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Analysis

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Progress towards sustainable agriculture hampered by siloed scientific discourses

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There is no consensus in society on how to achieve sustainability. Scientists' limited experience in reflecting on their guiding assumptions, combined with a tendency to inflate their own research findings, hinders interdisciplinary dialogue and limits the usefulness of science. Through bibliometrics and discourse analysis, we analysed highly cited articles on agroecology and sustainable intensification. In broad terms, agroecology prioritizes diversity while sidelining productivity and adheres to relational epistemology, while sustainable intensification emphasizes boosting crop production while reducing environmental impact within a reductionist epistemology. Both discourses claim to have the solution to agricultural sustainability but are largely inexplicit about their guiding assumptions and their own limitations, and rarely engage with research in the other discourse. Interdisciplinary dialogue based on transparent and self-critical reflection on the assumptions and limitations of research could increase the relevance of science in societal dialogues about alternative pathways towards sustainable agriculture.

There is broad global consensus that our interactions with nature are unsustainable and need to change. Agriculture is a case in point. There is widespread agreement that dominant modes of agriculture are unsustainable, but equally widespread disagreement about how sustainability should be achieved or what sustainable agriculture entails. Disagreements about sustainability are equally present in science as in other parts of society. Political ideologies, money and power are important factors underlying such disagreements, and science is not shielded from them. However, conflicting perspectives are also grounded in different, often implicit, epistemological assumptions, about how to build knowledge about the world and which knowledge counts. Through bibliometric and discourse analysis of two dominant scientific discourses on agriculture, we exemplify how all scientific endeavours are shaped by their approaches to knowledge and by their wider assumptions about the world. Increased attention to the presence and inevitability of such assumptions in science might facilitate a more fruitful interdisciplinary dialogue about progress towards sustainability without limiting the diversity of perspectives.

The complexity of today's sustainability challenges necessitates the interaction of multiple competences across many academic disciplines. However, the fact that science is a highly specialized enterprise poses challenges to this interaction[1,2]. It makes it difficult to communicate across disciplines and makes peer scrutiny of the validity and relevance of sometimes conflicting scientific knowledge claims challenging. Adding to this, scientists are often found to overstate the relevance of their own competence and research findings. The problem that these practices create for interdisciplinary dialogue, and for the role that science can play in societal change, has recently been highlighted in several publications[3]. In a recent article, scientists and journal editors are urged to acknowledge the need for diverse competences to research futures for agriculture and stop overstating the relevance of genetic modification in agricultural change[4]. Another recent example voices concern about the lack of openness within the scientific community to publishing diverse findings in climate science[5]. Indeed, there is currently increased attention to the need for more intellectual humility in research[6,7].

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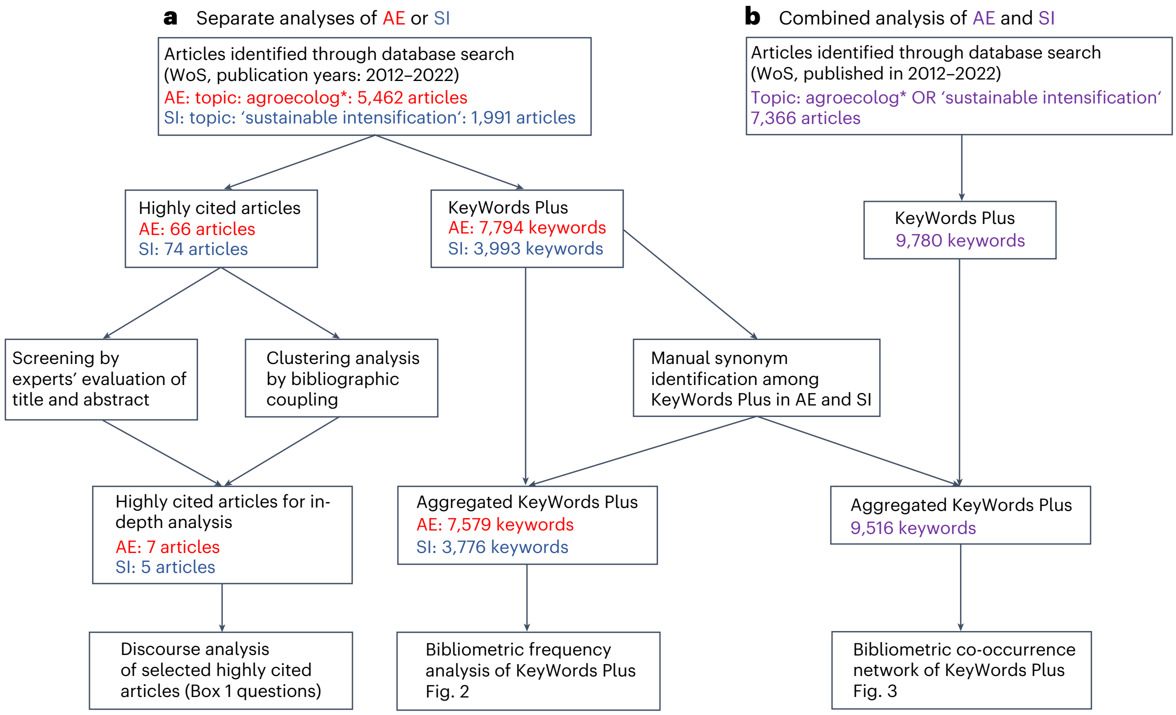

Fig. 1 | Flowchart of the article selections and analyses. a, Separate analyses of 'agroecolog*' (AE) and 'sustainable intensification' (SI). **b**, Combined analysis.

One reason why scientists sometimes overstate the relevance of their competence and their findings is that they want to make their research relevant to society, pushed by funders, publishers and the scientists' own desires. Without dampening this desire to contribute science of relevance to society, we suggest that this needs to happen in a different way. A starting point for such change can be to become more aware of, and transparent about, the assumptions that guide research.

Conflicting views and controversies regarding sustainability are particularly obvious when it comes to agriculture[4,8–11]. Agriculture is both a major contributor and highly vulnerable to global environmental change, including biodiversity loss, climate change and antimicrobial resistance[12–14]. There is broad agreement in academia that agriculture needs to change. However, scientists disagree about the specifics, magnitude and priority of the challenges faced, and about the knowledge and action needed to reach the desired situation[10,15].

To exemplify what some of these disagreements might look like in research, we analyse two highly influential fields of contemporary research on agriculture sustainability underpinned by different assumptions: agroecology (AE) and sustainable intensification (SI)[9]. Drawing on peer-reviewed literature on AE and SI published in the period from 2012 to 2022, we combine bibliometric network analysis[16,17] of a total of 7,366 articles featuring 'agroecolog*' or 'sustainable intensification' with discourse analysis[18] of 7 selected highly cited articles on AE[19–25] and 5 on SI[26–30] (Fig. 1 and Methods).

We focus our analysis on dominant perspectives in AE and SI rather than change over time. As such, we do not draw conclusions about emerging alternative discourses within the respective fields of research that we analyse.

While discourse analysis and network analysis have been fruitfully combined before[31,32], one important novelty here is our use of interdisciplinary dialogue within the author team to enrich the analysis and facilitate reflexivity about our own assumptions. We all have expertise in agriculture but from a variety of disciplines in the humanities and social and natural sciences, adhering variously to holistic and reductionist epistemologies in our research. Making use of our diverse competences and perspectives, we scrutinize the knowledge claims of the analysed articles, highlight components of agricultural and food systems that are missing in the respective discourses and unveil hidden assumptions (both our own and that of the articles we analyse) that guide the formulations of problems, solutions and knowledge claims.

Results

Both AE and SI articles build on the idea that current agriculture is unsustainable and needs to change. Within this overarching agreement, there is clear divergence in the details of the sustainability challenge and the knowledge and actions needed. Our analysis suggests that AE and SI can be considered as two separate scientific discourses on the future of agriculture, and we refer to them as such below. By discourse, we mean a comprehensive, dominant and internally consistent way of reasoning about a certain issue, in this case sustainable agriculture and the path towards achieving it. In the next section, we present our findings from the bibliometric analysis. Two sections then follow outlining the key findings of the discourse analysis. We quote from the analysed articles to exemplify reasoning in the respective discourses.

Bibliometric analysis

There is substantial overlap in the most frequent thematically aggregated KeyWords Plus in AE and SI (Fig. 2). SI has a wider set of frequently occurring keywords, but 10 out of a total of 11 keywords occurring in at least 5% of the AE articles are also common in SI articles, indicating that the two bodies of literature relate to similar issues. Despite this overlap in keywords, fewer than 2% of articles with the topic 'agroecolog*' or 'sustainable intensification' include both topics. This suggests that AE and SI authors respectively interact with largely separate scientific communities.

There are also some notable differences in the frequency of keywords and, thus, probably in the centrality of issues in the respective discourses. For example, 'crop yield' is related to only 9% of AE articles but to 24% of SI articles. Moreover, 'diversity' is the highest-ranked keyword in AE (pertaining to 19% of AE articles) but is ranked fifth in the SI list (appearing in 14% of SI articles).

Two clusters emerge when analysing the co-occurrence of thematically aggregated KeyWords Plus in AE and SI articles combined (Fig. 3).

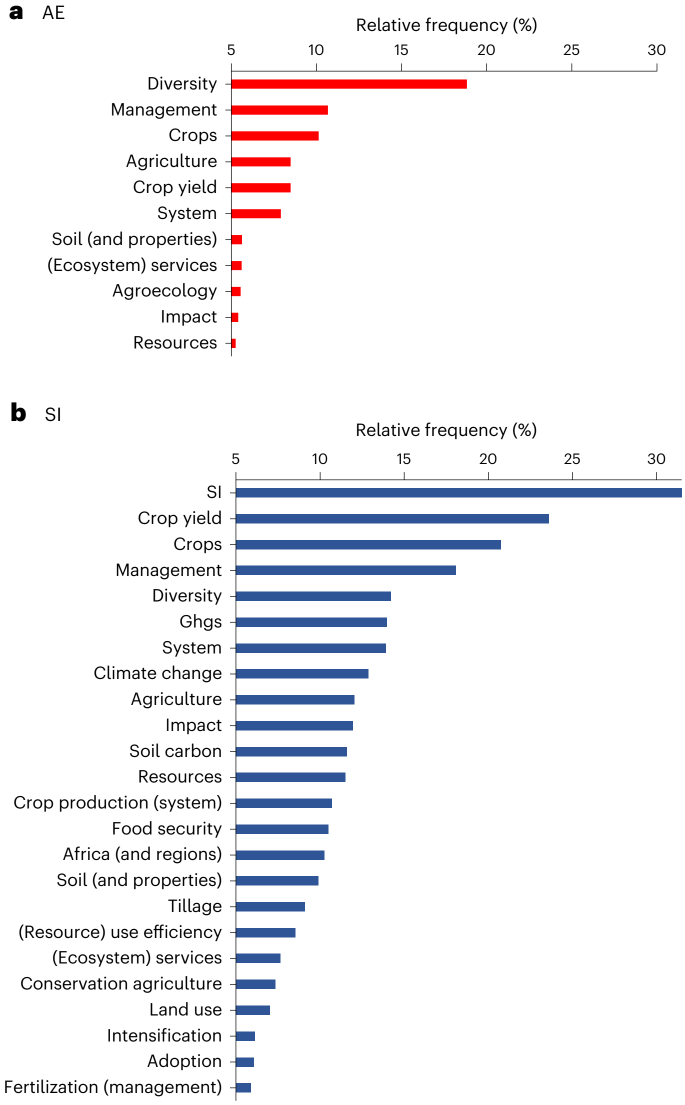

Fig. 2 | Bibliometric frequency analysis of KeyWords Plus. a,b, Relative frequency of the occurrence of KeyWords Plus after thematic aggregation in AE articles (**a**) and SI articles (**b**). Only the thematically aggregated KeyWords Plus associated with at least 5% of the articles (273 articles for AE and 100 for SI) are represented. Ghgs, greenhouse gases. See Methods for details on the thematic aggregation.

One is dominated by 'crop yield', 'crops' and 'sustainable intensification' (Fig. 3, top), the other by 'diversity' and 'management' (Fig. 3, bottom), approximately matching SI and AE, respectively, based on the keyword frequencies shown in Fig. 2. There are also other notable differences. While 'sustainable intensification' is central in the top (SI) cluster, the individual words 'sustainable' and 'intensification' also appear in the bottom (AE) cluster. This might suggest that sustainability is not seen as being related to intensification within AE. Another difference is the appearance of 'food security' in the SI cluster versus 'food sovereignty' in the AE cluster. The term 'food security' is commonly connected with the amount of food produced, that is, closely related to crop yield, whereas 'food sovereignty' places the emphasis on distribution rather than on amounts of food[33] and is strongly connected with social movements and struggles for farmers' rights and autonomy, issues that are closely connected with agroecology as a research field[34].

Contrasting problem formulations and proposed solutions

The dominant discourse in AE portrays the key sustainability problem as the "monoculture nature of dominant agroecosystems"[21] and the associated "production-oriented or productivist model of agriculture"[22] that dominates the food system.

This mode of production is described as having "contaminated soils, water, and air; eroded soils and biological diversity; caused pest outbreaks; led to the indebtedness of farmers; and contributed greatly to the abandonment of the countryside". Moreover "the world's arable land is increasingly being planted with a handful of crop commodities (corn, soybean, wheat, rice, and others), therefore dangerously narrowing the genetic diversity present in global agricultural systems"[21].

AE literature is often sceptical of "...'off-the-shelf' technologies (for example synthetic inputs, genetics)"[22] because of the strong connection between these technologies and what is seen as unsustainable industrial monoculture farming. It is assumed that these technologies cannot be disconnected from unsustainable farming practices.

According to AE, changing this situation and moving towards sustainable agriculture "involves supporting diverse forms of smallholder food production and family farming, farmers and rural communities, food sovereignty, local knowledge, social justice, local identity and culture, and indigenous rights for seeds and breeds"[19].

Marginal reductions in the environmental impact of industrial agriculture are assumed to be vastly insufficient for solving the crisis in agriculture, in the view of AE. Instead, we need "transformative transitions"[19], a "paradigmatic shift"[22] or even an "agroecological revolution"[20].

The analysed SI literature starts from the premise that the main challenge that science needs to address is the requirement to boost food production because of "Population growth and increases in per capita consumption, as people become richer"[29] and "can afford a more diverse dietary fare that includes meat and dairy"[26].

Taking a global perspective, SI suggests that yields should increase "on underperforming landscapes"[30], which are mainly located "in low-income developing countries of Sub-Saharan Africa and Asia where current yield gaps are large"[26]. Environmental impact must also be reduced, but the main goal is to increase productivity, as indicated by the use of the term 'complemented' in the following quotation: "clos[ing] crop yield gaps should be complemented by efforts to decrease overuse of crop inputs wherever possible"[30].

SI emphasizes the need for incremental, rather than revolutionary, changes. While it is suggested that "sensible diets"[30] should be promoted, a radical transformation of human behaviour or societal organization is assumed to be, and sometimes explicitly stated as, unrealistic: "there is no magic wand of redistribution. Most, if not all, farmers will need to raise yields while improving environmental services"[28]. It has been contended that "a radical reorganizing of the politico-economic landscape...seems to us a hugely risky strategy"[29]. As such, SI focuses on the already dominant commodity grain cereals[26,30] and emphasizes the importance of the adoption of new techniques and technologies at farm level, such as "precision agriculture techniques, conservation tillage, high-yielding hybrids"[30].

We summarize core assumptions, differences and tensions in the core tenets of the two discourses in two stylized examples of a model farm in AE and SI (Fig. 4).

Contrasting epistemologies

AE and SI differ in their assumptions about what counts as relevant and valid knowledge facilitating agricultural sustainability, that is, in their epistemology. This is reflected in the choice of theory and method, and their view on what counts as evidence.

The core focus of AE is to understand and support the "diverse forms of smallholder food production and family farming"[19] producing food in ways that preserve and even build biodiversity, "as they

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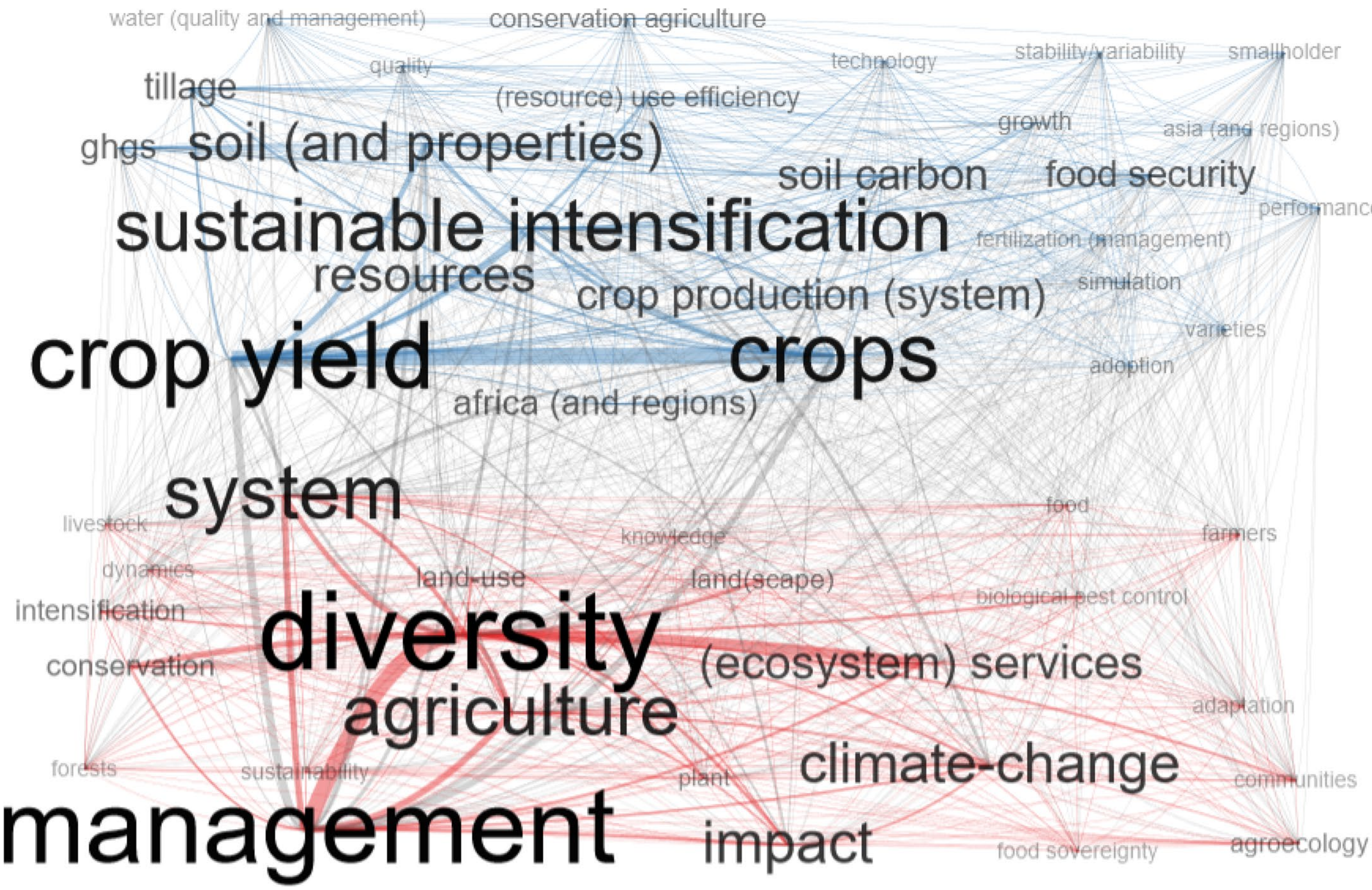

Fig. 3 | Bibliometric co-occurrence network of KeyWords Plus. Thematically aggregated KeyWords Plus co-occurrence among articles featuring the topic agroecolog* or 'sustainable intensification' (that is, the entire dataset). The label size is proportional to the frequency of the occurrence of the term, and the line thickness to the co-occurrence strength. The colouring is based on Walktrap clustering.

can serve as the foundation for the design of adapted agricultural systems"[21].

Methodologically, case studies of these diverse farming systems are central to building knowledge in AE. There is not a hard line either between knowledge and practice in AE or between scientific and other forms of knowledge. To embrace diverse forms of knowledge and practices, methods based on "participatory methodology"[22] that facilitate "the integration of research, education, action and change"[19] are commonly promoted. As knowledge and practice are understood as intertwined, "decisions have to be made on the basis of local knowledge and skills obtained through detailed observation of how the system works"[25].

As such, AE focuses on theories and methodologies that simultaneously aim to understand and practise sustainable agriculture. Theories that help improve our understanding of how components of farming systems together interrelate are used and often prioritized over the collection of data on specific and separate system components. For example, the need to "Understand the social-ecological system as a 'complex adaptive system' characterised by emergent and nonlinear behaviour, a high capacity for self-organisation and adaptation based on past experiences, distributed control and ontological uncertainties linked to incomplete knowledge of managers"[22] has been emphasized.

In sum, AE is grounded in a holistic and relational epistemology that understands the world as more than the sum of its parts and values other knowledge than what is traditionally seen as science: "Whether recognized or not by the scientific community, this ancestral knowledge constitutes the foundation for actual and future agricultural innovations and technologies. For years, agroecologists have argued that the new models of agriculture that humanity will need in the immediate future should be rooted in the ecological rationale of traditional small-scale agriculture, which represents long-established, successful, and adaptive forms of agriculture"[21].

SI also appreciates the importance of understanding local ecologies, and studying a diverse set of factors for agricultural sustainability: "Success in implementing an SI approach is best quantified by metrics that measure system outputs (again, broad sense) in terms of: (1) yield; (2) input requirements to achieve that yield; (3) impact on soil quality defined as the capacity to support crop yields and input-use efficiencies; and (4) impact on natural resources and ecosystems affected by the production system. Hence, in addition to yield, SI must be evaluated by efficiency metrics such as yield per unit input of energy, water and nutrients"[26].

While SI acknowledges that "the manner in which one factor is implemented influences the outcome from each of the other factors"[26], the understanding of farming systems is built in a fundamentally different way than in AE. In SI, the dominant approach is to gather data that are as precise as possible through empirical measurements of specific and separate factors that are then subsequently combined: "Yield gap assessments [...] depend on a robust 'bottom-up' spatial aggregation approach and location-specific data on soils, climate and cropping systems"[26].

This is the core of the reductionist approach and is based on the assumption that the aggregation of independently measured factors provides a reliable understanding of the whole. While interdependencies between factors are acknowledged to some extent, no method is proposed for measuring these interdependencies and potentially emergent properties. Instead, systems are to be understood by "putting the components together in viable production systems, and in

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Fig. 4 | Model farms in agroecology and sustainable intensification. In AE (left), the model farmer is a smallholder who produces for subsistence, but probably also for (local) sale and who is tightly connected within their local farming community. The farm is diverse with a range of different crops produced, possibly in agroforestry systems. Farming is labour intensive with minimal use of external inputs. Crop seed is generally produced on the farm or in the local community, and to a minimal extent, the farmer is dependent on large input suppliers or supermarkets. The SI model farmer (right) produces a crop yield close to the theoretical maximum with modern seed and precise input use. Remote sensing and big data facilitate precision and enable yields to be maximized without having an unnecessary environmental impact. Biodiversity is supported by efforts outside the crop field, for example, with flower strips, and, most importantly, by maximizing the production on the crop field, which ensures that other land can be spared for conservation. Credit, Anni Hoffrén.

quantifying SI potential in terms of both production and environmental performance in farmers"[26].

What we can know about the world, according to SI, is what can be measured. More data are needed to obtain precise information about "yield and climate data from a variety of different sources and on different scales"[30]. Methodological development and new technologies for measurement are needed to enhance precision and provide "robust metrics to monitor environmental performance"[26] and "inform research prioritization and investment strategies"[30]. The above quotations also highlight how, in SI, scientific knowledge is seen as separate from, and the starting point for, action.

Discussion

Our analyses of AE and SI exemplify how different, often implicit, assumptions are connected with diverging research priorities and different knowledge produced. The dominant discourse in AE research emphasizes loss of diversity and displacement of farmers' knowledge as the main challenges to the future of farming. Thus, AE aims to build knowledge and promote practices that support diverse farming systems, and relies on knowledge beyond that traditionally seen as scientific. By contrast, the dominant SI discourse prioritizes how to produce enough food in the future and strike a balance between productivity and environmental impact. While AE embraces relational and holistic epistemological approaches, SI is based on standard reductionist science (Table 1). Importantly, these prioritizations and epistemologies are rarely made explicit in the analysed literature. Instead, highly cited literature in both AE and SI makes claims about having the solution to how to shift farming systems towards sustainability.

Our analysis of the core tenets of these two scientific discourses also indirectly reveals what is not prioritized. AE clearly lacks a discussion about productivity, making it impossible to establish whether enough food can be produced in the proposed diversified farming systems. SI takes the issue of how to balance food production and environmental impact seriously, but sidelines biodiversity loss and lacks a methodology for taking account of the acknowledged interrelationships in farming systems. In both discourses, we see an almost complete absence of animals, despite them often being understood as essential for closing the nutrient cycle in the farming landscape and minimizing the need for external inputs (an exception among the highly cited AE articles is ref. 25).

Table 1 | Some key tenets of agroecology and sustainable intensification discourses

	AE	SI
What is the core problem?	The dominance of industrial monoculture farming leading to the erosion of biodiversity and loss of local traditional knowledge	Population increase and greater demand for meat as people get wealthier; agriculture's negative environmental impact
What key solutions are proposed?	Learning from and supporting farmers who keep diverse farming systems and have maintained local traditional knowledge	Increasing yields in regions where they are low due to low adoption of modern seed and fertilizer; reducing environmental impact through the use of new tools for precision agriculture
Epistemology	Holism	Reductionism
Theories and methods	Systems theories, multiple methods, participatory methods	Agronomic field experiments, mining of large datasets, semi-mechanistic modelling
What is the role of science and scientists?	Working with traditional smallholder farmers to develop ways to scale up smallholder farming practices	Gathering and communicating precise data on crop yields and environmental impact; developing tools for precision agriculture

Today's food production is steered at both ends of the value chain by the dominance of highly concentrated food retail and agricultural input sectors[35]. Both discourses largely overlook the role of the wider governance of farming systems, which makes it impossible to draw conclusions about the likely impact of the farm-level interventions they propose, relative to the impacts of other activities in the wider food system. Giving smallholder farmers access to technology (SI) or supporting them to become champions of sustainable farming systems (AE) will have a limited impact if multinational companies continue to dominate seed markets and produce seed unsuited to smallholder contexts[36] or if governments and international platforms do not acknowledge and provide opportunities for smallholders practising 'agroecological' farming to teach their approaches to sustainable agriculture[37].

We acknowledge that there are broader and alternative definitions of both AE and SI beyond the research analysed here, as well

BOX 1

Starting points and guiding questions for the discourse analysis of highly cited articles on AE and SI, and an outline of common epistemological approaches in science

We operationalized our study of the assumptions that guide research through a discourse analysis, identifying how problems and solutions are framed and their underlying epistemology, that is, the understanding of how we create knowledge about reality[18].

Each paper was coded with the following questions as a guide:
(1) What is the main problem (implicitly or explicitly stated) that the article addresses?
(2) Which solution(s) are proposed?
(3) What kind(s) of evidence is/are highlighted as important?
(4) Which theories and methods are used?
(5) Which (implicitly or explicitly stated) knowledge is needed?
(6) What are the underpinning assumptions?
(7) What is missing?
(8) Which epistemology[a] guides the reasoning?

With the above questions as support, we in the interdisciplinary team jointly reflected on our respective analyses and the assumptions guiding them.

[a]Two epistemological approaches in science are of relevance here because they have a direct influence on the discourses being analysed: reductionism and holism. In a reductionist approach, the world is broken down into its constituent parts, which are analysed separately, often with the assumption that understanding the parts can provide insights about the whole. Much natural science research relies on a reductionist epistemology. A holistic approach aims to understand the world as a whole and is often operationalized through analyses of systems. It assumes that changes in one part can affect other parts and that new properties can emerge as a result of the interactions; that is, the system as a whole is more than the sum of its parts.

as additional ideas in the rich and animated debate on the future of agriculture[10,35,38–40] that also go beyond the sphere of academia[41], which we focused on. Notably, there is an emerging literature on AE that includes issues of power in food systems and debates on how to achieve an agroecological transformation[37,42]. Nevertheless, according to our analyses, this literature remains peripheral. Instead, articles at the forefront of their respective fields are largely limited to the narrow topic of crop production on farms, while being guided by assumptions that are rarely made explicit to the reader.

This lack of transparency about guiding assumptions and limitations in the highly cited articles is problematic because these impact the wider scientific and policy debate about sustainable agriculture. Indeed, the largely incompatible assumptions and conclusions are used differentially to support arguments about sustainable agriculture in high-impact reports such as those published by The International Assessment of Agricultural Science and Technology for Development[43], The Intergovernmental Panel on Climate Change[13] and The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services[12], and policies such as the Farm to Fork strategy in the EU Green Deal[39]. As such, highly cited AE and SI literature effectively contributes to the polarization of the societal debate on the future of agriculture and to spreading a narrow understanding of the relative role of crop farming in the wider food system. There are indications, at least in AE, of increased transparency about guiding assumptions, and more frequent attention to power in the food system in more recent publications[37,42,44]. Nevertheless, we also see a continued tendency of assumptions remaining hidden and crop farming continuing to be in focus in newer publications on currently 'hot' topics such as climate-smart[8] or regenerative agriculture[11].

To change the current situation of scientists overstating their findings and not seriously engaging with alternative perspectives, we suggest that scientific work needs to encompass more of critical reflection on the assumptions guiding research. We appreciate that this is difficult, both because scientists are generally untrained in critical self-reflection and often see themselves and their work as objective and neutral[2,45], and also because such humility and self-critical reflection is not rewarded in the academic system[6]. Young people, newer and less well-established research environments and communities are often important drivers of change and should indeed be appreciated as a source of inspiration. But the responsibility for facilitating the change needed must be placed with those upholding and being supported by the current system, such as full professors, funding bodies and powerful scientific networks.

So how can we make these academic leaders broaden their horizons about the role of science for sustainable transformations? An activity in our work towards this article, which helped us reflect over our own assumptions, was reading articles together, guided by the discourse-analytical perspective outlined in Box 1, and jointly discussing our readings in an interdisciplinary group. Exploring our assumptions with curiosity about each others' perspectives led us to see limitations in our own research and the values of others'. We want to emphasize that the outcome of such interdisciplinary dialogue is not that scientists should achieve consensus about the path towards sustainability: pluralism is a cornerstone of science. However, engaging in the type of self-scrutiny and dialogue that we propose would better equip scientists to enrich and nuance the societal debate on the future of agriculture.

Methods

We performed a bibliometric analysis of all articles with the topic 'agroecolog*' (AE) OR 'sustainable intensification' (SI) in the Web of Science (WoS) Core Collection published in English between 2012 and 2022, and a discourse analysis of a subset of highly cited articles as of May 2023 on each topic (Fig. 1). Our analysis is designed to quantitatively and qualitatively explore key tenets of influential research in AE and SI as well as the similarities, differences and interaction between the two. The analytical design allows methodological triangulation in which findings in the bibliometric analysis can be interrogated in the discourse analysis and vice versa. The qualitative and quantitative elements also complement each other in terms of analytical purpose. While the quantitative analysis enables the exploration of patterns in the respective fields in terms of, for example, the frequency of certain terms used, the qualitative analysis enables the building of understanding about the wider reasoning underlying patterns identified in the quantitative analysis. In contrast to some other approaches to combined quantitative and qualitative analysis of literature[46], our approach cannot detect changes over time in the dataset.

Keyword analyses

To analyse the potential separation and interaction between AE and SI, we considered the 7,366 WoS articles with the topic 'agroecolog*' OR 'sustainable intensification' published between 2012 and 2022 (Fig. 1b). Only 1.7% of the articles included both topics. We extracted the WoS 'KeyWords Plus', that is, keywords that frequently appear in the titles of the references cited in the article, identified via a proprietary Clarivate algorithm. KeyWords Plus are generally more broadly descriptive than authors' keywords, but equally suited to delineating a scientific field[47]. AE and SI articles were associated with 7,794 and 3,993 KeyWords Plus, respectively.

Keywords with similar meanings were aggregated manually. To this aim, we carefully evaluated the KeyWords Plus appearing in at least 0.3% of the articles, that is, associated with at least 17 articles for AE and 6 articles for SI. The 0.3% threshold was such that all of the most common KeyWords Plus were included, but their number (504 unique keywords, after combining the keywords in the AE and SI articles) was manageable for manual aggregation. Singular and plural and different spellings or variants of the same word were grouped. Moreover, keywords that we, based on our expert judgment, considered thematically similar were grouped together. For example, 'diversity' was grouped with 'biodiversity', 'diversification', 'agricultural biodiversity', 'agrobiodiversity', 'crop diversification', 'functional diversity', 'plant diversity', 'species-diversity', 'biodiversity conservation', 'farmland biodiversity' and 'species richness'. Similarly, 'crop yield' was grouped with 'crop productivity', 'grain-yield', 'maize yield', 'yield', 'yield stability', 'productivity', 'yield response', 'corn yield' and 'yields'. The resulting list of synonyms is provided in Supplementary Data.

The thematically aggregated KeyWords Plus (7,579 for AE and 3,776 for SI) were analysed for their frequency within the respective datasets on AE and SI (Fig. 2). To evaluate the conceptual overlap and interaction between AE and SI, we created a co-occurrence network of the 9,516 unique thematically aggregated KeyWords Plus when both datasets were combined (Fig. 3). All the bibliometric analyses were performed in R (version 4.1.3) using the package 'bibliometrix' version 4.1.2 (ref. 48).

Discourse analysis of selected highly cited articles

To identify influential research within AE and SI, we extracted articles flagged as 'highly cited' by the WoS in November 2022 and May 2023 from the whole dataset of 5,462 AE articles and 1,991 SI articles. The 'highly cited' articles comprise the top 1% of articles based on the number of received citations compared with other articles published in the same year and field (based on data from the Essential Science Indicator). In May 2023, there were 66 highly cited articles on AE and 74 on SI (Fig. 1a). The full list of highly cited articles can be found in Supplementary Data.

By reading the titles and abstracts of all the highly cited articles, we selected a subset of articles that were judged to represent common ways of reasoning within the whole set of highly cited articles within AE and SI, respectively, and that embraced the issue more broadly, for example, through a review. To ensure that our in-depth analysis covered articles that can be seen as representative of a dominant way of reasoning within AE and SI, we also performed a network analysis to identify the articles' conceptual connections. Specifically, we identified clusters of the highly cited articles based on their bibliographic coupling, that is, the number of shared references. Highly cited AE articles belonged mostly to two large clusters, which included the articles from our initial selection. The remaining clusters comprised one to three articles each and pertained to very specific topics deemed not central for our purposes (such as microplastics, the use of nanoparticles for sustainable agriculture, aflatoxins and fertilization technology). SI articles grouped in one large cluster, three clusters with four to seven articles each, and several smaller ones, some of which were not directly related to our purposes. Our initially selected articles belonged to four clusters, including the largest ones. The only intermediate cluster not included in our initial choice was one that focused specifically on intercropping and was deemed too specific to represent the broader research field of SI. Other clusters not covered by our initial reading list were more methodological in nature. Ultimately, we selected seven articles on AE and five on SI, as outlined in Results.

The selected articles were subjected to a close reading and coding based on eight questions to guide the discourse analysis (Box 1)[18]. Each author read and coded the articles individually before a discussion was held about our respective codings, including reasons for the similarities and differences among us, and joint conclusions drawn about key findings from the analysis.

Reporting summary

Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Data availability

The 7,366 articles used in our analysis can be retrieved from WoS as described in Methods. Alternatively, this list can be provided by the authors upon request. The manual aggregation of KeyWords Plus appearing in at least 0.3% of the articles is appended in Supplementary Data. The highly cited WoS Core collection articles from 2012 to 2022 with 'agroecology*' and 'sustainable intensification' as topics as of 12 May 2023 from which we selected a subset for our discourse analysis are appended in Supplementary Data.

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Author contributions
K.F. and R.B. led the funding acquisition and conceptualization. K.F., G.V., H.R., H.L. and R.B. contributed in the funding acquisition and conceptualization. K.F. led the discourse analysis and the interdisciplinary discussions. K.F., G.V., H.R., H.L. and R.B. contributed individually and jointly to the discourse analysis and to the interdisciplinary discussions. G.V. designed and performed the bibliometric analysis with input from K.F., G.V., H.R., H.L. and R.B. K.F. led the writing. K.F., G.V., H.R., H.L. and R.B. contributed in writing the original draft and to the review and editing.

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The 7366 articles used in our analysis can be retrieved from WoS through a Topic search limited to the time span 2012-2022 for the terms "agroecolog*" OR "sustainable intensification". Alternatively, this list can be provided by the authors upon request. The manual aggregation of KeyWords Plus appearing in at least 0.3 % of the articles and the highly-cited WoS Core collection articles from 2012-2022 with "agroecology*" and "sustainable intensification" as topics as of May 12th, 2023 from which we selected a subset for our discourse analysis are appended in a supplement to the article.

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Study description

The study is a mixed methods study. We performed a bibliometric analysis of all articles with the topic "agroecolog*" OR "sustainable intensification" in the Web of Science (WoS) Core Collection published in English between 2012 and 2022, and a discourse analysis of a subset of highly cited articles as of May 2023 on each topic.

Research sample

We explored two dominant scientific discourses on agriculture with the fields of "agroecolog*" and "sustainable intensification" as identifiers. Data was sourced from Web of Science Core Collection published in English between 2012 and 2022 and the discourse analysis of a subset of highly cited articles as of May 2023 on each topic (see Methods for details). The bibliometric analysis drew on all 7366 identified articles in Web of Science Core Collection published in English between 2012 and 2022. The textual discourse analysis made use of a selection of highly cited articles in the two fields. The rationale for the bibliometric analysis included analysing the potential separation and interaction in terms of citations between the two scientific discourses. With the keyword analysis we explored and compared topics that were more or less promoted in each field. The rationale for the discourse analysis was to explore how scientific endeavours are shaped by their approaches to knowledge, and by their wider assumptions about the world. The discourse analysis was guided by a list of eight questions designed to capture the assumptions that guide research through a focus on dentifying how problems and solutions are framed and the underlying epistemology. We carefully considered representativity in the samples for both data sets analyzed: the bibliometric analysis and the discourse analysis. (see detailed description in Methods).

Sampling strategy

To bibliometrically analyse the potential interaction in terms of co-citations between AE and SI, we considered all the 7366 articles found in from Web of Science Core Collection with the search term "agroecolog*" OR "sustainable intensification" published between 2012 and 2022. We also explored the topics considered in each research field based on analysis of KeyWords Plus. To enable these analyses we first manually merged synonym keywords such as "biodiversity" with "diversity", "crop yield" with "maize yield" and "yield" and "yields". Hence, we did not sample a subset of the data to analyse. Instead we analysed the full data set.
For the discourse analysis we extracted articles flagged as "highly cited" by the Web of Science in November 2022 and May 2023 from the whole dataset of 5462 AE articles and 1991 SI articles. The "highly cited" articles comprise the top 1 % of articles based on the number of received citations in comparison with other articles published in the same year and field (based on data from the Essential Science Indicator). In May 2023, there were 66 highly cited articles on AE and 74 on SI. By reading the titles and abstracts of all the highly cited articles and discussing these within the author group, a subset of articles was selected that were judged to represent common ways of reasoning within the whole set of highly cited articles within AE and SI respectively, and that embraced the issue more broadly, for example through a review. To ensure that our in-depth analysis covered articles that can be seen as representative of a dominant way of reasoning within AE and SI, we also performed a network analysis to identify the articles' conceptual connections. Specifically, we identified clusters of the highly citied articles based on their bibliographic coupling, i.e. the number of shared references.

Data collection

We performed a bibliometric analysis of all articles with the topic "agroecolog*" OR "sustainable intensification" in the Web of Science (WoS) Core Collection published in English between 2012 and 2022.
To analyse the potential separation and interaction between agroecology (AE) and sustainable intensification (SI), we considered the 7366 WoS articles with the topic "agroecolog*" OR "sustainable intensification" published between 2012 and 2022. Only 1.7 % of the articles included both topics. We extracted the WoS 'KeyWords Plus', i.e. keywords that frequently appear in the titles of the references cited in the article, identified via a proprietary Clarivate algorithm. We manually grouped key words with similar meaning, such as singular and plural forms of the same words, maize and corn, diversity and biodiversity etc.

To identify influential research within AE and SI, we extracted articles flagged as “highly cited” by the Web of Science in November 2022 and May 2023 from the whole dataset of 5462 AE articles and 1991 SI articles. The “highly cited” articles comprise the top 1 % of articles based on the number of received citations in comparison with other articles published in the same year and field (based on data from the Essential Science Indicator). In May 2023, there were 66 highly cited articles on AE and 74 on SI.
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The researcher was not blinded by the experimental conditions. The analysis was not hypothesis driven beyond an a priory general expectation for there to emerge differences between the two fields of research, e.g., in terms of topic focus, epistemology, premises etc, in the analyses. The bibiometric analysis was exploratory. Hence, we did not have an a priory expectation on the extent of co-citation between the fields or research focus based on the keyword analysis. Given our research approach we consider that bias is always part of the resarch process. We have treated this by being reflexive and transparent with our approach and by critical peer-scrutiny in the author group.

Timing	The Web of Science searches were performed between November 2022 and May 2023
Data exclusions	No data were excluded from analysis
Non-participation	No participants were involved in the study
Randomization	For the bibliometric analysis we analysed all articles that we found from the literature database. Hence, a randomized sub-sample from the population of articles was not needed to be taken. For the discourse analysis we applied carefully chosen selection criteria, mainly based on the number of citations by the global scientific community, to achieve representativity of high impact articles to analyse in the two fields. Also here we analysed all selected articles.

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