carlberg et al., 2003	metric [0..4]

		Use the codes as appropriate to the case. For example, in some cases a distance of 100 km from the customers is far if the products are easily perishable and no means for transport with refrigeration are available.		
E.IV.c5	MEMBER DISPERSION	What was the level of geographical dispersion of those involved actors selling their produce to or through the intervention? 0 = Involved actors selling their produce to or through the intervention were located rather closely to each other. 4 = There were rather long distances between the involved actors selling their produce to or through the intervention.	Carlberg et al., 2003	metric [0..4]
E.IV.d Marketing & business strategy				
E.IV.d1	MARKETING COMPETENCY	Was the intervention competent and active in marketing (e.g. it followed a consistent marketing strategy and made strong marketing efforts)? 0 = The intervention was not very competent and active in marketing. 4 = The intervention was mostly competent and active in marketing.	Carlberg et al., 2003; Burandt et al., 2013	metric [0..4]
E.IV.d2	EXTERNAL COMMUNICATION	Did the intervention promote itself professionally, i.e. did it not only promote its services and/or products but also the fact that these originate from an effort to improve the sustainability of agriculture? 0 = The intervention hardly promoted itself. 4 = The intervention actively promoted itself.	Wadsworth, 2001; Burandt et al., 2013	metric [0..4]
E.IV.d3	TARGETED CUSTOMERS	Did the intervention have a targeted customer base for their products/services? 0 = The intervention did not target the products / services at a specific group of customers. 4 = (Almost) all the products / services were targeted at a clearly specified group of customers.	Carlberg et al., 2003	metric [0..4]

E.IV.d4	MULTIPLE MARKETS	Did the intervention offer and sell the products / services at a range of different markets and through different marketing channels? Examples for marketing channels are: direct marketing at farmers' markets or box schemes, selling to wholesalers and supermarkets; selling to grocery stores etc. 0 = Products / services were offered and sold mainly at one market / through one marketing channel. 4 = Products / services were offered and sold at several markets / through many different marketing channels.	Carlberg et al., 2003; Mburu and Wale, 2006; Azadi et al., 2010	metric [0..4]
E.IV.d5	BUSINESS MANAGEMENT	Were methods of professional business management applied in the context of the intervention? For example, did it have a business strategy? Did it have defined production guidelines? Did it perform risk management and ongoing planning and checking? 0 = Methods of professional business management were not applied or only to a low degree. 4 = The intervention was managed professionally through the application of business management methods.	Carlberg et al., 2003; Burandt et al., 2013	metric [0..4]
E.IV.e Financial performance				
E.IV.e1	PROFIT	How profitable was the intervention? -4 = Income was much lower than the costs; the intervention generated high deficits. 0 = Income and costs of the intervention were more or less balanced. 4 = Income was much higher than the costs; the intervention generated high profits.	Carlberg et al., 2003; Lamprinopoulou et al., 2006; Bhuyan, 2007; Azadi et al., 2010; Burandt et al., 2013	metric [-4..4]
E.IV.e2	INVESTMENTS	To which extent were continuing investments made in the intervention (e.g. into infrastructure, marketing campaigns, training etc.)? 0 = Low and/or rare investments into the intervention were made. 4 = High and/or frequent investments into the intervention were made.	Azadi et al., 2010	metric [0..4]

E.V Other factors				
E.V.1	NATURAL CONDITIONS	How favorable were the given natural conditions (e.g. soil quality, climate, altitude, ecological conditions) for the production of the type(s) of agricultural produce the intervention focused on? 0 = The given natural conditions were rather unfavorable for the production of the type(s) of produce of the intervention. 4 = The given natural conditions were very favorable for the production of the type(s) of produce of the intervention.		metric [0..4]
E.V.2	MEDIA ATTENTION	How much attention did the intervention receive in the media? And was the attention the intervention received of a positive, supporting and promoting type or of a negative and discrediting type? -4 = The intervention received a high level of negative, discrediting media attention beyond the local level (e.g. national or supra-national). 0 = The intervention received no or very little media attention and the attention it received was on a very local level. 4 = The intervention received a high level of positive, promoting media attention beyond the local level (e.g. national or supra-national)		metric [-4..4]
E.V.3	OTHER FACTORS	Describe other factors that influenced success or failure of the intervention and that are not covered by the variables above.		Text

F. Intervention success				
F1	ACHIEVEMENT STAGE	Indicate whether the following variables are assessed based on actual achievements (if the intervention had already finished or was very advanced at the latest known point in time) or on likely developments (if the intervention was still in the process of realizing/ achieving its goals at the latest known point in time). 0 = The assessment is strongly based on likely developments. 4 = The assessment is strongly based on actual achievements.		metric [0..4] ~~NIL~~ ~~n/a~~
F2	ACHIEVEMENT ENVIRONMENTAL GOALS (g_{1i})	Indicate to which degree the environmental goals of the intervention were achieved or, if the intervention was still in the process of achieving its goals at the latest point in time known, indicate how likely the achievement of the environmental goals was: 0 = The intervention did not pursue environmental goals or environmental goals were (likely to be) not or poorly achieved. 4 = Environmental goals were (likely to be) greatly or completely achieved. Code 0 if GOALS ENVIRONMENTAL (g_{1i}) = 0		metric [0..4] ~~NIL~~ ~~n/a~~
F3	ACHIEVEMENT ECONOMIC GOALS (g_{2i})	Indicate to which degree the economic goals of the intervention were achieved or, if the intervention was still in the process of achieving its goals at the latest point in time known, indicate how likely the achievement of the economic goals was: 0 = The intervention did not pursue economic goals or economic goals were (likely to be) not or poorly achieved. 4 = Economic goals were (likely to be) greatly or completely achieved. Code 0 if GOALS ECONOMIC (g_{2i}) = 0		metric [0..4] ~~NIL~~ ~~n/a~~

F4	ACHIEVEMENT SOCIAL GOALS (g_{3i})	Indicate to which degree the social goals of the intervention were achieved or, if the intervention was still in the process of achieving its goals at the latest point in time known, indicate how likely the achievement of the social goals was: 0 = The intervention did not pursue social goals or social goals were (likely to be) not or poorly achieved. 4 = Social goals were greatly or completely achieved. Code 0 if GOALS SOCIAL (g_{3i}) = 0		metric [0..4] ~~NIL~~ ~~n/a~~
F5	ACHIEVEMENT OF GOALS TOTAL (G(i))	Calculates the average value for the achievement of the goals: $$\mathrm{G(i)} = \frac{\sum_{j=1}^{3} a_{j_i} \cdot g_{j_i}}{\sum_{j=1}^{3} a_{j_i}}$$		Number
F6	DURABILITY OF GOAL ACHIEVEMENT (D_i)	Indicate how durable the achievement of the goals was: 0 = Goals were not achieved (ACHIEVEMENT OF GOALS TOTAL (G(i)) = 0) or durability of goal achievement was low, i.e. achievements were (likely to be) given up if conditions changed, e.g. end of project or funding, drop-out of key individuals etc. 4 = Durability of goal achievement was high, i.e. most achievements endured or were likely to endure despite changing conditions.		metric [0..4] ~~NIL~~ ~~n/a~~
F7	INTENDED EFFETCS (IE_i)	Calculates the strength of the intended effects, considering the medium ambitiousness of the goals, the degree of the achievement of goals, and the durability of the achievements: $$IE(i) = \sqrt[3]{A_i \cdot G(i) \cdot D_i}$$		Number
F8	POSITIVE SIDE-EFFECTS ENVIRONMENTAL QUAL	If the intervention had or was likely to have any positive environmental side-effects, describe them shortly.		Text
F9	POSITIVE SIDE-EFFECTS ECONOMIC QUAL	If the intervention had or was likely to have any positive economic side-effects, describe them shortly.		Text

F10	POSITIVE SIDE-EFFECTS SOCIAL QUAL	If the intervention had or was likely to have any positive social side-effects, describe them shortly.		Text
F11	POSITIVE SIDE-EFFECTS ENVIRONMENTAL (ps_{1i})	Indicate the significance of the positive environmental side-effects of the intervention: 0 = The intervention did not have any or very little positive environmental side-effects. 4 = The intervention caused significant positive environmental side-effects.		metric [0..4] ~~NIL~~ ~~n/a~~
F12	POSITIVE SIDE-EFFECTS ECONOMIC (ps_{2i})	Indicate the significance of the positive economic side-effects of the intervention: 0 = The intervention did not have any or very little positive economic side-effects. 4 = The intervention caused significant positive economic side-effects.		metric [0..4] ~~NIL~~ ~~n/a~~
F13	POSITIVE SIDE-EFFECTS SOCIAL (ps_{3i})	Indicate the significance of the positive social side-effects of the intervention: 0 = The intervention did not have any or very little positive social side-effects. 4 = The intervention caused significant positive social side-effects.		metric [0..4] ~~NIL~~ ~~n/a~~
F14	POSITIVE SIDE-EFFECTS TOTAL (PS_i)	Calculates the average significance of the positive side-effects: $PS_i = \frac{\sum_{j=1}^{3} ps_{j_i}}{3}$		Number
F15	NEGATIVE SIDE-EFFECTS ENVIRONMENTAL QUAL	If the intervention had or was likely to have any negative environmental side-effects, describe them shortly.		Text
F16	NEGATIVE SIDE-EFFECTS ECONOMIC QUAL	If the intervention had or was likely to have any negative economic side-effects, describe them shortly.		Text

F17	NEGATIVE SIDE-EFFECTS SOCIAL QUAL	If the intervention had or was likely to have any negative social side-effects, describe them shortly.		Text
F18	NEGATIVE SIDE-EFFECTS ENVIRONMENTAL (ns_{1i})	Indicate the significance of the negative environmental side-effects of the intervention: 0 = The intervention did not have any or very little negative environmental side-effects. 4 = The intervention caused significant negative environmental side-effects.		metric [0..4] ~~NIL~~ ~~n/a~~
F19	NEGATIVE SIDE-EFFECTS ECONOMIC (ns_{2i})	Indicate the significance of the negative economic side-effects of the intervention: 0 = The intervention did not have any or very little negative economic side-effects. 4 = The intervention caused significant negative economic side-effects.		metric [0..4] ~~NIL~~ ~~n/a~~
F20	NEGATIVE SIDE-EFFECTS SOCIAL (ns_{3i})	Indicate the significance of the negative social side-effects of the intervention: 0 = The intervention did not have any or very little negative social side-effects. 4 = The intervention caused significant negative social side-effects.		metric [0..4] ~~NIL~~ ~~n/a~~
F21	NEGATIVE SIDE-EFFECTS TOTAL (NS_i)	Calculates the average significance of the negative side-effects: $$NS_i = \frac{\sum_{j=1}^{3} ns_{j_i}}{3}$$		Number
F22	SIDE-EFFETCS (SE(i))	Calculates the net side-effects, weighting positive against negative side-effects: $$SE(i) = PS_i - NS_i$$		Number
F23	ACCEPTANCE (Ac_i)	Indicate the degree of acceptance of the intervention by the stakeholders, i.e. by both the involved and other affected actors:		metric [-4..4] ~~NIL~~

		-4 = All or most of the stakeholders opposed the intervention. 0 = All or most of the stakeholders accepted the intervention but did not favor/ support it or a substantial part of the stakeholders opposed the intervention while another substantial part of the stakeholders supported it. 4 = All or most of the stakeholders supported the intervention.		~~n/a~~
F24	INTERVENTION SUCCESS VALUE (S(i))	Calculates the total success of the intervention, considering intended and unintended effects: $S(i) = IE(i) + SE\ (i) + Ac_i$		Number

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Overview over the articles included in this cumulative Ph.D. thesis

(in accordance with §16 of the guideline for cumulative dissertations in Sustainability Science [January 2012], flowingly referred to as "guideline")

Title of Ph.D. thesis: Governing for Sustainable Agriculture in the EU: Promoting Multi-Stakeholder Collaboration

Included articles:

1) **Velten, S.**, Leventon, J., Jager, N.W., Newig, J., 2015. What is sustainable agriculture? - A systematic review. Sustainability 7 (6), 7833–7865.
2) Leventon, J., Schaal, T., **Velten, S.**, Dänhardt, J., Fischer, J., Abson, D.J., Newig, J., 2017. Collaboration or fragmentation? Biodiversity management through the common agricultural policy. Land Use Policy 64, 1–12.
3) Leventon, J., Schaal, T., **Velten, S.**, Fischer, J., Newig, J., 2019. Landscape Scale Biodiversity Governance: Scenarios for reshaping spaces of governance. Environmental Policy and Governance 46 (1), 1-15.
4) **Velten, S.**, Schaal, T., Leventon, J., Hanspach, J., Fischer, J., Newig, J., 2018. Rethinking biodiversity governance in European agricultural landscapes: Acceptability of alternative governance scenarios. Land Use Policy 77, 84-93.
5) **Velten, S.**, Jager, N., Newig, J., forthcoming. Success of Collaboration for sustainable agriculture: a case study meta-analysis. Environment, Development and Sustainability.

Auhor's contribution to the articles and publication status

Article	Title	Contributions of all authors	Author status	Weighting factor	Publication status	Conference contributions
1	What is sustainable agriculture? - A systematic review	**SV:** Design and realization of data collection and main part of the analysis, main contribution to writing the manuscript. **JL:** Participation in conceptual development, structuring of results and findings, and writing of the manuscript. **NJ:** Main part of the execution of the cluster analysis, creation of figures, participation in writing the manuscript. **JN:** Methodological and conceptual contribution, participation in writing the manuscript.	Co-Author with predominant contribution	1.0	Published in *Sustainability (MDPI)* (IF: 2.075)	-
2	Collaboration or fragmentation? Biodiversity management through the common agricultural policy	**JL:** Main contribution in study design, data collection, analysis, and writing of the manuscript. **TS, SV, JD:** Contribution in data collection (all: organization and realization of stakeholder workshops, additionally: TS: document analysis, SV: interviews), participation in writing the manuscript. **JF, DA, JN:** Conceptual contributions, participation in writing the manuscript.	Co-Author with small contribution	0	Published in *Land Use Policy* (IF: 3.194)	-
3	Landscape Scale Biodiversity Governance: Scenarios for reshaping spaces of governance	**JL:** Main contribution in conceptual development and writing of the manuscript. **TS, SV:** Creation of the worked example of the theoretical scenarios, participation in writing the manuscript. **JF, JN:** Conceptual contributions, participation in writing the manuscript.	Co-author with small contribution	0	Published in *Environmental Policy and Governance* (IF: 1.268)	-

4	Rethinking biodiversity governance in European agricultural landscapes: Acceptability of alternative governance scenarios	**SV, TS:** Design and realization of data collection, data analysis (qualitative content analysis), conceptual development, main contribution in writing the manuscript. **JL:** Design and realization of data collection, participation in conceptual development and writing of the manuscript. **JH:** Participation in design of questionnaire for data collection and execution of quantitative analysis, creation of figures related to quantitative analysis, participation in writing the manuscript. **JF, JN:** Conceptual contributions, participation in writing the manuscript.	Co-author with equal contribution	1.0	Published in *Land Use Policy* (IF: 3.194)	RGS-IBG Annual International Conference 2016*
5	Success of Collaboration for sustainable agriculture: a case study meta-analysis	**SV:** Design and realization of data collection and analysis, main contribution to writing the manuscript. **NJ:** Participation in the design of data collection and analysis, participation in writing the manuscript. **JN:** Methodological and conceptual contributions to design of data collection and analysis, participation in writing the manuscript.	Co-Author with predominant contribution	1.0	Submitted to *Environment, Development and Sustainability* (IF: 1.379)	4th World Sustainability Forum 2014, 12th IFSA Symposium 2016
Sum:				**3.0**		

Explanations

Contributions of all authors

DA = Dave Abson, JD = Juliana Dänhardt, JF = Jörn Fischer, JH = Jan Hanspach, JL = Julia Leventon, JN = Jens Newig, NJ = Nicolas Jager, SV = Sarah Velten, TS = Tamara Schaal

Author status and weighting factors

Author status (English)	**Author status (German, according to §12 of the guideline)**	**Description (according to §12 of the guideline)**	**Weighting factor (according to §14 of the guideline)**
Co-author with predominant contribution	Überwiegender Anteil	Own contribution is greater than the individual share of all other co-authors and is at least 35%.	1.0
Co-author with equal contribution	Gleicher Anteil	(1) Own contribution is as high as the share of the other co-authors, (2) no other co-author has a contribution higher than the own contribution, and (3) the own contribution is at least 25%.	1.0
Co-author with small contribution	Geringer Anteil	Own contribution is less than 20%.	0

Publication status

IF = ISI Web of Science Impact Factor 2017

Conference contributions

- 4th World Sustainability Forum 2014: Sciforum.net, online conference, 1-30 November 2014
- 12th IFSA Symposium: International Farming System Association, Harper Adams University, Newport, Shropshire, England, 12-15 July 2016
- RGS-IBG 2016 Annual International Conference: Royal Geographical Society, London, 30 August – 2 September 2016

* Paper presented by co-author.

Declaration (according to §16 of the guideline)

I affirm that all information given in this appendix is true, in each instance and overall.