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PRACTITIONER'S PERSPECTIVE

Implementing ecosystem service assessments within agribusiness: Challenges and proposed solutions

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Abstract

1. Incorporating the assessment of ecosystem services into land management decisions is increasingly recognized as an opportunity to support sustainable development. This, however, can be particularly challenging within the productive sector, a highly technical system often driven by multi-level private entities.
2. Here we present five key challenges, and suggest their corresponding solutions, when promoting the operationalization of ecosystem services within agribusiness. The challenges we developed are as follows: (a) building a common understanding of ecosystem services; (b) navigating strong power dynamics; (c) a highly technical system with diverse types of expertise; (d) limited understanding of the opportunity costs of alternative practices and (e), dealing with uncertainty.
3. We draw on our experience generated through the Wine, Climate Change and Biodiversity programme, a science-based initiative promoting the conservation of biodiversity and strategic use of ecosystem services in Chilean vineyards.
4. *Synthesis and applications*. This perspective piece provides advice to scientists and practitioners on how to navigate technical and practical challenges when promoting the incorporation of ecosystem services into agricultural management. While the assessment of ecosystem services can be a highly technical process, its successful integration into land management decisions relies on active engagement, balancing expectations and an ability to construct a shared understanding among different stakeholders. The approaches suggested here rely on principles of co-production and are illustrated with examples that are transferable to other crop and geographical contexts.

KEYWORDS
agriculture, decision-making, ecological intensification, knowledge co-production, land-use management, stakeholders engagement, sustainability

1 | INTRODUCTION

Incorporating the assessment of ecosystem services, the benefits that humans receive from ecosystems, into land management decisions is increasingly recognized as an opportunity to support sustainable development (Bateman & Mace, 2020; Guerry et al., 2015). The assessment of ecosystem services aims to explicitly integrate ecological, economic and social factors by focusing on the benefits nature provides to humans, thus presenting a framework suited to tackling complex problems related to sustainability (Jax et al., 2018). Impacts associated with intensive agricultural production systems on natural and semi-natural ecosystems are of growing concern (Garibaldi et al., 2017). Consequently, numerous efforts are underway to operationalize ecosystem service frameworks as tools for decision-making (Bateman & Mace, 2020). Yet, mainstreaming ecosystem services into land management has proven challenging (Reyers et al., 2015). Scientists, practitioners and stakeholders are required to engage through collaborative processes to integrate diverse expertise to generate context-specific knowledge for supporting decisions (the so-called 'knowledge co-production'; Norström et al., 2020). Incorporating ecosystem services into land management decisions is a difficult task. From a technical perspective, it often requires complex data analyses, including quantifying natural capital stocks and mapping ecosystem services, land-cover assessments using remote sensing methods, and nutrient cycling modelling (Martínez-Harms & Balvanera, 2012). Such analyses seek to understand how goods and services flow from natural ecosystem assets to different human beneficiaries, who invariably represent differing societal, economic and other well-being aspirations. From a practical perspective, this process requires participative approaches that ensure information is relevant to diverse stakeholders, whose needs relate to their socio-political context, the sector within which they operate, and their core values and perceptions (Davies et al., 2015). Therefore, no 'one-size-fits-all' solution exists. Instead, operationalizing ecosystem services knowledge requires practitioners and scientists to account for the contextual characteristics of different stakeholder groups and the ecosystems upon which they rely.

The agriculture sector critically depends on a broad suite of ecosystem services (such as nutrient supply, pest control and pollination; Landis, 2017). However, paradoxically, traditional agricultural practices (e.g. synthetic fertilizers, land conversion, tillage) result in deleterious effects to the same ecosystem services required to sustain crop system function. Broadly speaking, the goal of integrating the assessment of ecosystem services in agricultural systems is to encourage the use of natural processes to reduce or replace external (often detrimental) inputs, while preserving biodiversity (Garibaldi et al., 2017). Under this premise, several alternative approaches have emerged such as agroecological farming, ecological intensification, ecosystem-based management and organic farming (hereafter referred to under the umbrella term of 'ecosystem-based management'). These approaches can be implemented in a wide range of socio-ecological contexts and with numerous stakeholder groups, including conservation initiatives with rural smallholder farmers, municipal urban green infrastructure design with local authorities, sustainability strategies with agribusinesses and national land management with policymakers (Garibaldi et al., 2017). Also, ecosystem-based management requires active engagement between scientists, practitioners and stakeholders, a process that needs to navigate technical and practical challenges which are specific to each socio-ecological context (Margerum, 2008). Identifying both challenges, and ways forward, for different contextual settings and stakeholder groups can help scientists and practitioners fine-tune available approaches—both modelled and participatory—for incorporating the assessment of ecosystem services into sustainable agricultural practices.

Here we identify five key challenges and corresponding solutions to mainstreaming ecosystem services into decision-making of agribusiness; a socio-ecological context that is often highly technical and is driven by multi-level private entities. We define this sector as farming businesses, including small, medium and large enterprises, ranging from specialist premium producers, to mass bulk commercial production. We draw on our experience generated through the Wine, Climate Change and Biodiversity (WCCB) programme, a science-based initiative promoting the strategic use of biodiversity and ecosystem services within and around Chilean vineyards. The WCCB programme has focused its efforts on the Chilean Mediterranean ecosystem, a priority for biological conservation. This semi-arid environment represents 16% of the continental surface of Chile yet hosts 50% of Chilean flora and more than half of the country's endemic species (Barbosa & Godoy, 2014). It is also highly valued for agriculture and wine production due to its highly fertile soils. The ecosystem services of water supply and quality, wildfire avoidance, biocontrol and soil formation are important to both industries as they underpin healthy productive systems (Trippier et al., 2021). For example, in recent years, the Chilean Mediterranean has faced a greater number of droughts, exposing farmers to increased wildfires. Potential ways forward to reduce this risk are being explored. These focus on native vegetation that, in addition to maintaining microclimates with higher average humidity, slows down the spread of fires due to its lower susceptibility to ignite and burn (Paula et al., 2009). Since 2008, WCCB has worked in close collaboration with 22 wine companies, has carried out cross-level training for >2,500 people and contributed to the protection of 31,000 ha of Mediterranean native forest within private land (WCCB Programme, 2021). This paper includes insights from a 1-year project, developed in collaboration with the Joint Nature Conservation Committee, a public body that provides evidence-based advice on nature conservation both in the UK and internationally.

2 | COLLABORATING WITH AGRIBUSINESS

A range of contextual characteristics can make stakeholder groups different from each other, such as its history, technical complexity, power dynamics, membership size, resources and institutional structure (Margerum, 2008). These characteristics can dictate

the challenges that scientists, practitioners and stakeholders face at different stages of mainstreaming ecosystem services into decision-making. Generally, these stages are as follows: (a) defining the problem and relevant ecosystem services; (b) assessing and valuing ecosystem services; (c) suggesting and implementing solutions to decision-makers; (d) monitoring and evaluating the effects of the solution, and (e) adapting the process where necessary (Jax et al., 2018).

Here we suggest that the agricultural sector has three characteristics that can give rise to specific challenges when working with this particular sectoral group of stakeholders. First, like many businesses, agricultural production companies often present a strong hierarchical structure, that varies with company origin (i.e. family owned) and size, which can create power dynamics that must be accounted for in stakeholder engagement processes (Virah-Sawmy et al., 2019). Second, their underlying interests to implement the assessment of ecosystem services is usually affected by financial incentives, which can generate trade-offs when considering the design of alternative management solutions (Conradie et al., 2013). Finally, agricultural productive systems can be technically complex and can hinder the practical implementation of designed actions (Dendoncker et al., 2018). The next sections discuss how different contextual characteristics can produce five key challenges when mainstreaming ecosystem services into agricultural land-use management.

3 | CHALLENGES AND RECOMMENDED SOLUTIONS TO IMPLEMENTING ECOSYSTEM SERVICES KNOWLEDGE WITHIN THE AGRIBUSINESS

Below we present the challenges (Table 1) in the order that they might arise within the collaborative process. We note, however, there are various iterations of this order depending on the design of the engagement process. For each challenge, we provide a set of recommendations for how to address these issues (Table 1). Recommended solutions have been developed and refined over years of practical experience and, while applied to the wine sector, can be applicable across different collaborative contexts with agribusinesses.

3.1 | Building a common understanding of ecosystem services

To successfully define the 'problem space' of ecosystem services implementation, it is important to develop a common understanding within a collaborative group. A problem space consists of all the different components of a problem, as well as the possible solution pathways. However, it is likely that not all interested parties will share the same values and priorities and, as a result, specific components will be viewed and understood differently. Acknowledging these differences early in the process will aid the co-production of solutions that are credible, unbiased, inclusive and relevant to the needs of the stakeholders. Two components of implementing ecosystem services that require particular attention are the definition of ecosystem services and the function these services perform within an agribusiness's strategy.

The term 'ecosystem service' is often considered an interchangeable term, depending on the framework as it can refer to a process, a service, a good, a benefit or a value. For example, for the wine companies that have participated in the WCCB programme, ecosystem processes (e.g. nutrient cycling) lead to ecosystem services (e.g. soil fertility) which is converted into final goods (e.g. grapes) which possess a value for humans which may be measured in monetary terms (e.g. wine sales) or social values (e.g. iconic vineyard landscapes). While the broad umbrella of ecosystems services might appear challenging, it is the authors' opinion that the broad scope of this conceptual thinking can be beneficial, as it enables stakeholders to relate to certain aspects of ecosystem services that are important to the specific system which they inhabit or influence. WCCB have potentiated this by involving stakeholders with hands-on, participative, workshops and activities such as building biodiversity inventories of their own farms or doing participatory mapping of services (Márquez-García et al., 2018). This allows individuals to identify the ecological features that drive the ecosystem services critical to supporting production.

Participatory approaches, like the ones outlined above, can highlight how farmers regard ecosystem services in their business strategies, and therefore their underlying motivations to change their ongoing land management practices. These can include the following: reducing external products and costs, improving the public image of the business, allowing access to new markets, and improving quality of the product and better biodiversity management. Identifying these motivations reveals types of potential actions that can be co-designed for implementation and improves the chances of such actions being accepted by stakeholders as viable alternatives. For example, wine companies wanting to reduce the damage caused to vines by invasive rabbits now understand the need of increasing the density of Culpeo foxes *Lycalopex culpaeus*. The latter would require ecological restoration actions to increase the habitat of foxes throughout the vineyard landscapes. The active engagement of stakeholders in the mapping and monitoring of their own land through the lens of ecosystem services plays a crucial role in exploring management aspirations and related trade-offs.

3.2 | Navigating strong power dynamics

Power structures of agribusiness companies are generally hierarchical, and this can hinder two important principles of knowledge co-production and collaborative processes: pluralism and interaction (Norström et al., 2020). On the one hand, pluralism explicitly recognizes the multiple ways of knowing and doing. Unequal levels

TABLE 1 Summary of challenges in the implementation of ecosystem service (ES) assessments into farming systems, their potential solutions and Wine, Climate Change and Biodiversity (WCCB) case examples

Challenge name	Challenge description	Recommended solution	WCCB case example
1. Building a common understanding of ecosystem services	ES frameworks and definitions can vary. Its use requires finding a common vocabulary among parties and reaching consensus on how to put it in practice	• Start by agreeing on ES definition and its role in business strategy • Use 'hands-on' activities so stakeholders can discover themselves what elements from ES frameworks are relevant and practical to them	• Participative workshops where farmers develop qualitative maps of those ES that are most important to their crop systems. The concept of ES becomes tangible, measurable and easier to link to the crop system
2. Navigating strong power dynamics	Power structures of farming companies can hinder the quality of collaborative processes	• Invest time to get to know your stakeholders • Design the engagement process as inclusive and cross-level as you can • Acquire strong 'soft skills' to lead collaborative groups effectively	• Participative instances (working and social) where as many levels of the company engage simultaneously. Company members get to know each other better, and a higher participation across levels is observed during workshops
3. A highly technical system with diverse types of expertise	Designing and incorporating alternative agricultural practices require comprehensive understanding in ecological processes to match technical needs of crops production. For some ES, this understanding can be rather limited. Also, within farming companies, there are multiple expertise (with associated priorities) which need to be accounted for within the co-design of alternative farming practices	• As a starting point, identify ES that are compatible with the technical complexity of the crop system • Treat one business company as different actors and account for their diversity of expertise	• Implementation of university research projects within farming companies to bridge knowledge gaps on ES. Preliminary results of such research have triggered further research pathways, now led by the company
4. Limited understanding of the opportunity costs of alternative practices	Limited understanding in the operational and financial trade-offs when implementing new management hampers our ability to bring ES into practice	• Acknowledge uncertainty in the science and decision-making • Design actions that accounts for different company conditions • Embrace qualitative approaches that permit stakeholders to assess relative benefits of new practices	• Implementing a 'from-to' designing process of alternative farming practices so companies that face higher opportunity costs are not excluded. Replacement of invasive trees by native ones in green corridors was implemented as a 'from' practice. This permitted a first engaging opportunity with new farming companies
5. Dealing with uncertainty	Co-production knowledge and collaborative processes involve uncertainties of many sorts, which can be difficult to communicate	• Promote engagement among farmers so they can exchange experiences and lesson using a similar knowledge system	• Performing workshops with multiple companies where they can share lessons learnt along the process of implementing alternative practices. The exercise permitted to acknowledge different sources of uncertainty by each company, and how they worked around it

of power can result in over-representing perspectives from higher levels when considering shared values. On the other hand, interaction allows for ongoing learning among participants and active engagement. Power dynamics can affect the proactivity of participants to openly express their views about the issue in question. In the context of the assessment of ecosystem services, this might result in missing relevant information from those that are vital in the crop production process and local ecological knowledge resulting in the design of incomplete solutions.

From our experience, three aspects have been essential to effectively navigate power dynamics. First, investing time and effort to get to know the business and the people that make up its personnel. This refers to aspects that go beyond the formalities (e.g. needs of the company) and instead acknowledging people's interests, range

of skills and expertise, and personal experiences in the business. There are no two businesses with the same contextual characteristics, and therefore, the engagement process has to be tailored to each specific case. Second, designing an engagement process that is as representative and inclusive as possible. This requires building collaborative approaches where many levels of the company engage simultaneously and where scientists and managers avoid vertical positions and encourage bidirectional feedbacks. This helps to connect institutional silos and to capture broad perspectives. Third, scientists with little experience of stakeholder engagement should consider receiving professional training to acquire the so-called *soft skills* or employing specialists trained in stakeholder engagement and communication. Understanding how to effectively facilitate a meeting, listen, negotiate and resolve conflicts are essential to actively lead a collaborative process and must not be undervalued (Oliver & Cairney, 2019).

3.3 | A highly technical system with diverse types of expertise

One of the contextual characteristics that notably differentiate an agribusiness from other sectoral groups is its technical complexity. Different crops depend on numerous biophysical variables that require a highly specific, often narrow, range of environmental thresholds to be met to deliver expected production outcomes. To incorporate ecosystem services within these systems, a thorough understanding of ecological functions and processes, and their influence on agricultural practices and outputs, is needed. Although theoretically achievable, the uncertainty in much of the current knowledge of ecosystem services means that much understanding will fall below the threshold desired by production managers, who require higher levels of certainty to ensure businesses remain productive and financially viable. More experimental research is needed to incorporate ecosystem services at the level of precision that crop production systems require. In the context of our research, a good example would be that grapevines require specific irrigation and fertilization processes to achieve a specific berry skin-to-flesh ratio. The latter determines important characteristics of the wine such as flavour, body structure and colour. To obtain the same balance through ecosystem services would involve managing the services of water storage, soil formation and soil fertilization while integrating their outputs into a common result, the skin-to-flesh ratio. In reality, this is currently difficult to implement as current knowledge of ecosystem services is limited and the standardization of their management remains understudied (Bommarco et al., 2013).

The technical complexity of agricultural systems often goes together with diverse types of expertise and knowledge. For instance, the wine agribusiness comprises winegrowers, winemakers and wine marketers. This brings together numerous expertise; all of which need to be integrated into the knowledge co-production process. While such expertise are grouped under one stakeholder identity (i.e. wine producers), in practice they work as different actors within the same company. Each expert can arguably prioritize the ecosystem service that is more relevant to their production area. For instance, while marketers may prefer ecosystem services that are easier to showcase (e.g. scenic beauty), crop growers may want to focus on those ecosystem services that directly benefit the yield (e.g. nutrient retention). This complex group dynamic can be navigated using a transdisciplinary research approach (Carmen et al., 2018) as used by WCCB workshops (Márquez-García et al., 2018). Here, participatory workshops are performed with diverse stakeholders, but also with wine company staff coming from different departments and management levels. As a result, the barriers between types of expertise, status or power are deliberately blurred. There are no dominant roles, but a group of people who are collectively identifying and solving problems that are relevant to all parties. Nevertheless, our limited understanding of ecosystem services functioning often hampers the co-design of ecosystem-based measures and the engagement of different expertise at a high technical level. These group instances often remain in the anecdotal realms and lack technical bases to reach consensus in agricultural practice that meet the environmental thresholds required by producers to maintain profitable crop systems.

3.4 | Limited understanding of the opportunity costs of ecosystem-based management practices

For farming businesses to incorporate an alternative practice, there often needs to be a net benefit, most commonly realized as increased financial profit. A way to support this decision process is through the assessment of opportunity costs, which are estimates of the difference in economic net benefit between the new practice and the conventional approach. However, precise estimation of opportunity costs of alternative practices presents a twofold challenge. First is to search and secure a market demand for products that have been produced through sustainably farming. In a globalized economy, such demand is often in another country, requires specific certification schemes and/or can be covered by premium consumers who are willing to cover the additional costs of a sustainable product. These obstacles can be major constraints for small and medium businesses who, despite having the interest and resources to implement alternatives practices, lack means to assess and locate market demand. Second is the estimation of site-specific costs for the design and implementation of a new alternative practice. This relies on numerous ecological and management factors that vary depending on crop and other context specifics (i.e. location of production site). Assessments on the effects of ecosystem-based management on a farm's economic performance tend to be limited to crop yields. Factors that significantly influence farm profitability are often not considered, such as operational costs, investment costs, market prices and subsidies (Bommarco et al., 2013). As a result, current understanding regarding the financial and operational trade-offs when implementing new ecosystem-based management practices are limited.

When opportunity costs are uncertain, scientists, practitioners and farmers can jointly explore the relative benefits of new practices. Qualitative opportunity costs can be assigned to a range of practices and across a spectrum of agribusiness contexts. The position of an agribusiness along this qualitative space can provide information on the relative benefits that a new practice can bring to a company. This approach can enable stakeholders to monitor expected outcomes and manage the levels of uncertainty in the science and the decision-making.

The Sustainability Code of the Chilean Winemaking Industry provides a case in point. Chilean wine business can be awarded certification if they meet a certain score calculated from ranked management practices. The final score compensates for the absence of certain practices with the presence of others based on that company's contexts. For instance, if a company cannot have areas of biodiversity protection because land cost is disproportionally high, then other practices can compensate the absence of protection sites. This assessment accounts, therefore, for the (qualitative) opportunity costs that farmers face to incorporate an alternative measure. Finding qualitative approaches that consider businesses' contexts so they can demonstrate their relative progress towards sustainable farming generates endorsements which can help small and medium businesses to position themselves in a global market.

3.5 | Dealing with uncertainty

Incorporating the assessment of ecosystem services in decision-making involves uncertainties of many sorts. As illustrated across the aforementioned challenges, these uncertainties can be present in various stages of the collaborative process. While different options for overcoming each of the challenges, and corresponding uncertainties, have been identified, we highlight a solution considered pertinent to any stage of the engagement process: fostering the sharing of experiences among stakeholders. Revealing the different contextual characteristics of agribusinesses in the context of the assessment of ecosystem services can contribute with lessons and experiences on a specific matter. For instance, some stakeholders might have implemented several alternative practices, whereas others have implemented none, thus locating them at very different stages of a sustainable transition. Therefore, promoting peer-to-peer knowledge transfer, where producers can share hands-on experiences of their systems, creates enriched pathways to operationalize ecosystem services in practical management.

4 | CONCLUDING REMARKS AND FUTURE DIRECTIONS

Incorporating the assessment of ecosystem services into land management decisions presents technical and practical challenges which can be specific to the stakeholder group in question. Here, we have identified five main challenges, and suggested their corresponding solutions, when working with agribusiness (Table 1). These insights are based on years of practical experience, in which academic knowledge has been adapted through participative processes to effectively address in-the-field issues. To conclude, we highlight future research directions that will further strengthen the implementation of ecosystem service knowledge.

Building a common understanding of ecosystem services is a critical step when assessing their implementation during a collaborative process. As suggested in Table 1, using an initially broad definition of ecosystem services, such as 'the benefits that humans receive from nature', can help stakeholders to hone in on the aspects that are important to them. For instance, we have identified that, to vineyards, such benefits are mainly related to water supply, topsoil formation, wildfire avoidance and pest control (Trippier et al., 2021). In addition, to further improve the pathways by which the concept of ecosystem service is communicated, consensus on a practical and common ecosystem service framework is needed. From our experience, a scientifically robust yet practical framework will allow the successful navigation of different stakeholder groups and sectors. We consider particularly novel and helpful the development of qualitative and participative approaches that allow farmers to map and prioritize ecosystem services within their crop system. This could be complemented with the assessment of flow diagrams to visualize causal linkages between ecosystem services, biodiversity, crop health and farming practices.

The design of alternative agricultural practices, that meet the technical requirements of farmers, remains an important challenge. Here, a key limitation is our lack of understanding of how systematizing the incorporation of specific ecosystem services within productive systems. To improve this knowledge, further controlled experiments are needed to help standardize alternative practices across different sectors and contexts. For example, the planting of wildflower strips has the win–win objective of conserving wild pollinators and increasing the crop yield (Feltham et al., 2015). Yet, to improve the efficacy of this measure, experiments are needed to quantify how crops respond to variation in the density and species composition of these wildflower strips (Feltham et al., 2015). Furthermore, experiments comparing the effect of organic (e.g. mulch, manure) vs synthetic fertilization will help to standardize the implementation of ecosystem services such as nutrient retention and soil structure (Djigal et al., 2012).

Imbalanced power structures within agribusinesses can impede collaborative processes. In this regard, we have highlighted that inclusive and participative engagement processes, with expert facilitation capacity, are essential to navigate such power dynamics. As such, consolidating and agreeing on a *package* of participatory approaches that permit the co-production of knowledge under imbalanced power contexts can lead to more robust and durable solutions (Chambers et al., 2021).

Farms are, first and foremost, businesses and consequently understanding the impacts of alternative agricultural practices on their economic performance is crucial to any successful incorporation of ecosystem services. Since such understanding is still limited, focusing on practices that have the potential to save farmers time or money should be prioritized. We have illustrated the case of a qualitative

approach that helps exploring the opportunity costs and alternative pathways of action (Table 1). Yet, the scaling of alternative practices will be only possible with better understanding on the economic impacts of alternative practices in agribusiness. This can be complemented and reinforced with better knowledge on the economic consequences of disregarding ecosystem services role goods production.

We have highlighted that the co-production of knowledge and collaborative processes involve uncertainties of many sorts. These can be difficult to communicate. Fostering the sharing of experiences among stakeholders can help navigate this. Stakeholders often have a common language and have overcome similar practical challenges. However, we acknowledge that this approach is not always applicable, especially in the context of competing businesses.

The challenges and solutions presented in this perspective were derived from experience within the wine sector in the Chilean Mediterranean ecosystem. Nevertheless, we believe that these will resonate with other experiences in other sectors and regions of the world. We judge that the challenges 'Navigating strong power dynamics', 'Limited understanding in opportunity costs of alternative practices' and 'Dealing with uncertainty', take particular relevance in initiatives that work with the private sector, given the highly hierarchical structure and the lucrative business model of the latter. Finally, regardless of crop type, the ecosystem services that are relevant to agricultural production tend to be the same (e.g. soil formation, fertilization, water retention, biocontrol). Although it can change the technical specificities in the design and implementation of an alternative practice, the challenges of 'Building a common understanding of ecosystem services' and 'A highly technical system with diverse types of expertise' are common to initiatives that seek to incorporate ecosystem services in land decision management. We hope that the solutions presented here will be a catalyst for further discussions on how best to collaborate and implement the assessment of ecosystem services.

AUTHORS' CONTRIBUTIONS

A.P.D. and O.B. conceived the ideas; A.P.D. led the writing of the manuscript; M.S., B.T., K.G., M.P., M.L., I.C., G.R.L., N.O.-A. and A.R. contributed to the development of the framework. All authors contributed critically to the drafts and gave final approval for publication.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

We will not be archiving any data because this manuscript does not use data.

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BIOSKETCH

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