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Review

How helpful are the "hidden costs of food systems" numbers?

Jonathan Brooks [a,*], Eugenio Diaz-Bonilla [b]

[a] Johns Hopkins University, School of Advanced International Studies Europe, Italy and University of Exeter, United Kingdom
[b] Inter-American Institute for Cooperation on Agriculture, Costa Rica and International Food Policy Research Institute, United States

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ABSTRACT

The "hidden costs of foods systems" calculations reported by the Forestry and Land Use Coalition, the Food System Economic Commission and the UN Food and Agriculture Organization may not provide helpful policy guidance for the transformation of food systems for both economic and political reasons. Economically, the hidden costs numbers exclude countervailing social benefits which imply unavoidable trade-offs across policy objectives. They also aggregate costs that are fundamentally different in their economic character and require different policy approaches, while including some costs that are not attributable to food systems at all. Politically, the headline numbers risk impeding transformative change because they identify food systems participants – particularly farmers –in terms of the damage they inflict while ignoring critical benefits they confer, and implicate them in social failings for which they are not primarily responsible. However, the hidden costs numbers can be useful if integrated into a more balanced assessment of the performance of food systems. Such an approach could support a positive agenda which engages the actors whose contributions will be indispensable.

1. What do the numbers include?

Some disturbing statistics drive a "broken food system" narrative:

- Over 700 million people are undernourished, representing about 9 % of the world population (FAO et al., 2023). Around 2.5 billion people are overweight, including nearly 800 million who are obese (WHO, 2024). So far no country has found a way of reversing the obesity epidemic and the consequent growth in non-communicable diseases.
- The global food system accounts for around one third of global greenhouse gas (GHG) emissions, even if the emissions intensity of production is declining (Crippa et al., 2021; Poore and Nemecek, 2018). Agriculture, forestry and other land use account for about 22 %, with half of that coming from farming and the other half from land use, land use change and forestry. Agriculture also accounts for up to 80 per cent of biodiversity loss and up to 70 per cent of freshwater use (IPBES, 2019).
- Paradoxically, no population group is more likely to go hungry than the world's 500 million smallholder farmers, who comprise a large share of the world's poor. Low farm incomes are also a problem within the agricultural sectors of many rich countries, even if farmers are not on average poorer than other groups in society (Hill, 2017).

Reflecting these failings, and to energize global efforts to address them, four closely related initiatives have been made to aggregate the "hidden costs of food systems". The first major attempt was by the Forestry and Land Use Coalition (FOLU, 2019). This was followed by the study of Hendriks *et al.*, prepared for the Scientific Group of the UN Food Systems Summit in 2021 (Hendriks et al., 2021; Hendriks et al., 2023;). The recent work of Lord (2023) at the University of Oxford Environmental Change Institute has since provided measurement foundations for the report of the Food System Economic Commission (Ruggeri Laderchi et al., 2024), where the Food and Land Use Coalition is a lead research partner, and, most recently, for the FAO's annual State of Food and Agriculture (SOFA) flagship (FAO, 2023; FAO, 2024). In addition, a Rockefeller Foundation study has provided national estimates for the United States (Rockefeller Foundation, 2021).

Conceptually, these studies break down the "true cost" of food into observed private costs, which include the costs of producing, processing, wholesaling and retailing food; and hidden social costs along three dimensions: health (the costs of poor nutrition), the environment (emissions and other), and socio-economic outcomes (including poverty within the food system).

The four global studies differ in terms of which hidden costs are included and how they are measured, yet each produces aggregate estimates of a similar order of magnitude, supporting the claim that the

* Corresponding author at: SAIS Europe, Via Beniamino Andreatta, 3, 40126 Bologna BO, Italy.
E-mail address: jbrook47@jh.edu (J. Brooks).

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annual hidden costs of the global food system exceed its estimated market value of around USD 10 trillion (Table 1).

The Rockefeller Foundation study observes that in 2019 American consumers spent an estimated USD 1.1 trillion on food (the observed cost), but that the hidden costs of the healthcare for those who fall ill with diet-related diseases – as well as the costs of the food system's contributions to water and air pollution, reduced biodiversity, or GHG emissions – add a further USD 2.1 trillion, raising the "true" cost to USD 3.2 trillion per year. In this case the hidden costs do not just exceed the system's market value, but are in fact double it.

Globally, the overall costs are dominated by the estimated health effects of inadequate nutrition, which average around USD 9 trillion per year, almost equal to the value of the agri-food system in three out of four studies. Those costs are huge and immediate. The environmental effects, dominated by climate change are of a lower order, at around USD 3 trillion, partly because climate effects, while already catastrophic for some, are for now more incipient. Socio-economic costs rank third in order of importance, at around USD 1 trillion or less. The Food System Economic Commission (https://foodsystemeconomics.org) maintains a real time aggregator of the "hidden costs of food" on its website. By the end of November 2024 these had reached $133 trillion since the signing of the Paris Agreement on Climate Change in 2016.

Such wide ranging exercises are inevitably fraught with data limitations and measurement issues, not least in terms of whether one measures a social cost in terms of the damage inflicted or the cost of abating that damage. These issues are described and discussed at length in FAO SOFA reports, where it is acknowledged that those numbers remain first estimates.[1] The Hendriks *et al.* study reports a wide confidence band around its central estimates. Even so, the orders of magnitude are huge, similar and broadly consistent with more partial studies, including those of the costs of food-borne diseases (Jaffee et al., 2019); the hidden costs with respect to health and climate by 2030 and 2050 (Springmann, 2020); the ecological and health costs of poor diets (Lucas et al., 2023); and a global assessment report of biodiversity and ecosystem services (IPBES, 2019). Reflecting the difficulties of establishing the boundaries of food systems, the numbers exclude the estimated 3.2 million premature deaths caused each year by air pollution from cooking with wood and charcoal (WHO, 2023).

A primary function of these numbers is to make a case for a food systems transformation, in line with the Summary and Statement of Action of the UN Food Systems Summit.[2] In the case of FSEC, the recommended elements of that transformation all make good sense: shifting consumption patterns towards healthy diets; targeting revenue from new taxes to redress the above social costs; repurposing government support for agriculture; innovating to increase labor productivity and workers' opportunities; and scaling up safety nets to keep food affordable for the poorest.

A secondary role is to serve as an input to analysis that can trace out the benefits of alternative "food system transformation" scenarios, which can be effected with overwhelmingly positive benefit-to-cost ratios. The FSEC report specifies a scenario that assumes convergence towards the EAT-Lancet reference diet (Willett et al. 2019) and estimates this would generate savings of at least USD 5 trillion per year. The cost of the scenario is estimated at around one-tenth of that, or USD 500 billion per year, with about USD 200 billion coming from investments and USD 300 billion from the provision of social safety nets. The EAT-Lancet diet specifies country-specific minimum food intake levels for fruits, vegetables, soybeans and other legumes, and nuts; and healthy maximum

Table 1
The "hidden costs" of global food systems*.

	FOLU (2019) USD trillions 2018 PPP		Hendriks et at. (2021) USD trillions (most recent data)	FSEC (2023) USD trillions 2020 PPP	FAO (2023) USD trillions 2020 PPP
Market value	10.0		9	10	10.0
Health costs	6.6	(productivity costs of obesity and undernutrition, pollution, pesticides, AMR)	12 (mortality, medical costs, informal care, lost working days, economic costs of poor diets)	11 (negative effects on labor productivity)	9.3 (negative effects on labor productivity)
Environmental costs	3.2	(GHG emissions, loss of natural capital)	7 (GHG emissions, biodiversity loss, nitrogen pollution)	3 (GHG emissions, biodiversity loss, nitrogen pollution)	2.9 (GHG emissions, nitrogen emissions, water and land use).
Socio-economic costs	2.3	(rural welfare, food loss and waste)		1 (poverty in agri-food systems)	0.6 (productivity losses from undernourishment or poverty)
Total "hidden costs"	**12.2**		**19**	**15**	**12.7**

* Measurement approaches for each component differ across the studies. **Health:** FOLU calculates hidden costs in terms of productivity losses due poor nutrition and an associated burden of disease. Unlike the other studies it also includes the costs of non-communicable diseases from pollution, pesticide use and anti-microbial resistance. The FSEC and FAO measures are also based on productivity losses implied by poor nutrition. By contrast the Hendriks *et al.* study measures the costs of mortality, medical expenditures and lost working days. **Environment:** FOLU evaluates the hidden cost of emissions at a carbon price of USD 100 per tonne, whereas FSEC and FAO measure the damage inflicted by emissions in terms of the cost of adopting optimal abatement strategies. All studies calculate the cost of air pollution from NH3 emissions, and the effects of water pollution on biodiversity. Again the FOLU study is more exhaustive, with estimates for the effects of water pollution on health, pesticide expenditures, land degradation, AMR and over-exploitation of biological resources. **Social:** Socio-economic costs derive from the productivity drag of structural poverty, which is measured as rural poverty in the FOLU study, but by poverty in agri-food systems by FSEC and FAO (which can arise from low incomes or the burden of food prices). These numbers also include productivity losses due to undernutrition, as distinct from the productivity losses from the burden of disease. FOLU include the costs of food loss and waste, as well as fertilizer leakage.

[1] The 2023 FAO report constitutes a first effort to disaggregate hidden costs down to the national level and ensure they are comparable across cost categories and between countries. The 2024 report provides more targeted assessments and seeks to identify mitigation pathways.

[2] https://www.un.org/en/food-systems-summit/news/making-food-systems-work-people-planet-and-prosperity.

food intake levels for sugar and vegetable oils, as well as red meat, poultry, eggs, and milk products. It has proven contentious, both in terms of its health impacts (Zagmutt et al., 2020; Young, 2022) and in some cases its environmental consequences beyond GHG emissions (Tulloch et al., 2023). There is also evidence that the EAT-Lancet diet may be unaffordable for much of the world's poor, exceeding per capita income for at least 1.58 billion people (Hirvonen et al., 2020a; 2020b). The strengths and weaknesses of the EAT-Lancet study have received a lot of attention, but whatever the study's shortcomings it signaled the potential to exploit important synergies between human health and the environment.

In summary, the hidden costs of food systems numbers are individually plausible, are used to support some sensible policy recommendations, and can serve as an input to wider analysis. Unfortunately, however, we believe that an approach that does not consider countervailing benefits, that aggregates social problems that are fundamentally different in their economic character and origins, and attributes those costs solely to food systems, may not be the best guide for a differentiated policy analysis. By feeding a narrative of "system failure" it is also more likely to impede than propel the transformative agenda that it calls for.

2. Why are the hidden-cost calculations unhelpful?

First, it is not illuminating to aggregate the true (private and social) costs of food systems without properly accounting for the true benefits on the other side of the ledger – a point recently made by Díaz-Bonilla et al., 2024. In fairness, the studies do take care to acknowledge the positive contributions of food and agriculture, and in the FSEC and FAO reports some environmental benefits are accounted for in the form of negative social costs (such as the conversion of pasture or cropland into forests). Fundamentally, however, the true cost approach only focuses on the cost side.

This means that the calculations ignore the spectacular achievement through which farmers have fed – *and continue to feed* – a world population that has grown from 3 billion since 1960 to over 8 billion today (or, inconsistently, assume it away as a purely private benefit). Gollin et al. (2021) find that the adoption of high yield varieties of staples alone increased yields by 44 % between 1965 and 2010, with further gains coming through reallocation of inputs. Those higher yields increased income and reduced population growth, with the authors estimating that a ten-year delay of the Green Revolution would in 2010 have cost 17 % of GDP per capita and added 223 million people to the developing-world population.

In their latest SOFA report (FAO, 2024), FAO effectively dismisses these benefits, maintaining that the total benefits of agrifood systems, while real, are unlikely to change much with policy interventions, and that the bulk of the impact will be in terms of the *visibility* of the hidden benefits of agrifood systems, not total benefits.[3] This contention effectively reverses the "multifunctionality" argument advanced the early 2000s (OECD, 2022), whose proponents emphasized the social co-benefits that farmers provided along with agricultural production but paid scant attention to social costs. Indeed, FAO's own work around that time stressed the "multiple roles of agriculture", which included the contributions of agriculture to poverty alleviation, household food security, the provision of environmental services, out-migration control, buffering in times of economic crisis and national cultural identity (Bresciani et al., 2004; FAO, 2007; Renting et al., 2009).

The exclusion of social benefits, and the contextualization relative to private costs and benefits measured in terms of economic value, are collectively misleading. A more appropriate measure of private economic benefits (welfare) would be the sum of consumer surplus (the difference between what consumers would be willing to pay for each unit and what they actually pay – in principle infinite for people who are starving – and producer surplus (the difference between what producers would require to supply each unit and what they actually receive), rather than the market value of exchange. The focus on expenditure values rather than economic surplus leads the FSEC report to state that "our food systems are destroying more value than they create", a statement which, taken literally, implies that we should ban farming or stop eating.

The hidden cost numbers also aggregate social costs that are different in their economic character and therefore require different kinds of policy responses. Some are externalities, or other forms of market failure, generated in the production and consumption of food, such as GHG emissions and local environmental impacts. Others are not market failures as such, but shortfalls in social outcomes that may be attributable to a lack of economic development, inefficiencies or distributional choices (Díaz-Bonilla et al., 2024). In the case of an externality, the theoretically optimal policy is one that taxes a negative externality and subsidizes a positive one. Yet, most of the enumerated hidden costs are not direct externalities, but rather performance shortfalls, which call for a diverse range of government policies. The assumption that social costs are negative externalities leads Hendriks *et al.* to claim that "food is roughly a third cheaper than it would be if these externalities were included in market pricing" (Hendriks et al., 2021). This assessment ignores the fact that adequate nutrition remains unaffordable for the world's poorest people (Yan Bai et al., 2021) and the potential social, political, and even military costs that a countervailing increase in food prices could imply.

The hidden costs estimates benchmark the global food system's performance against an ideal and non-existent world in which all costs are eliminated and there are no unavoidable trade-offs. Thus, the harmful effects of chemical input application are counted, but the land-sparing benefits of technology adoption are not. Further, since the 1980s, total factor productivity (TFP) growth has been the dominant driver of production increases, alleviating the pressure on natural resources (USDA, Economic Research Service, 2024) – a good news story that the hidden cost narrative ignores.

Moreover, some social costs may not just be inevitable, but in fact desirable. Notably, Sheahan and Barrett (2017) provide examples where the optimal levels of food loss and waste may not be zero. Thus, farmers may find it more profitable to incur some post-harvest losses to expedite planting of a second annual crop, while a degree of loss may also be needed to remove adulterated products from the food supply. Similarly, consumer food waste is not simply a moral matter, but reflects private opportunity costs which need to be balanced against the social cost of resource depletion.

A further objection is that multiple failings are attributed to "food systems", when their fundamental causes originate outside the food and agriculture sector (see also Díaz-Bonilla et al., 2024). A major reason for poor nutrition in developing countries is poverty, with the FAO estimating that over 3 billion people are too poor to be able to afford a healthy diet (FAO et al., 2023). Around 120 million people in 19 countries suffer from acute food insecurity because of conflict (FSIN, 2023). Food poverty is also a shameful issue in developed countries, with increased recourse to food assistance programs (Giner and Placzek, 2022). But poverty itself is a wider problem, and the primary levers for solving it mostly lie outside agriculture and the food system. Smallholder development can be an important driver for poverty alleviation in low income countries, yet more than half the world's absolute poor now live in urban areas. Moreover, in developed countries, poor diets are associated with a complex range of lifestyle and socio-economic factors – couples both working, higher consumption of processed foods, urban poverty, more eating away from home and more sedentary lifestyles. Several aspects of the operation of food systems are contributing to these problems, but they are not the only, or even the primary, generator of malnutrition.

The grouping of health, environmental and economic elements under a "systems" umbrella fuels the impression that the problems are all

[3] See FAO (2024) Chapter 1, Box 2.

related. Yet not every issue is a system issue. There are certainly critical interactions across the dimensions of food security, resource use and livelihoods that call for coherent policies. Most notably, there is an argument for encouraging healthy and more sustainable diets as a complement to supply side initiatives to improve the environmental performance and lower the carbon footprint of food supply chains. But many of the challenges across food and agriculture are specific problems that require targeted policies that range from correcting externalities and other forms of market failure, to improving efficiency and addressing equity and justice concerns.

Agricultural policies in many countries remain particularly misconceived, with a lack of clarity about their economic, social and environmental objectives (Brooks, 2023). Structurally, they prop up incomes, sometimes with environmental strings attached. Broadly, however, they fail to address the implications of productivity growth for the livelihoods of less competitive farmers. The so-called "farm problem", which has existed for decades, is, however, far removed from the issue of resolving the obesity pandemic in high income countries. Ultimately there are connections of course, but to over-emphasize them risks leading to muddled policies with unintended consequences.[4]

3. Will the numbers help or hinder reform?

In policy terms, the emphasis on social costs immediately raises the issue of how those costs can be mitigated, rather than how social benefits may be leveraged, for example through technology and innovation. That leads to the final difficulty with approaches which focus on the cost side; namely that it fuels divisive politics. If you only stress the costs then naturally you start looking for culprits. And if you are only identifying culprits how do you get the buy-in necessary for transformative change? Viewed through a social cost lens, farmers appear as wreckers of the environment and producers of food that lacks nutrition; seed and agrochemical suppliers, together with processors, are exploiters of farmers and contributors to environmental damage; while processors, retailers and major brands are purveyors of unhealthy foods and manipulators of diets. Yet each group has positive contributions to make. Seed companies are potential suppliers of technologies that can boost yields, lower the environmental footprint of agriculture and help farmers adapt to climate change. Developed country farmers are not wrong with their protest slogan "no food without farmers". In developing countries, where many farmers may have few other livelihood options, counting only the social costs of farming is likely to be particularly counter-productive, at least within the current generation. Processors, distributors and retailers each have critical roles to play in getting food efficiently to consumers. Of course, oversight of these stakeholders is necessary, but emphasizing only the damage they inflict, without recognizing the important global advances in reducing hunger and improving food security during the last decades, gives a false impression to consumers with little knowledge of food and farming, and risks alienating the very actors that are indispensable to solving the problems that need to be addressed.

A truly transformative agenda for food systems will require difficult adjustments by each of these constituencies, not least by farmers. A vast amount of amount of support is provided to farmers globally. Across 54 countries, total support to agriculture reached USD 842 billion per year during 2021–2023 (OECD, 2024). Of this, USD 508 billion per year was paid from government budgets, with USD 295 billion of that going directly to farmers. The remaining USD 334 billion per year came through policies that raise domestic prices received by farmers above international reference prices. A large share of support is linked to output, which tends to favor larger farmers, while increasing pressures on natural resources and raising GHG emissions. There is a strong case for reforming price policies, and repurposing budgets to redress market failures in the agricultural sector, a rationale that would include paying farmers for the social benefits they provide, including environmental goods, and underwriting those elements of risk that cannot be covered by farmers themselves or by private insurance mechanisms (Glauber et al., 2021). A number of public goods are also specific to the sector, not least research and development, where there is evidence of high returns albeit with long time lags (Alston et al., 2023), as well as biosecurity and some elements of physical infrastructure. Any budgetary savings, net of resources that need to be put into strengthening social safety nets, could potentially be hypothecated to health and climate policies. It is also reasonable to expect farmers to make a fair contribution to climate change mitigation targets, which currently they do not.

A parallel "repurposing" agenda along those lines has been promoted by the UN system (FAO, UNDP and UNEP, 2021), the World Bank and IFPRI (Gautam et al., 2022), the WRI (Ding et al., 2021) and a wider Just Rural Transition coalition (Just Rural Transition, 2021). Unfortunately, that agenda is unlikely to be helped by the hidden costs numbers, so one set of international efforts is potentially being compromised by another.

Agriculture has always been difficult to reform. Productivity growth confers broad social benefits, but induces the aforementioned "farm problem". In developed countries, farmers not at the vanguard of innovation lose competitiveness and increasingly struggle to make a living. These farmers have a strong incentive to mobilize for support – either in the form of trade protection or subsidies – and that support can account for a vital share of their income. By contrast the burden those support policies impose on consumers via higher prices, and on taxpayers through subsidies, is proportionally lower. A consequence is a lack of incentive to become fully informed ("rational ignorance") on policy specifics among the general public, which makes them especially susceptible to being misled by the hidden costs numbers. Moreover, farmers' businesses are inextricably tied to the land, and changes wrought by the competitive process – fair or otherwise – pose a threat to traditional ways of life. Faced with a need for adjustment, many citizens are more inclined to trust the voices of farmers than government officials trying to push through necessary but painful reforms. The political calculus is often reversed in low-income countries, where the voices of poor urban consumers typically weigh more heavily than those of more remote farmers and there is a tendency to tax rather than subsidize the agricultural sector (OECD, 2024).

The politics is even hardening. A bold first step of a transformative agenda would include an adequate carbon tax on all emissions, including those from the food and agriculture sector. This is a long way away, with Denmark so far the only country to announce an explicit tax on agricultural emissions, to be introduced in 2030. In February 2024, tractor blockades in France were enough for France to retreat on the removal of diesel tax breaks for farmers – a marginal not a transformative change. President Macron also ruminated on the need for a return to minimum support prices – policies that created decades of disruption on international markets. Moreover, there was widespread public support for the French farmers' protests, which probably

[4] One such muddle stems from the view that agricultural policies that foster productivity growth for basic food staples, such as R&D, are inherently problematic because, by lowering prices, they contribute to over-consumption and unbalanced diets (Benton and Bailey, 2019). While this may be an unwelcome side effect, it is important to note that even in high income countries such as the United States, the social costs are still small relative to the private benefits, while lags of decades mean that curbing R&D in food staples would not reduce obesity in the short term (Alston et al., 2016). Moreover, TFP growth is essential for sustainability, while basic foodstuffs still account for a large share of consumer budgets in many developing countries. A consumer tax could counteract over-consumption, but it is worth recalling that high bread prices sparked the Arab Spring in 2011 (Brooks and Giner, 2021).

reflected a broad concern for farmers' standard of living rather than knowledge of the specific policies to which they were objecting.[5] At the EU level, the Commission has moved to re-approve the use of glyphosate for another ten years and stalled on implementation of the Green Deal (Matthews, 2024). Across Europe and elsewhere, farmers perceive themselves to be unfairly blamed for health and environmental problems, with livestock producers foreseeing a major threat to their existence. In Europe, there is evidence that some farmers are becoming allied with far-right movements that fundamentally reject the need for climate action. In the US, farmers are supportive of adaptation responses, but few endorse GHG reduction, preferring interventions that have adaptive and mitigative properties (e.g., reduced tillage, improved fertilizer management) (Arbuckle et al., 2015).

4. Is there a way forward?

The broad contours of transformative food systems policies are identifiable, even if implementation lags. On the supply side, polices must spur innovation in order to unlock faster TFP growth and thereby decouple agricultural production growth from the degradation of natural resources and from emissions. In parallel, they need to tackle the "farm problem" that productivity growth itself creates, providing viable livelihoods within or outside agriculture. Subsistence and small farmers in developing countries most likely need complementary cash transfers to address poverty, nutrition, and environmental problems. On the demand side, a multi-pronged approach will be needed to get people to adopt healthier and more sustainable diets, and to make sure that such diets are affordable. The FSEC report, in common with others (e.g. OECD, 2021) rightly stresses the need to avoid policy silos, so that synergies can be exploited (e.g. healthy diets with low emissions) and trade-offs identified and mediated (e.g. the effects of lower ruminant production on the incomes of livestock farmers). In mediating across competing objectives, food and agriculture policies will need to be country and even locally specific, with agriculture integrated into a wider view of rural development that recognizes the growing contribution of non-farm activities, be they linked to agriculture via value chains or fundamentally unrelated (Hazell et al., 2024). More widely, addressing the health, environmental, and social problems of food systems will require a detailed consideration of not only agricultural policies, but also all government interventions with impacts on food systems, ranging from social protection, health, infrastructure and the environment in general, to trade, fiscal, finance, and other overall economic policies (Díaz-Bonilla, 2023).

The FSEC's and FAO's recent numbers are inevitably rough estimates, but the orders of magnitude are a plausible representation of one side of the ledger. Few would argue with the need for substantial efforts or for system-wide coherence to address the daunting challenges humanity faces. Blind optimism in technological fixes, such as new feeds to curb emissions from ruminant livestock, or pills to eliminate obesity, would be myopic. So there is much to commend in the efforts to quantify the health, environmental and social problems associated with the world food system. But the alarmist and one-sided hidden costs approach risks entrenching identity politics and is likely to backfire. The data gathering effort has not been wasted; however, to provide adequate policy guidelines the exercise must be integrated into a more balanced assessment of the performance of food systems, avoid lumping together problems that have different economic characteristics and hence require different approaches, and acknowledge that some of the postulated hidden costs emerge from drivers outside food systems. This approach would also be more constructive on political-economy grounds, presenting a positive agenda that can engage the actors – not least farmers – indispensable for transformational change.

[5] Even before farmers protested President Macron had vowed to veto any EU-Mercosur trade agreement, notwithstanding over 20 years of negotiations and a return to more credible climate and deforestation policy efforts in Brazil under President Lula.

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Jonathan Brooks: Writing – original draft, Conceptualization. **Eugenio Diaz-Bonilla:** Writing – original draft.

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