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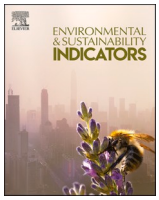

Mapping the economic sustainability indicators for European livestock systems and their alignment with policy objectives: A systematic review

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ABSTRACT

Livestock production is a cornerstone of the European agri-food system, contributing substantially to food security, rural livelihoods, and economic activity, while simultaneously facing increasing economic, environmental, and social pressures. As European agricultural policy evolves, there is a growing need for robust indicators capable of monitoring the economic sustainability of European livestock production systems (ELPS) and assessing policy outcomes. This study presents a systematic literature review (SLR), mapping and evaluating farm-level economic indicators used to assess ELPS, with a specific focus on their alignment with current Common Agricultural Policy (CAP) economic objectives. Following PRISMA guidelines, the literature between 2015 and 2025 was reviewed, and a total of 626 indicators were identified, which were subsequently classified into four economic objectives aligned with CAP specific objectives. Results reveal a strong dominance of profitability indicators, particularly income- and cost-based measures, while indicators addressing durability, autonomy, and diversification remain comparatively scarce. Significant but weak associations were found between indicator use and livestock sector and region. Overall, the literature aligns well with CAP objectives related to farm income and competitiveness but insufficiently addresses objectives linked to fairness, risk management, and diversification. The findings underscore the need for a more balanced and harmonized indicator framework, greater methodological transparency, and expanded use of indicators beyond profitability. The ongoing transition from the Farm Accountancy Data Network (FADN) to the Farm Sustainability Data Network (FSDN) offers a key opportunity to address these gaps and strengthen policy monitoring.

1. Introduction

Livestock production is a key component of global food systems, but is also associated with significant sustainability challenges (Akash et al., 2022; Smith et al., 2013). Over the last decades, global demand for animal-based protein has risen alongside population growth, leading to steadily increasing consumption (FAO and Shaping the future of livestock, 2018). Livestock production plays a substantial role in both developed and developing countries, contributing to food supply, livelihoods, and agricultural economies (Smith et al., 2013). At the same time, it is the major land use activity, and food-feed competition is an issue that impacts not just environmental sustainability but also food security (Poore and Nemecek, 2018).

In Europe, livestock production signifies a crucial part of the block's agricultural economy, representing 42% of the total agricultural output (European Commission, 2025a). The sector is a key source of income and employment for rural areas, and plays a vital social role in enhancing rural vitality (Hostiou et al., 2020; Mosnier et al., 2021). Additionally, livestock production underpins diverse value chains, generating a multiplier effect, and contributes to the European food security strategy, ensuring a stable supply of high-quality animal protein (Mosnier et al., 2021; Adams et al., 2025). Livestock production at the European level has also mixed effects on biodiversity and other ecosystems services: it contributes positively through the maintenance of permanent grassland and hedges, but is also associated with biodiversity loss, largely driven by feed production (European Commission: Directorate-General for Agriculture and Rural Development; Kricsfalusy et al., 2011; Leip et al., 2015).

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However, European livestock production is currently facing many challenges across the economic, environmental, and social sustainability dimensions. These challenges include greenhouse gases (GHG) emissions, particularly methane emission derived from enteric fermentation, air and water pollution, negative consumer perceptions, and animal welfare issues (FAO and Strategic Framework, 2022-2031, 2021; Zakova et al., 2020; Bielza et al., 2025). In the economic dimension, volatility in international markets has affected the viability of livestock systems (Hristov et al., 2024; Timpanaro and Foti, 2024). Additionally, income distribution across the different actors remains as a factor of concern, particularly regarding income returns for labour employed across sector compared with the non-agricultural activities (Parzonko and Borawski, 2020). Competitiveness has become a crucial factor, adding pressure, mostly in light of international trade and competition and potential free-trade agreements (Cele et al., 2022).

Accordingly, the European policy landscape and the livestock sector are evolving to adapt to the new circumstances and support farmers through these challenges. Interest in sustainable livestock production systems continues to grow, reflected within various European Union (EU) policies and private initiatives (European Commission, 2022). The objectives and supports of the EU 2023-2027 Common Agricultural Policy (CAP) highlight the importance placed on the multidimensionality of agriculture, and the urgent need to transition towards more sustainable agricultural systems (European Commission, 2022). Moreover, the ongoing development of the CAP 2028–2034 proposal illustrates that these objectives are being reinforced, even if the current structure may change (European Commission, 2025b).

Additionally, as stated in the Farm to Fork Strategy, the European Union (EU) is aiming to become the global standard for agri-food production (European Commission, 2020a). Nevertheless, this ambition is adding pressure on farmers to adapt to regulatory frameworks, restraining competitiveness, and generating an 'administrative burden' (Malak-Rawlikowska et al., 2024; Kuhn et al., 2019; El et al., 2025). At the same time, recent EU policy developments suggest an evolving recalibration of priorities, reflecting ongoing tensions between sustainability objectives, food security, and the economic viability of farming within the agri-food system (Council of the European Union, 2024).

In this transformation process, the CAP objectives have evolved from just income support to include other aspects of economic sustainability, stating its aim of a resilient agricultural sector capable of long-term economic viability (European Commission, 2022). Specifically, CAP objective 1 targets farm income and its distribution, risk management, and public support, while objectives 2 and 3 focus on competitiveness (productivity and costs) and farmers' position in the value chain, including premium prices and diversification.

In this context, it is fundamental to improve our understanding of economic sustainability in livestock production, and track changes in production systems to ensure desired policy outcomes. Key to the monitoring of livestock production system sustainability is the existence of indicators which can measure policy objectives and provide a comprehensive and consistent picture of the performance of these systems (Dillon et al., 2016). Overall, a growing body of literature is focusing on the definition and measurement of farm-level sustainability (Custodio et al., 2023; Chopin et al., 2021; Arulnathan et al., 2020). Although the environmental dimension has received increased attention in recent years, the economic dimension has also been extensively studied and is well represented in both the literature and European and national statistics (Lynch et al., 2019; Latruffe et al., 2016; van der Linden et al., 2020). As a result, a large number of economic indicators are currently available (Latruffe et al., 2016; Lebacq et al., 2013; Smith and Hayden, 2025), with such availability revolving around the existence of the Farm Accountability Data Network (FADN), a standardised database that allows to study the characteristics and evolution of European agriculture (Tomaš et al., 2025).

Nevertheless, the current challenges of the sector and evolving policy landscape may challenge the completeness, usefulness, and depth of existing economic indicators, highlighting the need to systematically assess the economic indicator literature in relation to European livestock production and policy. Indeed, identifying and mapping indicators which assess the economic sustainability of livestock production is needed to examine their alignment with emerging policy objectives and evaluation needs in different European regions and sectors. As a result, gaps for further indicator development could be identified, notably for EU CAP monitoring. This is the main objective of this article.

In the literature, studies analysing and reviewing economic indicators for livestock production are not new. Several reviews have systematically examined the literature on sustainability indicators for specific livestock systems of developed countries (see Gunnarsson et al., 2020a; Gunnarsson et al., 2020b; Arvidsson Segerkvist et al., 2020; Arvidsson Segerkvist et al., 2021). These studies concluded that the literature tended to focus on individual dimensions of sustainability, rather than capturing the trade-offs and synergies between them. Bathaei and Štreimikienė (2023) conducted a systematic review of sustainability indicators in the agricultural sector worldwide, proposing a set of indicators for sustainability assessment. Latruffe, Diazabakana et al. (Latruffe et al., 2016) discussed different sustainability indicators in relation to European policies, highlighting the importance of validation, credibility and replicability of indicators. Finally, Smith and Hayden (2025) systematically reviewed the economic sustainability of farming enterprises, followed by a thematic analysis on the economic themes researched.

While these reviews establish a strong foundation for the study of economic sustainability indicators in livestock systems, several limitations remain. First, many of those reviews adopt a broad focus on agricultural systems across multiple regions, limiting their ability to capture the specific characteristics and policy context of different European livestock sectors. Hence, the importance of regional specificities is diluted, which is particularly important for EU policy development and monitoring. Moreover, EU agricultural policy is unique, notably through its model of income support, therefore requiring its own literature review (Mitchell et al., 2019). Second, many of the reviews are focused on one livestock system, e.g., dairy, or poultry, missing the interactions and differences among sectors. Third, these reviews generally examined the three sustainability dimensions: economic, social, and environmental. This holistic approach reduces the focus on the economic dimension and limits the depth of analysis. Final, to the best of our knowledge, the most recent reviews are dated 2020 – 2021, prior to the constitution of the CAP 2023-27 objectives. Thus, a more contemporary analysis is missing.

Therefore, we aim to address these knowledge gaps through the following specific research objectives: (1) to systematically review and map existing economic indicators used to measure the impact of European Livestock Production Systems (ELPS) at the farm level; (2) to evaluate the adequacy and alignment of these indicators with the evolving objectives of European agricultural policy, particularly the CAP 2023-2027 period; (3) to analyse if and how these indicators differ across livestock sectors and regions; and (4) to provide an updated synthesis of the state of the art, highlighting knowledge gaps and proposing areas for further development.

2. Methodology

This research adopts a systematic approach to achieve the intended objectives and map the existing indicators measuring the economic impact of ELPS. Systematic Literature Reviews (SLR) are a strong method for mapping the current knowledge in a given area and highlighting potential gaps, improving the replicability, transparency, and robustness of traditional review methods (Gunnarsson et al., 2020a; Arvidsson et al., 2021). Particularly, the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) methodology aims to homogenise and standardize the process of SLR by proposing a detailed, step-by-step structure for the search and retrieval of the information

(Page et al., 2021). The PRISMA methodology is a standard commonly followed by SLRs (Smith and Hayden, 2025; Page et al., 2021; Sullivan et al., 2024) and is adopted in this article.

For conducting the SLR, a relevant search string was designed, looking to be broad enough to retrieve all the relevant literature, but specific enough to reduce the results that were not related to the research topic. The design of the search string included expert consultation and multiple focus groups. The final search string contained four modules, targeted at the Title, Abstract, and Keywords:

1. A first module identifying articles dealing with indicators, impact categories, metrics, parameters, and externalities;
2. A second module restricting the search to economic or financial articles;
3. A third module focusing on the population (ELPS, including large and small ruminants, pigs and poultry, and associated livestock products); and
4. A fourth module limiting the region of analysis (European Union (EU), European Economic Area (EEA), and United Kingdom (UK)).[1]

Boolean operators were used to combine the modules, with 'OR' operators within modules and 'AND' operators between modules. Additionally, three more restrictions were introduced to reduce the search to the last 11 years, to original peer-reviewed articles, and to articles written in English only. The complete search string can be found in the supplementary material.

The search string was used in the Scopus database, retrieving 904 articles. Additionally, after expert recommendations, 23 more articles were added, totalising a sample of 927 articles. Following removal of duplicates, these articles were screened by title and abstract, assessing them against a set of inclusion and exclusion criteria. The inclusion and exclusion criteria are described in Table 1. After the screening and inclusion and exclusion criteria assessment, 181 articles were selected for inclusion in the review. These figures are expressed in the following PRISMA diagram presented in Fig. 1.

The full text of the 181 selected articles was reviewed, and their relevant information included in a data extraction table, which is provided as supplementary material. The extracted information included the following items:

- General information about the article:
  - o Year of publication,
  - o Location of the research,
  - o Livestock systems studied,
- Specific information about the indicator(s) under study:
  - o Utilised indicators,
  - o Scope of sustainability assessment (economic-only vs. multi-criteria across multiple sustainability dimensions),
  - o Economic objective (based on the Lebacq, Baret et al. (Lebacq et al., 2013) classification described hereafter),
  - o Data type (quantitative or qualitative)
  - o Data structure (cross-sectional or panel),
  - o Ex-ante or ex-post analysis,
  - o Obtained values. These refer to the average figures for the indicator at the specific article,
  - o Measurement unit,
  - o Indicator methodology, referring to the standards followed to calculate the indicator. For instance, FADN methodology, or Sustainable Assessment of Food and Agriculture Systems (SAFA).

Table 1
Inclusion and exclusion criteria.

Inclusion criteria	Rationale
Contain one (or more) economic indicator(s) and focus on economic impact	The purpose of the review is to map existing economic indicators.
Be based (at least partially) in the region of analysis	The targeted region of analysis is the EU, EEA, and UK.
Study a livestock production system	The targeted population are Livestock Production Systems.
Focus up to the farm gate	The targeted population was limited up to the farm gate, excluding post-farm gate studies.
Original peer-reviewed article	Review articles, working papers, and grey literature are excluded from the SLR.

The extracted data was analysed and categorised. Categorisation of the results has been recommended as a tool for interpretation of the results of a systematic literature review (Bathaei and Štreimikienė, 2023; Siksnelyte-Butkiene et al., 2021). Several frameworks are available to conduct economic sustainability assessment and classify economic indicators (e.g., de Olde et al., 2016; FAO et al., 2013; Robling et al., 2023). In this work, we adopted the classification of economic sustainability indicators suggested by Lebacq et al. (2013) as the main conceptual framework. This framework was chosen because it can be easily aligned with the 2023-27 CAP specific objectives and, therefore, can provide insights on the adequacy and alignment of reviewed indicators with those objectives. Table 2 illustrates the structure of farm-level economic based CAP objectives. Additionally, this classification was established based on a literature review of European livestock production, which is still widely used in scientific literature. Hence, the classification was aligned with the targeted population.

Following the mentioned framework, the reviewed indicators were coded into groups representing the same or similar concepts. Those concepts where subsequently grouped into economic subthemes. Finally, the subthemes were categorised into different economic themes or objectives. It is important to highlight that the classification was not completely exclusive: i.e., the same indicator can be used to reflect different themes.

In our context, the number of subthemes in Lebacq, Baret et al. (Lebacq et al., 2013) was expanded, looking to describe more precisely the indicators identified, and to align them with current CAP objectives. According to the Lebacq, Baret et al. (Lebacq et al., 2013) framework, economic indicators can be grouped into subthemes that are subsequently aggregated into four different economic objectives. The four economic objectives and subsequent subthemes, and how they align with the 2023-27 CAP specific objectives, are presented in Table 3.

Following this classification, the use of the different indicator categories was analysed for the different livestock sectors and regions[2] (United Nations et al., 2018), looking for potential differences in the application and use of different types of indicators in the different livestock sectors or regions. For this reason, the Pearson's Chi-square Test was used to examine the potential association between the livestock sector (region) studied and the economic objective of the indicators. Pearson's Chi-square test was estimated as:

[1] Although the UK and EEA countries are not governed by the CAP, their inclusion is justified as their agricultural policy frameworks share similar objectives. In addition, their inclusion allows for a more comprehensive mapping of the economic indicators used for assessing the sustainability of ELPS.

[2] Each region included the following countries:
Northern Europe: Denmark, Estonia, Finland, United Kingdom, Ireland, Latvia, Lithuania, Norway, Sweden.
Eastern Europe: Bulgaria, Hungary, Moldova, Ukraine, Poland, Romania, Slovakia, Czech Republic.
Southern Europe: Greece, Italy, Croatia, Malta, Portugal, Slovenia, Spain.
Western Europe: Belgium, Germany, France, Liechtenstein, Luxembourg, Netherlands, Austria, Switzerland.

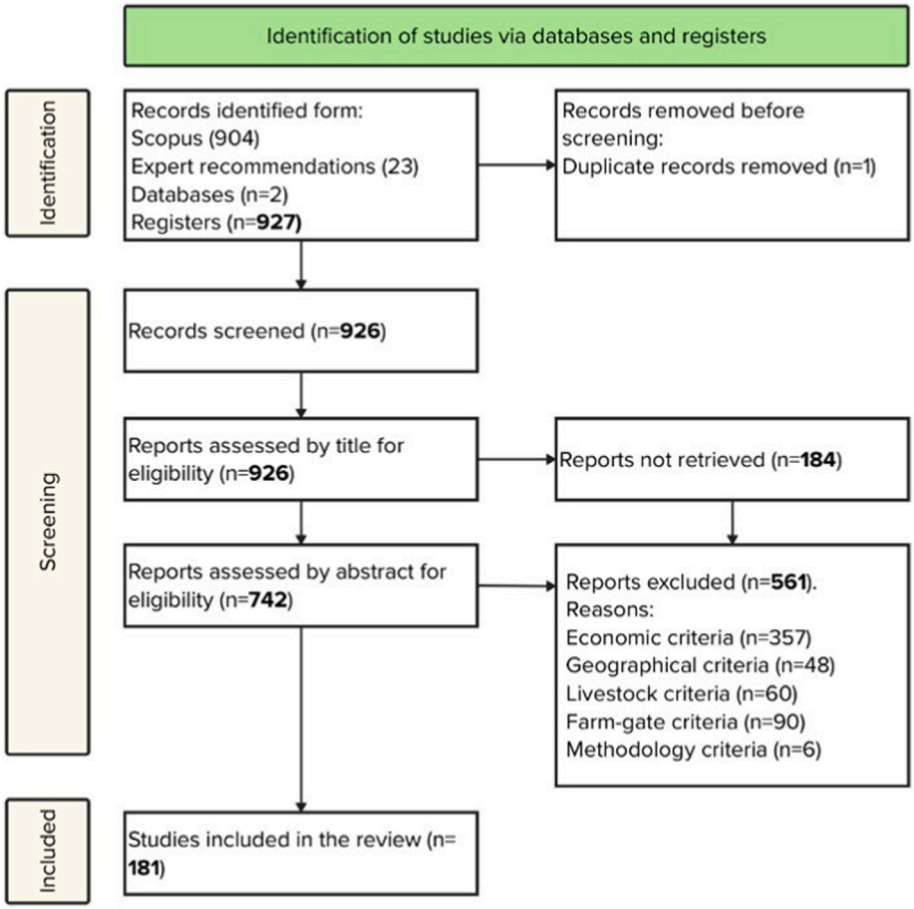

Fig. 1. PRISMA diagram.

Table 2
Description of economic CAP specific objectives.

CAP specific objective	Subobjectives
CAP specific objective 1: Ensuring viable farm income	Farm income
	Income distribution
	Assets and liabilities and resilience
	Public support
	Public support distribution
	Income volatility
	Risk management
CAP specific objective 2: Increase competitiveness	Productivity
	Production costs
CAP specific objective 3: Improving the position of farmers in the food chain	Premium prices
	Diversification

$$x^2 = \sum_{i=1}^{R} \sum_{j=1}^{C} \frac{(o_{ij} - e_{ij})^2}{e_{ij}}$$

Where i and j are the indexes for a contingency table of livestock sector (region) and economic objective, and o_{ij} and e_{ij} are the observed and expected frequencies, respectively. The null hypothesis for the test (H_0) is that the livestock sector (region) studied is independent of the economic objective. When significant, the Cramer's *V* test was used to determine the strength of the association. Cramer's *V* ranges from 0 to 1, with <0.3 being a weak association, and >0.5 a strong association. Additionally, a standardised results table was used to analyse the differences between observed and expected frequency for each sector (region).

Finally, indicators were also classified according to their measurement units and methodological approach. In particular, the FADN framework, along with other recognised methodologies, was used as a reference benchmark for this classification.

3. Results and discussion

3.1. Sample description

The timeline of the 181 articles included in the SLR is reported in Fig. 2. The figure shows an overall increasing trend in publications between 2015 and 2021, followed by a decline in 2022 and a recovery towards 2025.

Table 4 summarises the main characteristics of the reviewed studies. Most articles were based on retrospective (ex-post) analysis, while a smaller share adopted prospective (ex-ante) approaches. The literature is overwhelmingly based on quantitative data, with only a limited number of studies using qualitative methods, typically for more complex aspects such as risk management. In terms of scope, most studies focused exclusively on the economic dimension, while a smaller proportion applied multicriteria approaches integrating additional sustainability dimensions. This finding is consistent with previous reviews (Gunnarsson et al., 2020a, 2020b; Arvidsson et al., 2020, 2021), which show that studies typically focus on a single sustainability dimension.

The classification of articles by livestock sector is presented in Table 4. Bovine systems were the most studied, accounting for 45% of the literature (31% dairy and 14% beef). Small ruminants represented 30% of the sample (12% meat sheep, 10% dairy sheep, and 8% goats). Finally, monogastric systems accounted for the remaining 24% of the articles (12% pigs, 7% broilers, and 5% laying hens).

Interestingly, the distribution does not fully reflect the economic size

Table 3
Economic objectives and subthemes.

Economic theme	Economic subtheme	Description	CAP specific objectives
Profitability *Analysis of economic outputs, inputs and the relationship between them* (Bathaei and Štreimikienė, 2023)	Income	Measures of the difference between output and costs	Specific objective 1: Ensuring viable farm income
	Costs	Analysis of the value of production factors	Specific objective 2: Increase competitiveness
	Output	Value of the generated output	Specific objective 3: Improving the position of farmers in the food chain
	Efficiency	Relationship between the level of inputs and outputs	
	Price	Market value of the output units	
	Investment	Economic analysis of improvement strategies	
	Breakeven point	Amount of outputs needed to equal incurred costs	
	Management	Decision-making process	
Durability *Economic capacity of systems to perdure over time*	Resilience	Ability of systems to overcome external shocks maintaining their core functions (Meuwissen et al., 2019)	Specific objective 1: Ensuring viable farm income
	Liquidity	Capacity to answer short-term obligations (Bathaei and Štreimikienė, 2023)	
	Solvency	Structure of assets and relation between assets and liabilities	
	Income volatility	Levels of fluctuation in income over time	
	Risk	Impact of uncertainty on systems and their capacity to deal with it (Asseldonk et al., 2016)	
Autonomy *Systems' dependence on external factors*	External inputs	Reliance of systems on external actors for supply of production factors (Lebacq et al., 2013)	Specific objective 1: Ensuring viable farm income Specific objective 3: Improving the position of farmers in the food chain
	Subsidies	Level of dependence on public support	
Diversification *Level of dependence on one main income source*	Diversification	Level of dependence on one main income source (Lebacq et al., 2013)	Specific objective 3: Improving the position of farmers in the food chain

of each sector. Fig. 3 compares the share of reviewed articles with the economic size of each sector over the period 2015–2024, measured as the proportion of total livestock production value at basic prices attributable to each subsector (European Commission, 2025a). For bovines, research attention is broadly aligned with economic size (45% of articles vs. 56% of economic output). In contrast, small ruminants account for only around 3% of total livestock economic output, while monogastric systems account for approximately 45%. Despite this, the literature places comparatively greater emphasis on small ruminants (30%) than on monogastric systems (24%).

This imbalance between the relative size of livestock sector and research focus has previously been highlighted in the literature (van der Linden et al., 2020). A range of factors may contribute to this discrepancy. On the one hand, sheep and goats constitute an important source of income in disadvantaged areas and are a significant part of the European cultural heritage. Both factors, in a context of low profitability and constant decline in farm numbers, have made those systems a target for public support (European Parliament and Policies, 2008; Soriano et al., 2024). On the other hand, monogastric production is frequently characterized by concentrated sectors with a smaller number of highly intensive, vertically integrated large companies, with little or no public support (European Parliament and Service, 2019, 2020). This lower level of support also reduces the reporting requirements, making less data publicly available (Sullivan et al., 2024).

The research location of published articles, classified by region is presented also in Table 4. This reveals that research has not been conducted evenly in the different regions. Particularly, Western Europe has attracted most articles (34%). Southern and Northern Europe have conducted similar proportion of articles (26%), while Eastern Europe has the lowest number of articles (14%). While this regional classification facilitates comparison, it may conceal heterogeneity within regions. Geographically, most studies have been completed in France (12%), Italy (11%), Spain (9%), Germany (7%), Ireland (6%), the Netherlands (6%), Poland (6%), and the UK (6%).

The research location of articles was also compared with the animal economic output of each area, measured as the proportion of total livestock production value at basic prices at the EU aggregate level that is attributable to each region (European Commission, 2025a). The comparison can be seen in Fig. 4. In this case, the distribution of articles by research location does follow an expected distribution, reflecting a similar trend to that of the economic output of each region. Particularly, for Southern Europe, both the reviewed articles and the economic output represent circa a quarter of the total (26% and 23%, respectively) – similar to Eastern Europe, where both figures account for 14% and 13% of the total. There are smaller differences for Northern Europe, with 26% of the reviewed articles and 19% of the economic output. Similarly, Western Europe represents the larger frequencies, with 34% of the articles and 45% of the economic output. Overall, the distribution of articles relates more to the economic output when classified by research location than when classified by livestock sector.

3.2. Mapping of indicators

The 181 reviewed articles included a total of 626 economic indicators. These 626 indicators were summarized into 108 concepts, or 'unified indicators'. Afterwards, these 108 unified indicators were grouped into 16 subthemes, or impact categories. Finally, the 16 impact categories were grouped into the 4 different economic objectives based on Lebacq et al. (2013)'s framework. The frequencies of each economic objective and impact category are represented in Fig. 5. Table 5 presents some examples of the different indicators identified for each impact category. The complete list of articles, indicators, and unified indicators is presented in the supplementary material provided.

Most identified indicators (79.9%) belonged to the profitability objective, highlighting its central role in the literature. This category includes indicators based on revenues, costs, and their relationship. Within profitability, income-related indicators were the most prominent, including measures such as gross margin, income over feed costs, return on assets, and farm net income. Cost-related indicators were the second most frequent, followed by output, and efficiency. Efficiency indicators included both economic efficiency ratios and technical efficiency measures derived from frontier analyses. Other subthemes, such as investment, price, breakeven, and management, were less frequently

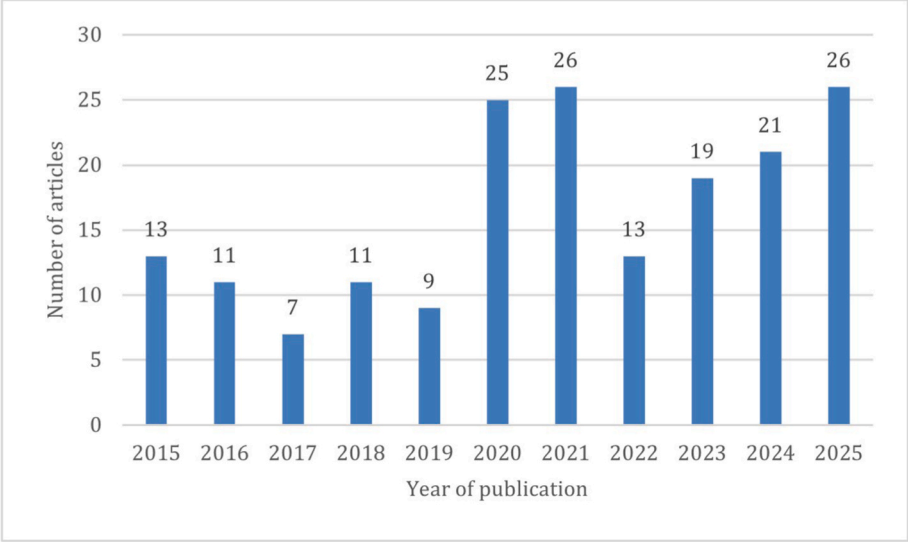

Fig. 2. Timeline of included articles.

Table 4
Sample characterisation.

Classification	Variable	Frequency
Type of analysis	Ex-ante	24%
	Ex-post	76%
Type of data	Quantitative	96%
	Qualitative	4%
Type of assessment	Purely economic indicators	70%
	Multicriteria assessment	30%
Livestock sector	Dairy cattle	31%
	Beef cattle	14%
	Dairy sheep	10%
	Meat sheep	12%
	Goats	8%
	Pigs	12%
	Broiler	7%
	Laying hens	5%
Region	Southern Europe	26%
	Northern Europe	26%
	Western Europe	34%
	Eastern Europe	14%

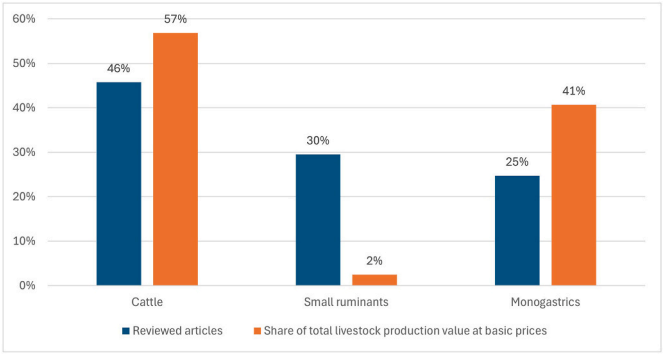

Fig. 3. Frequency of reviewed articles and economic output by livestock sector (European Commission, 2025a).

represented.

Durability was the second most represented objective (12.9%). Within this category, resilience was the most prominent subtheme, followed by liquidity and solvency, which included various financial ratios related to assets, liabilities, and cash flow. Indicators related to income volatility and risk were less common, although they capture important aspects of economic stability and exposure to uncertainty.

The autonomy objective accounted for 5.3% of the indicators and was mainly represented by subthemes related to subsidies and dependence on external inputs. These indicators reflect the extent to which farm performance relies on public support or external production factors. Finally, diversification was the least represented objective (1.9%), including indicators that assess the degree of farm diversification and the relative importance of different production activities.

As shown in Fig. 5, most of the mapped indicators corresponded to profitability indicators. These findings coincide with previous literature (Latruffe et al., 2016; van der Linden et al., 2020; Lebacq et al., 2013; Díaz de et al., 2021). Conversely, durability, autonomy, and diversification received less attention. Particularly, diversification is the economic objective that received the least attention in the literature. Different arguments can be discussed to explain this trend. Firstly, the traditional approach for analysing economic performance has been dominated by the analysis of productivity, income, costs, and overall profitability (Lebacq et al., 2013; Gunnarsson et al., 2020b; Arvidsson et al., 2020). There has been a more recent shift in policy towards broader economic objectives such as fairness, resilience, and diversification. This is reflected in the Farm to Fork Strategy (European Commission, 2020a, 2022). Nevertheless, as these policy changes are recent, their effects are not yet fully reflected in the literature. In this context, the transition from the Farm FADN to the Farm Sustainability Data Network (FSDN), which expands the scope of available data, is expected to support this process.

Secondly, classifying the different indicators and objectives among a cause-effect chain may help to understand the distribution. Different authors (Lebacq et al., 2013; Bockstaller et al., 2011, 2015) classify sustainability indicators in a continuum between causal or means-based indicators, based on a causal variable that will generate an impact; and measured effect indicators, which measure the actual impact or effect. Following this framework, profitability indicators tend to measure the actual effect and final objective of farming systems and economic activity, i.e., the result generated. Alternatively, durability, autonomy and diversification are more related to causal indicators, as they tend to measure variables that will impact economic performance.

Thirdly, data availability may influence the frequency of indicators. This is particularly true for some indicators that require sensitive data, such as solvency or debt management. Additionally, the existence of public databases, such as FADN, facilitates the use of secondary data for research purposes. When using indicators that are not based on this

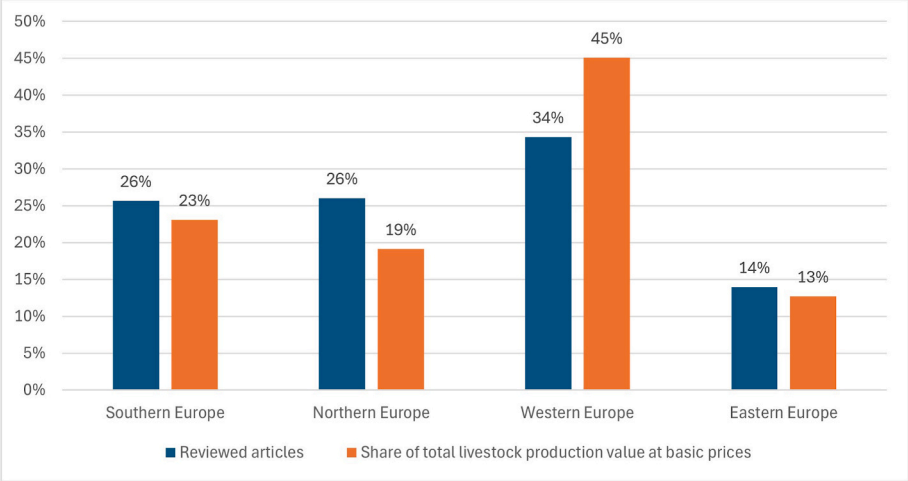

Fig. 4. Frequency of articles and economic output by location (European Commission, 2025a).

Fig. 5. Frequency of indicators by economic objective and subtheme.

database, data collection may constitute a barrier– for example, the limited data to measure "diversification". Finally, some of the indicators that appear less frequently are related to concepts that are still being discussed in the literature, and where the level of consensus is lower. For example, this is the case of resilience or diversification, where the definition, impact and ways of measurement are not clear (Paas et al., 2021; Wilczyński and Kołoszycz, 2021).

3.3. Alignment with CAP objectives

Based on this mapping of economic indicators present in the literature, it can be concluded that their distribution does not align evenly with CAP objectives, i.e., that some CAP objectives are more represented in the literature than others. This is particularly true for the CAP specific objective 1, ensuring farm income. In this case, some of the sub-objectives are much more represented in the literature than others. Most notably, this is the case for farm income levels, which is the most frequent subtheme described above. On the other end, some stated sub-objectives are less represented: risk management, income volatility, fairness in income support, and income distribution. Those sub-objectives are related to some of the less frequent subthemes described. In the middle of them, some sub-objectives are present in the literature but are less abundant, e.g., public support, and assets and liabilities.

In the case of the CAP specific objective 2, increased competitiveness, all its components are widely represented in the current review. Furthermore, indicators targeting the two subobjectives stated in this objective are substantially present: Production costs and Productivity. On the other hand, the reviewed indicators that target the CAP specific objective 3, improving the position of farmers in the food value chain, were less common. Particularly, neither premium prices, nor diversification, two of the sub-objectives of this CAP objectives, were frequently represented in the sample.

Therefore, this review shows that the literature uses and produces many different indicators capable of measuring the achievement of some of the CAP specific objectives. Nevertheless, it also shows that the use and presence of indicators for measuring some other specific objectives and, particularly, some of their subobjectives, is relatively scarce. Importantly, to adequately measure the impact of current policy, and the achievement of the stated objectives, development of new indicators

Table 5
Economic objectives, subthemes, frequencies, unified Indicators and identified Indicators.

Economic objective	Subtheme	Unified indicators (examples)	Indicators identified in the literature (examples)
Profitability	Income	Gross Margin Income over feed costs Farm net income	Gross margin, EBITDA, contribution margin Income over feed costs Family farm income, Net profit
	Costs	Feed costs Compliance costs Total costs	Feed purchased costs, cost of feed per kg of gain Compliance costs Total cash costs, unit cost
	Output	Revenue Value of production	Total value of production Land productivity
	Efficiency	Economic efficiency Technical efficiency	Output to input ratio Technical efficiency (Data envelopment analysis)
	Price	Price Milk to feed price ratio	Price premium Milk to feed price ratio
	Breakeven point	Breakeven point Income equal feed costs	Breakeven point of milk price Income equal feed costs
	Investment	Net present value Internal rate of return	Value of sow space unit Internal rate of return
	Management	Value chain analysis Innovation potential	Horizontal cooperation Innovation potential
Durability	Resilience	Income volatility Resistance to economic shock	Variation coefficient of income with an economic shock Resistance to economic shock
	Liquidity	Liquidity ratio Debt repayment	Quick ratio Level of indebtedness
	Solvency	Debt to equity ratio, Assets	Long-term debt-to-equity ratio Assets to land
	Income volatility	Income volatility Economic disruptions	Gross margin SD Number of economic disruptions
	Risk	Economic vulnerability, Risk management	Economic vulnerability Risk management
Autonomy	Subsidies	Subsidies dependence	Dependence on subsidies Subsidies over farm net value added
	External inputs	External input dependence, Share of rented land	Reliance on own resources Share of rented land
Diversification	Diversification	Diversification	Sources of income % of income from animal production

for the assessment of these less-represented categories is required. This is especially the case of fairness in public support distribution, income distribution, risk management, premium prices, income volatility, and diversification. Addressing these gaps will also be important in informing the design and monitoring of future policy frameworks beyond the current CAP programming period, particularly in the context of evolving sustainability objectives.

Notwithstanding this, it should be noted that CAP objectives extend beyond farm-level economic sustainability and include broader system-level and societal goals. This may partly explain why not all CAP objectives are fully captured within farm-level economic assessments. Therefore, the scope of this review, which focuses on farm-level economic indicators, does not encompass all dimensions of CAP policy design.

3.4. Test of association

A chi-square test of independence was performed to evaluate both the relation between the livestock sector, or the region, and the economic objective studied. In the analysis of the livestock sector, broiler and laying hens were grouped into poultry for increasing the level of observation in the lowest categories. The relationship between these variables was significant, $X^2\,(18, N = 1336) = 48.9, p < 0.01$. Therefore, the null hypothesis was rejected, i.e., the results suggest that the livestock sector and economic objective of reviewed indicators are significantly associated. However, the strength of the association was small (Cramer's $V = 0.11$).

The standardized results, presented in Table 6, suggest that profitability indicators are used more frequently than expected in the dairy sector. Conversely, durability indicators were used less frequently than expected in the same sector, and more frequently in poultry, pigs, and meat sheep sectors. Autonomy indicators were found more commonly in beef cattle, and less in the dairy cattle and poultry sectors. Finally, diversification indicators were infrequent for dairy cattle, while more recurrent in the poultry sector. Beef cattle, meat sheep, goats and pigs presented an overall similar tendency with slightly lower than expected for profitability indicators and higher than expected for durability, autonomy, and diversification indicators.

One explanation for this trend relies on the number of sectors targeted by the different studies. On the one hand, half of the articles analysing durability indicators targeted more than one livestock system. On the other hand, just 30% of the articles analysing profitability indicators targeted more than one livestock system. Therefore, distribution of durability indicators were more homogeneous among livestock systems. Conversely, profitability indicators, that tended to be based on just one livestock sector, concentrated more heavily on dairy farming. Nevertheless, the reasons of this trend are not completely clear. Further research is needed to better understand its causes.

As in the analysis of the livestock sector, the relationship between the region studied and the economic objectives of the indicator was significant too: $X^2\,(9, N = 1001) = 30.6, p < 0.01$. Therefore, the results suggest that there is a significant association between the variables. Nevertheless, as in the previous analysis, the strength of the association is small (Cramer's $V = 0.1$). The standardised results, presented in Table 7, suggest that Southern Europe studies were more focused than expected in autonomy, and less on durability. A similar trend is found for Eastern Europe, with less than expected frequency for durability, and more in profitability. Oppositely, Western Europe studies focused more than expected in durability, with less focus on profitability. Finally, Northern Europe data shown a similar trend for durability, and less than expected observations for autonomy.

Table 6
Standardized results from Chi-square test of association between livestock sector and economic objective of reviewed indicators.

	Profitability	Durability	Autonomy	Diversification
Dairy cattle	2.7	−2.6	−1.7	−2.2
Beef cattle	−0.9	0.5	1.1	0.6
Dairy sheep	0.7	−1.2	0.2	−0.6
Beef sheep	−0.3	0.7	0.0	0.0
Goats	−0.7	0.0	1.1	0.7
Pigs	−1.9	2.7	0.7	0.8
Poultry	−1.1	1.4	−0.3	1.9

Table 7
Standardized results from Chi-square test of association between region and economic objective of reviewed indicators.

	Profitability	Durability	Autonomy	Diversification
Southern Europe	0.6	−1.9	1.6	−0.3
Northern Europe	−0.2	1.9	−2.5	0.4
Western Europe	−1.5	1.3	1.7	0.7
Eastern Europe	1.4	−1.2	−1.4	−1.0

3.5. Indicators methodology

The units used to express the different indicators are presented in Fig. 6. The results show substantial variability, with similar indicators often expressed using different units. For example, farm net income was expressed as a total value (farm net income per farm per year), or normalised by different production factors, such as labour (farm net income per annual working unit), land (farm net income per hectare), livestock (farm net income per cow), output unit (farm net Income per kg of milk), or output value (profit margin).

More broadly, indicators were expressed using different types of units. These included monetary values (e.g., income or costs), ratios (e.g., debt-to-assets or output–input ratios), and physical or productivity-based units (e.g., per hectare or per animal). In addition, some indicators were expressed using scales (e.g., Likert scales), dimensionless measures (e.g., technical efficiency scores), variability metrics (e.g., coefficient of variation), composite indices, or binary (dummy) variables used to represent specific conditions such as viability.

Units, generally a monetary value, were expressed mostly in Euros (€), although other currencies were frequently present, including Sterling Pounds, United States Dollars, Romanian New Leu, Polish Zloty Equals, among others. This is not surprising as reviewed studies focused on different countries in the EU, EEA, and UK. Moreover, these values were expressed either as a total per farm, e.g., euro per farm per year, or as a function of other production factors, as shown in Fig. 6. Similarly to the use of different functional units in Life Cycle Assessments (LCA), indicator denominators varied depending on the purpose of the study (Kim et al., 2017). For example, values per land area were used to analyse land productivity or to compare farms of different scales. Values per labour unit were used to analyse labour productivity and compare with substitute activities, e.g., average income in other sectors. Unlike the use of indicators as total values, including a denominator can facilitate the comparison among farms and studies, if formulas and models used to generate the indicators remain the same and raw data is collected in similar ways.

The indicators were further classified into categories according to the methodology used for their calculation, which can be seen in Table 8. Approximately half of the indicators were based on the FADN framework or followed a similar methodological approach. An additional 5% relied on other recognised methodologies, e.g., FAO's Sustainability Assessment of Food and Agricultural systems (SAFA). A further 19% of the indicators captured specific concepts for which FADN methodologies are not applicable, e.g., partial budgeting. However, 14% of the indicators addressed concepts covered by FADN, but did not follow its methodological guidelines. Additionally, for 11% of the indicators, the methodology was not clearly described in the corresponding articles.

The findings of the economic SLR highlight the diversity of methodologies used for calculating the economic indicators. Harmonization and diversification of economic assessments appear as opposite concepts, both with benefits and challenges. On the one hand within the EU the FADN establishes the methodological standard for calculating different economic indicators (European Commission, 2020b). This methodology determines clearly different income indicators, and how each of them should be calculated. This method is aligned with international good practices related to bookkeeping and financial analysis (Argilés and Slof, 2001). As shown, a substantial proportion of the reviewed studies either adopted FADN as a baseline or applied other established methodologies. Harmonized approaches, such as those based on the FADN framework, improve the replicability and the impact of the results. Harmonization enhances comparability between studies and transparency of the research. The importance of validation, credibility, and replicability of indicators has already been highlighted by Latruffe, Diazabakana et al. (Latruffe et al., 2016).

On the other hand, diversification of approaches is necessary to capture the heterogeneity of livestock systems and the evolving scope of policy objectives. Particularly, region and system diversity imply that different indicators are needed to reflect different situations. Additionally, new CAP objectives include topics that may not be covered by standardised accounting frameworks. Nevertheless, the lack of a

Table 8
Indicators methodology.

Classification	Frequency
Using FADN as a baseline or FADN similar methodology	51%
Using other recognised methodologies	5%
FADN methodology non-applicable	19%
FADN methodology applicable, but not been followed	14%
Methodology is not clearly explained	11%

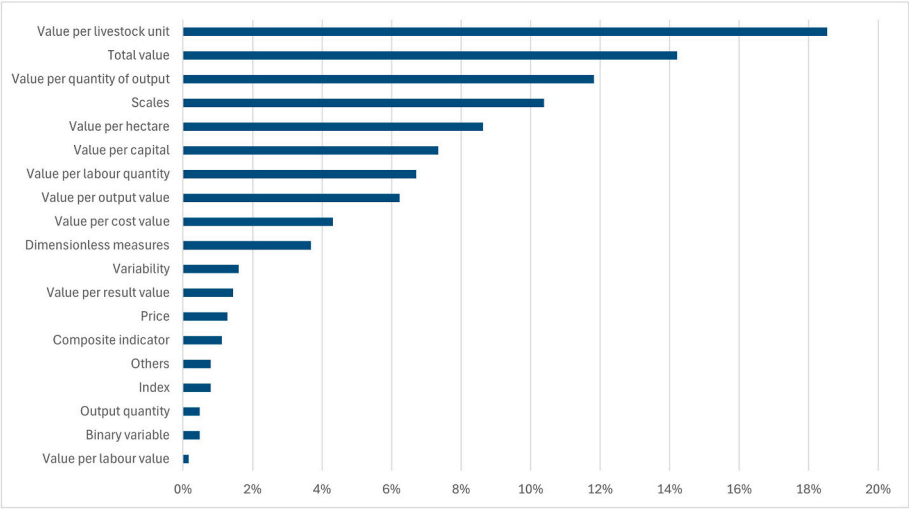

Fig. 6. Frequency of units.

standardised framework jeopardises the interoperability and comparability of research results. For example, in this review, the definition of gross farm income varied considerably, with some studies including overhead costs, labour costs, or subsidies, while others did not. Moreover, inconsistent terminology further complicates comparison. For instance, more than 25 different terms were used to refer to the indicator gross farm income as defined in the FADN methodology (European Commission, 2020b). Therefore, a balance between harmonization and diversification could be beneficial for the impact of studies.

4. Conclusions

The livestock sector is an important part of the European Economy, and its sustainability a focus of interest for public policy. The sector and the policies focusing on it are adapting to the current context and its challenges. In this process, it is important to have a clear understanding of how economic sustainability is being measured in livestock systems. This work, therefore, used a systematic literature review to map the existing economic indicators used in European livestock systems, analysing their alignment with policy objectives and how they differ across sectors and regions.

The findings reveal that some categories of indicators and livestock sectors are underrepresented in the economic literature. Particularly, small ruminants have received much more attention than the relative economic size of the sector, while the opposite can be said for monogastric systems. Overall, the results of the SLR showed that much of the attention has been placed on profitability indicators, with less research focusing on other economic objectives such as durability, autonomy, and diversification. Notwithstanding this, the results show that the literature is well aligned and has consistently produced indicators to measures some of the CAP objectives related to these themes, like parts of CAP specific objective 1 (ensuring viable farm income) and 2 (increasing competitiveness).

Although this is not a surprise, the move towards a broader view of sustainability, and the inclusion of other objectives such as fairness, resilience, or diversification, should lead to further development on these less-developed themes. This is the case of CAP specific objective 3 (improving the position of farmers in the food chain) and parts of CAP specific objective 1, related to the fairness of public support distribution, income volatility, and risk management. In those cases, more indicators would be needed to adequately measure the achievement of the relevant objectives. Also, the transition to FSDN provides an opportunity to expand indicators of economic objectives that are not yet commonly assessed in the literature and become a reference in these areas.

Furthermore, there is a need to unify the methodology and terminology surrounding economic indicators to improve replicability, comparability, and transparency in livestock research. As the FADN methodology is already established and commonly used across Europe, it is an obvious choice to guide this process. However, given that it does not fully capture all dimensions of economic sustainability and that new indicators continue to emerge, a balance between harmonization and methodological diversity is required.

Some limitations have been identified during this work. Firstly, indicator categorisation, which followed Lebacq, Baret et al. (Lebacq et al., 2013)'s framework has limitations, as it does not completely represent the wide range of indicators identified. Therefore, it was decided to modify the framework to better reflect the literature. Also, the categorisation was performed by a single researcher, which might have introduced researcher bias in the process. Additionally, it could be argued that some indicators potentially fit in different categories, blurring the limits between groups. Furthermore, the analysis was limited to studies published in English, as it is the principal language of international academic research. Consequently, relevant studies published in other languages may not have been captured.

A further challenge relates to the heterogeneity and limited transparency in how indicators are defined and calculated across studies. While many articles clearly describe their methodology, others provide insufficient detail, requiring interpretation and harmonization during data extraction, which may introduce some bias. This reinforces the need for greater standardisation in reporting practices. Despite these limitations, the present SLR accurately establishes the current state-of-the-art and provides important insights into the mapping of existing economic indicators.

CRediT authorship contribution statement

Santiago Esteban De Ponti: Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Lorraine Balaine:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Methodology, Resources, Supervision, Validation, Visualization, Writing – review & editing. **Ryan McGuire:** Conceptualization, Data curation, Funding acquisition, Methodology, Validation, Writing – review & editing. **Cathal Buckley:** Conceptualization, Formal analysis, Funding acquisition, Validation, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Cathal Buckley, Santiago De Ponti, Lorraine Balaine reports financial support was provided by Horizon Europe. Ryan Mcguire reports financial support was provided by UK Research and Innovation. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.indic.2026.101388.

Data availability

The data used has been shared as supplementary material

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