# Revealing the sustainability performance of novel food system technologies- a systematic scoping review

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# Revealing the sustainability performance of novel food system technologies- a systematic scoping review

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## Abstract

Food system technologies (FSTs) are being developed at an unprecedented rate to accelerate the transformation towards sustainable food systems. Sustainability is a multi-faceted concept and innovations may inadvertently promote one facet while compromising another. Yet, limited empirical evidence on the sustainability performance and trade-offs of novel FSTs exist. We conducted a systematic scoping review that accounts for multiple dimensions of sustainability to synthesize peer-reviewed research assessing the sustainability performance of four novel FSTs: plant-based alternatives, vertical farming, food delivery and blockchain technology. Included literature assessed a wide range of sustainability indicators, with a dominant focus on environmental sustainability. Significant research gaps on the public health and socio-economic implications of these FSTs remain. Additional research is explicitly required to understand the general sustainability implications of plant-based seafood alternatives and blockchain technology, public health consequences of food deliveries, and socio-economic consequences of vertical farming. The sustainability performance of FSTs varied across the literature and for sustainability indicators. The development of a holistic sustainability assessment framework that illustrates the implications of deploying and scaling FSTs is needed. This can guide investments in and the development of sustainable food innovation.

## List of Abbreviations

BT- Blockchain Technology

EU- Energy use

FD- Food Deliveries

FST- Food System Technology

GHGe- Greenhouse Gas Emissions

GH- Greenhouses

LCA- Life Cycle Assessment

LU- Land use

PBA- Plant-based alternatives

PBMA- Plant-based meat alternatives

PBDA - Plant-based dairy alternatives

PM- Particulate Matter

SDGs - Sustainable Development Goals

VF- Vertical Farming

WU- Water use

## Introduction

New technologies in the food sector are being developed at a considerable pace to facilitate the transformation towards achieving food system sustainability[1]. We here define them as novel food system technologies (FSTs) that are introduced at various parts of the food supply chains to address current systemic challenges. Data on investment trends show that their development has been accelerated by the COVID-19 pandemic and that they attract strong interest from venture capital firms[2]. These novel FSTs are often surrounded by a sustainability halo, a socio-psychological phenomenon of perceiving a product as sustainable based on one positive attribute, often lower CO2 emissions, leading to a higher willingness to pay (WTP)[3]. This has created an innovation space that often strives to reduce climate impact from the food sector, but disregards other dimensions of sustainability. As outlined in the Sustainable Development Goals (SDGs), the comprehensive concept of sustainability addresses multiple environmental, economic, and social impact factors[4]. Innovations in the food industry can impact all these sustainability pillars, potentially leading to co-benefits or negative trade-offs, so called unintended consequences[5]. Yet, while many well-defined tools exist to study the food system as a whole[6,7], there is no such defined toolset and inventory of sustainability indicators to quantitatively assess the sustainability performance of technologies in the food supply chain.

Considering the three pillars of sustainability, this multidisciplinary scoping review examines how the sustainability performance of novel FSTs has been assessed in the peer-reviewed literature, and how they compared to the technologies they intend to replace. To accomplish this, we first identify sustainability indicators that have been used in the literature to assess novel FSTs, then synthesize empirical evidence indicating FSTs sustainability performance, and finally identify implications for research and practice in relation to the development of comprehensive sustainability assessments.

We focus on four divergent but representative divergent FSTs that aim to address sustainability-related issues at different parts of the food supply chain: plant-based alternatives (PBA), vertical farming (VF), food deliveries (FD) and blockchain technology (BT) (Fig.1). We selected these FSTs by mapping investment flows into food startups in the Nordic region, and selected the four FSTs that received most investments in the first half of 2021 (Supplementary Methods S2).

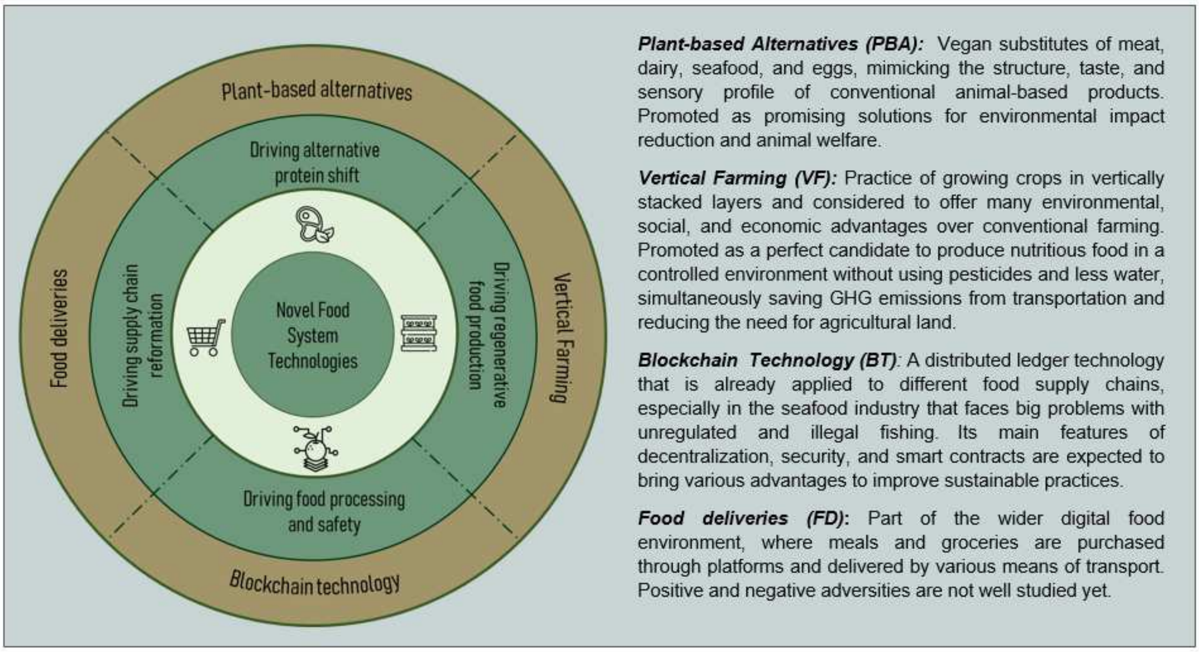


**Fig.1| Conceptual Framework of included FSTs.** Overview of included FSTs in this review that are driving food system transformation at different entry points of the food supply chain.

## Results

We retrieved 1,493 studies from the initial search, of which 79 articles met our inclusion criteria and have been included in the analysis (Fig. 2). Main exclusion criteria at full text stage was that no empirical evidence was provided.

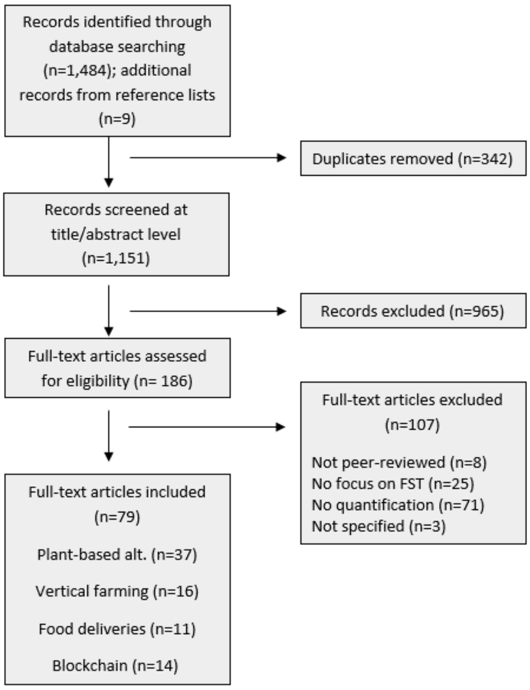


**Fig.2| Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow chart.**

### Characteristics of included evidence

The majority of the included papers assessed PBAs (n=37), dominated by meat alternatives (PBMA) and dairy alternatives (PBDA) while only two studies assessed seafood or egg alternatives. This was followed by literature that assessed VF (n=16), BT (n=14) and FD (n=11).

The sustainability of these FSTs has been addressed using a range of study designs assessing different indicators. The majority of the literature employed life cycle assessment (LCA) case studies to study the environmental impact (n=26), behavioral studies (n=11) and nutritional analysis (n=10) to assess social indicators, and modelling studies for economic indicators (n=7). We captured systematic and non-systematic reviews (n=13), mostly focusing on BT (n=8). Miscellaneous methods have been applied to case studies (n=12), including qualitative interviews to study BT (n=4).

The retrieved literature represents a wide geographical scope, with case studies spanning 40 countries across six continents. Regional representation varied across the different FST, mapped out in the Supplementary material (S4). Case studies on VF had a dominant focus on Europe (63%), FDs on Asia (60%) and PBAs on Europe (55%) and Northern America (19%). Literature on BT mainly elaborated a global perspective, with some case studies focusing on different countries, primarily from Asia (56%).

## Sustainability indicators

For PBAs, VF and FD we observed a wide range of indicators empirically assessing all three dimensions of sustainability, with clear differences across FSTs (Fig. 4).  Results for BT are presented separately (Fig. 5) and are not analysed further as BTs contribution to sustainability was described using different indicators, such as improving food literacy, and was not empirically investigated.

Studies investigating PBAs comprehensively assessed a wide range of environmental impact factors, dominated by greenhouse gas emissions (GHGe) (n=16), land use (LU) (n=11), water use (WU) (n=12). Evidence on the release of excess nutrients were also frequently provided, assessing the eutrophication (n=12), acidification (n=8) and ecotoxicity potential (n=10). Three studies assessed the carbon opportunity cost (COC) of agricultural land, taking into account the amount of CO2 that could be sequestered by replacing conventional meat with PBMA[8–10]. As metrics for social sustainability, studies assessed primarily nutritional adequacy (n=14). Consumer acceptance (n=11), willingness to buy and pay (WTB/WTP) (n=8), energy use (EU) (n=7) and product price (n=2) were assessed as economic indicators.

Studies that focused on the environmental impact of VF most frequently assessed GHGe (n=9) and WU (n=6). To indicate their economic sustainability EU (n=7), yield production efficiency (n=4), financial profit (n=3) and consumer acceptance have been assessed (n=2).

The literature on food deliveries focused primarily on assessing GHGe (n=10) and plastic waste (n=7) as environmental impact factors, and EU as an economic indicator (n=3). As social indicators, human health consequences have been assessed, deriving from food plastic packaging[11] and increasing consumption of unhealthy products[12].

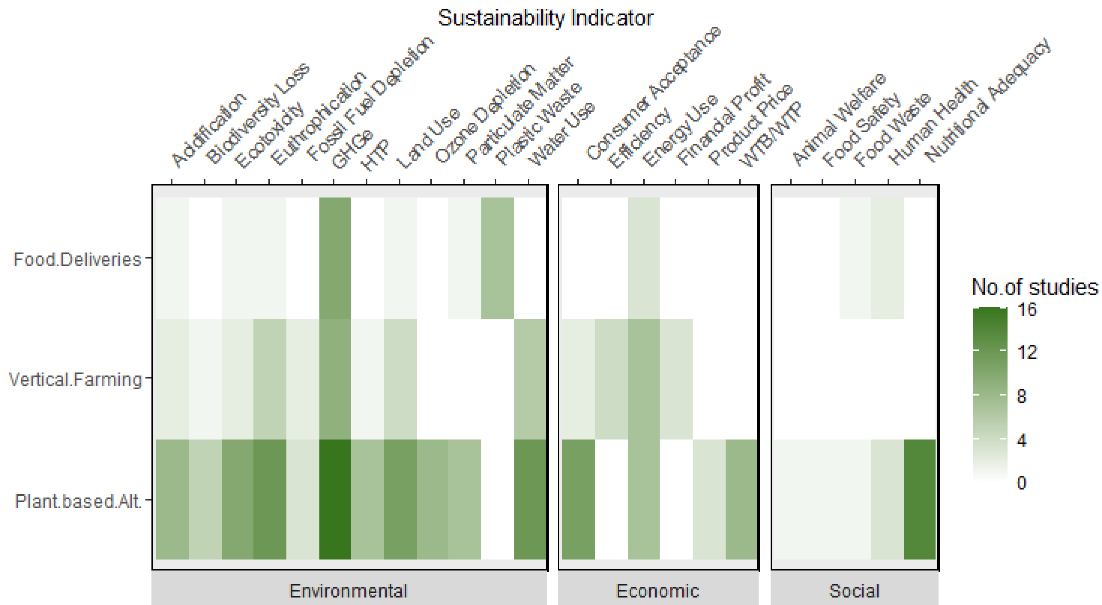


**Figure 3| Sustainability indicators assessed in the included literature.** The heat map cross-references all the included studies (n = 79) to show the frequency of studies that investigated sustainability indicators. Impact domains are split by social, environmental, and economic sustainability, from the left. Note: the heatmap displays only a selection of environmental indicators, a detailed overview is provided in the extracted data available in the Supplementary Material.

Applying BT to the food sector was described, but not analytical assessed, as enabling primarily social, but also environmental and economic sustainability. As indicators and methods to describe BTs sustainability deviated from the other FSTs, they are presented in a separate format (Fig. 4). Through its main function, food traceability, it can contribute to food safety by reducing the consumption of contaminated food worldwide, thereby reducing food waste and improving economic efficiency[13–19]. BTs potential to decrease food waste has been emphasized in case studies from the dairy industry[15] and the supply chains of pork products and mangoes[18]. Findings from case studies on the halal food industry[14] and the tilapia fish industry in Ghana[20] indicate that BT can increase food quality, safety and integrity. It can further foster collaboration among food supply chain actors, thereby increasing process and cost efficiencies, trust and profitability[16]. Regarding environmental sustainability, BT can be applied to monitor environmental impacts and support farmers to reduce the use of chemical inputs, water and soil. Traceability enabled food labelling can then indirectly improve environmental sustainability through consumers demanding veracity of sustainable food production and processing[16]. Two studies emphasized BTs potential to reduce overfishing[17,21] in line with SDG 14.6 to combat illegal, unreported and unregulated fishing[17]. In general, applying BT to the fish industry has been described as beneficial to a range of SDGs[21]. Included literature also elaborated on limitations that deploying blockchain could entail (Fig. 4).

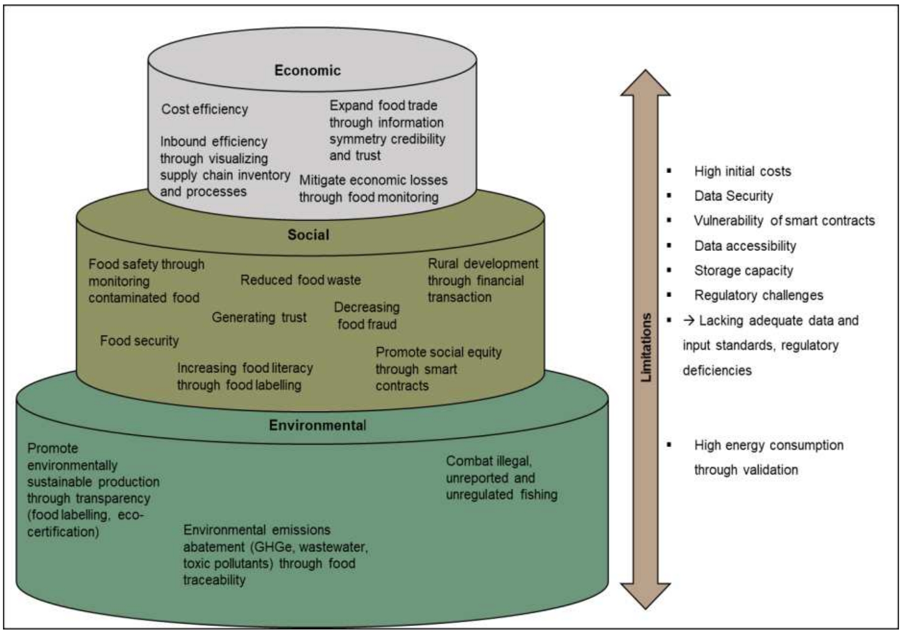


**Fig. 4| Benefits and limitations of deploying Blockchain Technology to the food sector**. Extracted from retrieved literature and positioned in relation to the biosphere-based foundation of sustainability science adapted from Folke et al. (2016)[22].

## Sustainability Performance

Below we outline how the various FSTs performed in relation to the three sustainability pillars and indicators compared to the baseline technology they are intended to replace. BTs are not included in this section as their sustainability performance was not empirically investigated (detailed in methods).

*Plant-based alternatives*

We observed high level agreement across the literature that PBAs tend to have a lower environmental impact than conventional animal-based products (Fig. 5). In general, they are associated with less CO2-eq, less WU[8,23–25], less LU[8,23–26], have a lower ecotoxicity[8,9,24,27–29], acidification[8,9,24,27,29,30] and eutrophication potential[9,24–30], with some exceptions. For instance, almond milk is more water-intense than dairy milk and has a higher environmental footprint in general when assessed on a cradle to consumer system boundary[27]. Two studies found that the production of PBDA has a higher energy demand than conventional dairy[27,30].

In contrast, no such clear agreement was observable for nutritional performance. We found PBAs generally contained lower levels of proteins, with discernible differences depending on the commodity they are based on. For instance, Smetana et al. (2021) found that burger patties made out of mycoprotein contained higher protein, those made from peas similar and those on a soy-basis lower levels of protein content than beef patties[29]. Sodium content was found higher in cheese alternatives based on coconut-oil than on cashew nuts or tofu[31]. PBAs had generally lower contents of saturated fat, except coconut-oil based cheese products[31] and two legume based burger patties[25]. The total nutritional performance of PBAs, assessed with nutrient profiling models, was mostly higher[9,29,32] or no difference was discernible[29,33]. PBAs received lower consumer acceptance[29,34,35] and were higher in cost than conventional animal-based products[36,37].

*Vertical farming*

We found consensus that growing vegetables in VFs outperforms cultivation on-field and in greenhouses (GH) in terms of LU[38–41] and WU[39,40,42,43]. One study modelled that lettuce production in VFs could require up to 95% less water compared to production in GHs due to water recycling potential[43]. We identified agreement that VFs are responsible for higher GHGe than open-field cultivation[38,39], but lower than greenhouses[38,39,43,44]. By contrast, VFs have been assessed less efficient in terms of energy inputs than on-field cultivation[39] and greenhouses[39,42,43]. The degree of environmental impact has been found to depend to a large extent on the growing substrate, packaging material as well as the source of energy[45]. Regarding economic indicators, we found agreement that VFs have a higher yield production than greenhouses[42], leading led to slightly higher economic revenues[42,46].

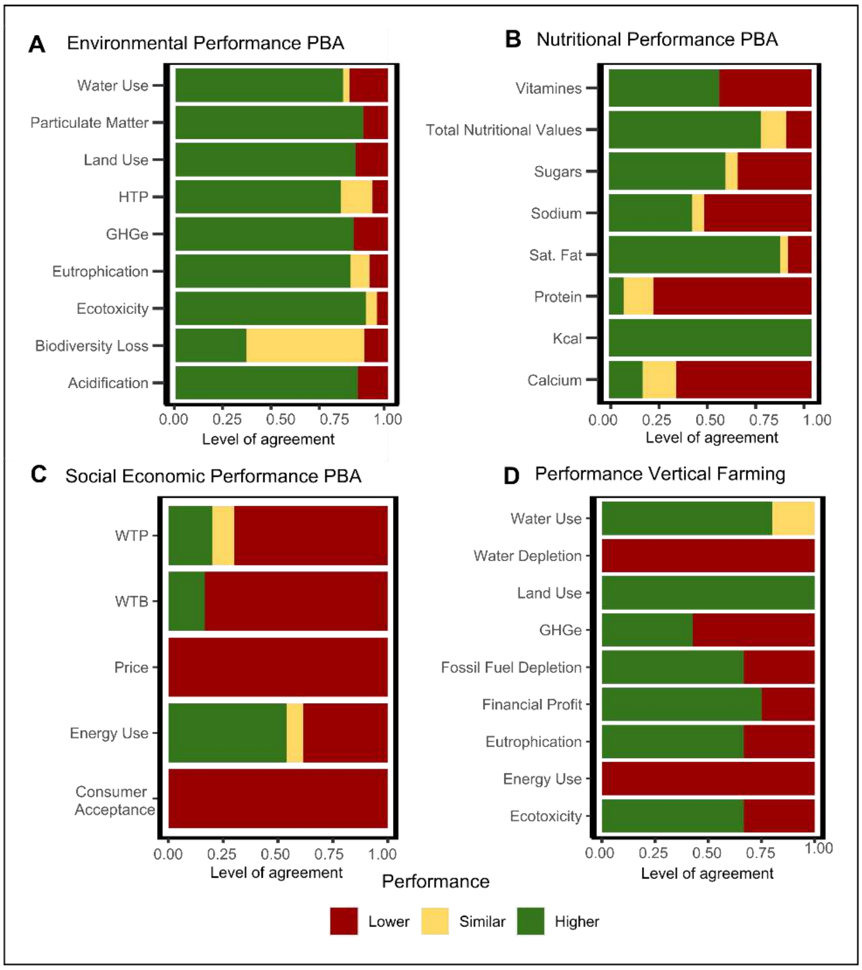


**Fig. 4| Agreement on the sustainability performance of PBAs and VF across the literature.** Stratified results according to different system boundary and functional unit settings are presented in the Supplementary Material (S5). This assessment could not be carried out for BT and FD as we identified insufficient literature comparing them with the baseline scenario they intend to replace.

### *Food delivery*

Grocery delivery performed better in terms of GHGe and EU compared to individual retail trips when assumed they are made by car, but not on foot, by bike or public transport[47]. Meal delivery had a lower performance than preparing the meal at home or consuming it at the restaurant[48,49], mainly attributed to plastic food packaging waste generated by delivered meals[50]. Research demonstrates that walking to the restaurant and consuming the meal there instead of having it delivered could reduce the total amount of GHGe by 68% per meal[49].

## Discussion

### Summary of evidence

We synthesized empirical evidence indicating the sustainability performance of novel FSTs. Environmental indicators were assessed more frequently than social and economic indicators, adding on the widespread concern to ensure that socio-economic sustainability receives more attention[5,51].

Our analysis on the sustainability performance of FSTs revealed that PBAs should be favored over animal-based products for the sake of the environment, but no such clear trend was observable for social and economic consequences. Public health consequences of PBAs have been exclusively addressed by comparing their nutritional profiles against conventional products, with no focus on other indicators such as food safety (through reduced pesticide and antimicrobial use) or epidemiological implications. We found that that PBAs are often high in sodium, one of the leading dietary risk factors for global mortality and morbidity[52]. Investigating the long- term health consequences of their frequent consumption is of high importance[53]. There is a distinct lack of studies assessing the social and economic implications of shifting towards PBAs, which should not be neglected to ensure that they are contributing to an equitable and inclusive transformation. Included studies revealed that PBAs are currently higher in costs than conventional animal-products, which could generate the impression that a plant-based diet is more expensive and seen as a luxury, leading to social inequalities. In contrast, a recent modelling study found plant-based dietary patterns based on legumes and vegetables are cost-saving compared to current diets in in most high-income and many middle-income countries[51]. We synthesized research showing that the consumer acceptance and WTP for PBAs is currently lower than for conventional meat, but could increase to the same level after information concerning health or environmental consequences is provided[54]. Interestingly, studies found consumer acceptance of PBAs is primarily driven by health benefits as well as taste and appearance rather than environmental or animal welfare concerns[55].

The vast majority of included PBA-studies assessed meat and dairy analogues. Despite a market predicted to grow rapidly[56], only two studies investigated the sustainability of seafood analogues[26,32]. This is most likely because seafood analogues are still relatively novel, especially outside Asia. We can assume that LCA studies on seafood analogues would present similar results to PBMA, as both are derived mainly from terrestrial plant sources such as soy and sunflower oil. However, blue foods have been associated with lower GHGe than terrestrial meat[57]. Future studies should therefore compare seafood analogues with conventional fish, including impact factors specific to aquatic systems such as wild stock depletion. Further, while the consumption of conventional meat products is linked to human health hazards, consuming seafood is associated with nutritional benefits[58]. While seafood analogues could help to meet the growing seafood demand and reduce overfishing, it is necessary to investigate the socio-economic and public health implications of these products.

Food delivery services, especially on-time groceries, are growing rapidly and are backed with billion-dollar investments. The retrieved literature focused primarily on assessing GHGe and EU. Beyond that, we found that their implications on environmental and social sustainability have not yet been empirically assessed. The World Health Organization also expressed concern about the still insufficiently studied public health consequences of the growing delivery sector and has called for more evidence[60].

VFs have been described as a resource-saving production system, improving food safety and quality, while providing economic benefits[61]. However, we found a distinct lack of evidence modelling the socio-economic implications of upscaling it. Further, the local food production enabled by VFs is often considered as environmentally sustainable, partly due to the general assumption of high CO2-eq emissions resulting from transport. Conversely, we gathered evidence that VFs are responsible for higher GHGe and are more energy-intense than open-field cultivation. However, a widespread transition to renewable energy and resource-saving materials, such as paper pots and coir as growing substrate, could lead to large environmental impact reductions[45]. Further, the sustainability performance and benefit of VFs depends to a large extent on the regional context, being particularly recommendable for climate-extreme areas[43,62].

Systematic reviews and descriptive case studies revealed BT's potential to enable a sustainable food supply chain, but there is a distinct lack of empirical case studies validating these assumptions. Further studies that estimate correlation or causal inferences between applying BT and sustainability benefits are needed. Aside from the opportunity to strengthen the ecological dimension of sustainability through blockchain adoption, the majority of the literature addressed the potential of BT to improve social and economic rather than environmental sustainability.

Our review demonstrates that the sustainability performance of FSTs is influenced by methodological specifications, such as defining the functional unit and system boundary in LCA studies. For instance, Grant et al. (2021) calculated that almond and soy milk have a lower environmental footprint than dairy milk when assessed from cradle to gate, but a higher footprint when assessed from cradle to consumer as it also factors in transport emissions[27]. We conducted a cross-spatial analysis of the study results, which necessitates cautious generalizations. Each study is unique from a geographical, temporal and methodological perspective. For example, results revealed that VFs generally require more electricity than their baseline scenario[63], but the extent strongly depends on the region and type of purchased energy. A comparative analysis found that the relative efficiency of VFs compared to greenhouses in mainland Europe is low, while it is much higher in low-light spatial conditions such as northern Sweden or water-scarce regions such as Abu Dhabi[43]. Similarly, cultural differences can lead to geographically different social sustainability performances of innovations. For instance, consumer acceptance of PBMA and cellular meat was assessed higher in China and India than in the USA[64].

We therefore echo the concern expressed in previous studies that methodological inconsistencies among environmental assessment studies complicate generalizing results[65]. To investigate how the methodological assumptions in the included studies affect the sustainability performance of FSTs, we conducted the analysis separately for different functional unit and system boundary settings (Supplementary material S5).

## Strengths and limitations:

The breadth and interdisciplinarity of this review posed challenges on the inclusion and analysis of heterogenetic data. We focused on synthesizing peer-reviewed articles, which excluded conference proceedings, reports and book chapters. Since novel FSTs is still an emerging field of research, we assume that a range of grey literature exists that future systematic reviews should include. We yielded a wide geographic scope of publications, but our searches were limited to English-language literature. We compared the sustainability performance of FSTs against the baseline scenario they intend to replace, but not among and in-between them. This generalizing approach does not necessarily allow conclusion to be drawn on individual products as the performance depends on a range of factors, such as the raw material they are based on. For example, cheese analogues based on tofu have a better nutritional performance than those based on coconut-oil[31].

The chosen traffic light classification to indicate the sustainability performance is a conceptual and subjective approach to harmonize and standardize heterogenetic data. However, it does not allow to draw conclusion on the scientific strength of evidence. This is in line with the Prisma guidelines, which state that scoping reviews are not intended to critically appraise the risk of bias of a cumulative body of evidence, but to present results and guide future systematic reviews and meta-analyses[66].

## Implications for research and practice

The rapid development of FST and their expected impact on different pillars of sustainability requires improved multi-indicator sustainability assessment to reduce the risks of unintended trade-offs. It would be useful to develop a defined inventory of sustainability indicators that can be used to assess FSTs and contrast them against each other to determine the most sustainable alternative option in a given context. This scoping review reveals important evidence gaps on the four included FSTs that targeted empirical assessments should aim to fill. The literature on PBAs sustainability is widespread, but there is a need to study the performance and implications of the growing market of seafood analogues. Such a comprehensive sustainability assessment should include LCA indicators specific to aquaculture (such as stock depletion) and focus on human health and social implications. More analyses should also be conducted comparing PBAs against other alternatives such as tofu, insects, cellular meat and legumes to determine the most sustainable protein and fat alternatives. Studies in-between current PBAs are also of relevance to determine the most sustainable commodity and production processes. Finally, longitudinal and controlled dietary studies comparing the nutritional and epidemiological effects of substituting animal products with alternative protein sources over long-term are needed.

For food deliveries, their scaling and rapid development needs to be assessed from public health, socio-economic, and environmental perspectives beyond GHGe (e.g. air pollution from transportation) to inform governmental policies, urban planning processes and guide more sustainable practices.

To validate the promise of blockchain technology for a sustainable, effective and efficient food supply chain, it would be important to empirically assess whether food traceability and labelling actually improves agricultural sustainability, and to what extent.

Given the often-emphasized potential of vertical farms to contribute to more resilient food supply chains, it is necessary to assess their socio-economic implications and evaluate the efficiency and benefit for different geospatial and cultural contexts.

## Conclusion

We synthesized empirical evidence indicating the sustainability of four representative FSTs and found varying levels of performances across different indicators and pillars. In general, novel FSTs have the potential to support parts of the transformation towards a sustainable food system and enhance human health. However, unintended side-effects are often inherent to deploying new innovations. Guiding transformative investments necessitates a more rigorous, quantitative assessment of the sustainability implications of novel FSTs, encompassing broad environmental, economic and social indicators, to safeguard against undesirable effects. We hope that the findings of this review provide a starting point to build such a sustainability assessment framework to assess novel FSTs, to inform political guidelines and to guide the development of and investments into long-term sustainable solutions. The inventory of novel FSTs is long and future research is required to provide regional context specific recommendations and inform policy guidelines. This will have to include socio-economic sustainability impact factors to ensure that they contribute to a just transformation of the food system.

Furthermore, our results underline the necessity to compare novel FSTs against each other and across different sustainability categories to determine the most promising option.

Finally, and perhaps most importantly, the implications of deploying novel FSTs depends to large extent on how they are scaled and in which geospatial and cultural context. FSTs already have and will continue to play a substantial role in the future food system, just as novel technologies are transforming other parts of societies[1]. To allow them to accelerate the transformation towards sustainable just food systems and mitigate unintended consequences, it is therefore of outmost importance to plan their deployment to responsible scaling principles. This will require to first evaluate them against the baseline scenario and other existing alternatives they intend to replace and for explicit regional contexts from a comprehensive sustainability perspective.

## Methods

Scoping reviews are well suited to study the breadth of an area which has not been reviewed comprehensively before to provide a detailed and structured overview of the reviewed literature, and to identify research gaps in the existing literature[67]. We followed the PRISMA guidelines extension for scoping reviews[66] and provide the detailed checklist in the Supplementary material (S1). Searches in the databases Web of Science Core Collection and Scopus have been carried out in September 2021 to identify peer- reviewed literature. We included literature published from 2016 as there was an exponential rise in scientific literature focusing on these four FSTs since then (Fig. 4). Further details on the literature review are given in the Supplementary material (S3).

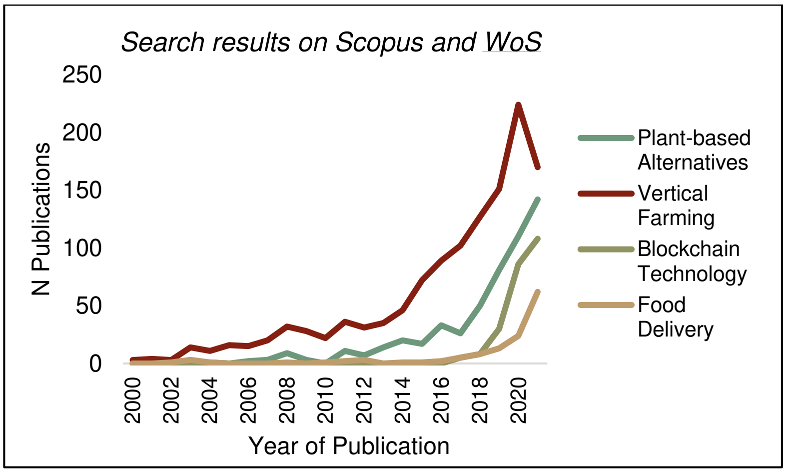


**Fig. 5| The increase in peer-reviewed literature assessing the sustainability of the four FSTs.**

We used CADIMA[68] for study screening and duplicate removal. To check for selection consistency among all researchers, a consistency check has been conducted by independently screening a certain number of articles (5%=57) and discuss potential divergencies. Once consistency was achieved, one reviewer (ACB) screened the remaining articles at the title and abstract stage against the eligibility criteria. Full text screening has been performed by all three reviewers ACB (80%), AW (10%) and LG (10%), independently. Contradictory and inconclusive assessments were discussed and resolved with all authors at both abstract and full-text screening stage.

### Eligibility criteria

As a primary inclusion criterion for this review the studies had to assess the sustainability of one of the four selected FSTs as defined in the conceptual framework (Fig.1). We exclusively searched for PBAs that are designed to mimic conventional animal-based products and hence excluded cellular meat, insect-based food products and traditional legume-based alternatives such as tofu. We also excluded literature focusing on non-vertical aqua- or hydroponically systems, and the application of blockchain technology to non-food sectors. Included studies had to provide quantification for at least one indicator of sustainability. An exception was made for blockchain literature, since we found there is yet limited empirical evidence available. Hence, the blockchain literature only had to provide a narrative description on at least one indicator of sustainability. We included peer-reviewed case studies and reviews that provide a quantification, subjective studies that do not use data to back up the assessment of indicators or conference proceedings have been excluded.

### Search strategy and data charting

We devised the search strategy to reflect concepts of sustainability assessment and the four selected novel FSTs. Search strings were tested several times against a set of predefined benchmark articles. Detailed outline on the search strategy is provided in the Supplementary material (S3).

Data charting was done for all included articles between October and December 2021 by one author with feedback on the process by all authors. We used CADIMA and Microsoft Excel for data extraction and charted data on study design, study location, sustainability indicators assessed, methods, LCA settings, and results indicating the sustainability performance. The fact that no defined inventory of indicators spanning all dimensions of sustainability exists posed an inherent challenge to the search for and selection of them. We therefore approached to extract all sustainability indicators encountered in the literature and discussed inclusion among all study authors.

## Assessing the sustainability performance of FSTs

Performing a meta-analysis on the results of included studies was not applicable due to cross-study, cross-FST and methodological inconsistencies across sustainability indicators. However, in order to translate the results of the included studies into comparable quantitative representation we developed a coding scheme, classifying the level of agreement on the sustainability performance per study, FST and sustainability indicator. For that step, only studies that performed a comparison against the baseline scenario they intend to replace have been included (PBA=27, VF=10, FD=3). Blockchain literature was not applicable for that assessment. We defined baseline scenarios in this context as animal-based products for PBA, on-field and in-greenhouse cultivation for VF, and individual grocery retail or restaurant dining for FD.

In order to assess the sustainability performance of novel FSTs in comparison to the baseline scenarios, we extracted study results and coded the level of performance using the traffic light approach. A higher level of performance was assigned if they scored better (green), a similar performance (yellow) if there was no difference assessed, or a lower performance (red) if they scored poor compared to the baseline scenario. We coded every FST that has been assessed in the included literature and compared against a baseline scenario. When different functional unit and system boundary settings were applied in one study, we extracted results for each setting to reduce bias due to modelling choices. As a certainty assessment, we run the performance analysis stratified by system boundaries and functional units (Supplementary material S5). Duplicates have been removed.

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## Author contribution

The project was conceptualized by all authors. ACB developed the search strategy and conducted peer-reviewed literature searches. ACB, AW, LG conducted study screening. Data charting and analysis by ACB with feedback by AW, LG. Data visualization by ACB with feedback by AH. Original draft written by ACB, reviewed and edited by LG and AH.

## Competing Interest

The authors declare no competing interest.

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