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Cultural Synergy and Agrobiodiversity: Indigenous-Led Agroforestry Projects in Brazil

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Abstract

Agroforestry emerges from the dynamic interaction between humans and the environment, fostering agrobiodiversity. However, a significant challenge to its adoption is the limited availability of technical assistance. In the Brazilian Amazon, Indigenous Agroforestry Agents affiliated with the Acre State Pro Indigenous Commission (CPI-Acre) have been instrumental in promoting sustainable land management. Through participatory approaches, they integrate traditional knowledge with innovative techniques to enhance food security, support environmental conservation, and improve overall quality of life. By facilitating knowledge-sharing, they drive behavioral changes that encourage more sustainable agroforestry practices.

Keywords: ***agrobiodiversity, agroforestry, Indigenous Agroforestry Agents, sustainable land management, food security, environmental conservation, knowledge-sharing.***

1.Introduction

Agroforestry represents a dynamic interaction between humans and the environment, fostering a relationship of integration and exchange that enhances agrobiodiversity. The protection of agrobiodiversity extends beyond environmental conservation it also safeguards traditional knowledge, customs, and the cultural heritage of Indigenous peoples and small-scale farmers. Agrobiodiversity and cultural diversity are deeply interconnected, as highlighted by Klaus Töpfer (UNESCO & UNEP, 2003), who identified a strong correlation between areas of high biodiversity and regions of rich cultural diversity.

The management of agrobiodiversity by farmers offers numerous benefits, including maintaining crop diversity across agroecosystems, preserving traditional values, and conserving local plant varieties a key factor in enhancing climate resilience and adaptation to diverse environments (Machado, Santilli & Magalhães, 2008). However, at a global scale, conventional agricultural practices, such as monoculture and pesticide use, significantly contribute to greenhouse gas emissions and biodiversity loss. Addressing these environmental challenges requires a shift towards sustainable land management practices(1).

In the Brazilian Amazon, Indigenous Agroforestry Agents affiliated with the Acre State Pro Indigenous Commission (CPI-Acre) play a vital role in this transition. Chosen from within their ethnic communities, these agents combine traditional knowledge with modern techniques to implement agroforestry systems, promote environmental conservation, and support food security. Their work is grounded in participatory and educational approaches, fostering behavioral change and empowering local communities.

This paper is structured as follows: The first section explores agroforestry systems as a product of the interaction between humans and nature. The second section examines the role of Indigenous Agroforestry Agents in knowledge-sharing across the Brazilian Amazon. The final section highlights their contributions to socio-environmental management, emphasizing their impact on sustainable development and the resilience of indigenous territories.

2.Literature Survey

Agroforestry is increasingly recognized as a sustainable land management approach that combines trees, crops, and livestock to boost biodiversity, enhance soil health, and improve agricultural productivity. Research shows that agroforestry systems play a vital role in mitigating and adapting to climate change by promoting carbon sequestration, minimizing soil erosion, and enhancing water retention. Altieri (2004) notes that agroecological practices, including agroforestry, focus on conserving biodiversity and using natural resources sustainably, while also supporting food security and resilience in farming communities. The importance of traditional knowledge in agroforestry is well-documented, illustrating how Indigenous and smallholder farmers have effectively managed diverse agricultural landscapes through techniques like intercropping, rotational planting, and utilizing native species to maintain

ecosystem balance. These practices have been essential for preserving local genetic resources and ensuring long-term agricultural productivity. Nevertheless, despite these advantages, the broader adoption of agroforestry often faces challenges such as limited access to technical support, inadequate

While the benefits of agroforestry are increasingly acknowledged, there are still significant hurdles to its widespread adoption. The agricultural industry, largely characterized by intensive monoculture practices and heavy reliance on chemical inputs, remains a key factor in greenhouse gas emissions and the decline of biodiversity. Research indicates that moving towards agroforestry-based systems demands substantial institutional backing, which includes financial incentives, supportive policy frameworks, and collaborative interdisciplinary research. De Schutter (2011) emphasizes that transitioning to agroecological practices requires a fundamental change in agricultural development, shifting from extractive industrial methods to regenerative and community-focused strategies. In this context, the efforts of Indigenous Agroforestry Agents exemplify effective grassroots environmental governance, showcasing how locally tailored practices can provide practical solutions to global sustainability issues. Future studies should aim to expand these initiatives, incorporate them into national agricultural policies, and investigate innovative funding strategies to bolster Indigenous-led agroforestry projects(2).

3.Existing and Proposed System

The current agricultural practices in many parts of Brazil, including the Amazon, heavily depend on traditional farming techniques like monoculture and large-scale industrial agriculture. These methods often result in deforestation, soil degradation, and a loss of biodiversity. They also contribute to climate change by increasing greenhouse gas emissions and diminishing the ability to sequester carbon. Although agroforestry is recognized as a more sustainable option, its broader adoption has been limited due to a lack of technical support, financial resources, and institutional backing. Many smallholder farmers and Indigenous communities encounter obstacles in accessing essential resources such as training, seeds, and market opportunities, which prevents them from fully realizing the benefits of agroforestry. While government initiatives and NGOs have worked to promote sustainable agriculture, the integration of Indigenous ecological knowledge into mainstream agricultural policies is still lacking. Current policies often overlook the connection between agrobiodiversity and cultural diversity, resulting in fragmented efforts that do not fully utilize the expertise of Indigenous communities in environmental conservation and agroecological practices.

To tackle these challenges, we propose a participatory, Indigenous-led agroforestry system that empowers Indigenous Agroforestry Agents to facilitate knowledge-sharing and sustainable land management. This approach combines traditional ecological knowledge with modern agroecological practices, ensuring that agroforestry methods are culturally appropriate, environmentally sound, and economically feasible(3). The Acre State Pro Indigenous Commission (CPI-Acre) has already initiated similar projects, showcasing the success of peer-to-peer training and local capacity-building. Expanding this model would require bolstering institutional support, establishing dedicated funding sources, and incorporating Indigenous-led agroforestry systems into national agricultural policies. Furthermore, community-driven research initiatives, agroforestry cooperatives, and digital platforms could improve the sharing of knowledge and best practices. By promoting collaboration among Indigenous communities, researchers, and policymakers, this proposed system seeks to enhance agroforestry adoption, boost food security, and strengthen climate resilience while honoring cultural heritage and traditional farming methods.

4. Agroforestry Systems: A Harmonious Interaction Between Humans and Nature

Agroforestry is widely recognized as a sustainable land management system that integrates trees, crops, and livestock within the same unit of land, creating economic and ecological interactions that benefit both agriculture and the environment. According to the World Agroforestry Center, agroforestry encompasses all land-use systems where woody perennials are deliberately cultivated alongside crops and animals, either in a spatial arrangement or time sequence, ensuring sustainable interactions between its components (Clarke & Thaman, 1993). King and Chandler (1978) further expand this definition, highlighting agroforestry as a system that optimizes land productivity while maintaining cultural compatibility with local agricultural practices. Unlike conventional farming, which emphasizes technological manipulation for maximum output, agroforestry mimics natural ecosystems, promoting biodiversity, improving soil health, and enhancing resilience to environmental changes(4).

The sustainability of agroforestry lies in its ability to generate economic, social, and ecological benefits. Its seasonal production cycles allow farmers to achieve greater economic stability, as revenue from one crop can balance the fluctuations of another, mitigating market risks (Müller, 2006). From an environmental standpoint, agroforestry significantly contributes to soil conservation, organic matter retention, and nutrient cycling. It enhances nitrogen fixation, maintains biodiversity, and even rehabilitates degraded land (Müller, 2006). Furthermore, agroforestry systems have been found to sequester higher levels of carbon compared to traditional agricultural systems, as they store carbon in both vegetation and soil, making them an essential tool in climate change mitigation. By improving microclimates and macroclimate conditions, agroforestry aids in adaptation strategies by enhancing resilience to natural hazards, reducing vulnerability, diversifying income sources, and strengthening rural livelihoods (Uthappa et al., 2017). These qualities establish agroforestry as a climate-smart agricultural technique that fosters long-term sustainability(5).

From a socio-cultural perspective, agroforestry represents a dialectical relationship between humans and nature, deeply rooted in traditional and Indigenous knowledge systems. Across generations, communities have developed agroecological practices that integrate ecosystem knowledge with agricultural techniques, ensuring sustainable resource use. This cultural transmission of knowledge has led to the development of new environmental management techniques, shaping more sustainable land-use behaviors (Vivan, 2011). Unlike industrial agriculture, agroforestry promotes stable rural populations, requiring a consistent workforce throughout the year and fostering food security, economic diversification, and improved quality of life (Paludo & Costabeber, 2012).

In examining agroforestry practices, Clarke and Thaman (1993) identify two primary approaches: the institutional approach, which is grounded in modern agronomic science and field experimentation, and the traditional approach, which has its roots in cultural geography and ecological anthropology. Within the Brazilian Amazon, the Indigenous Agroforestry Agents exemplify the traditional approach, serving as key disseminators of agroforestry knowledge. These Indigenous Agents, chosen from their respective ethnic groups in Acre State, are responsible for implementing agroforestry techniques within Indigenous territories, integrating ancestral practices with new innovations to promote sustainable land management (Gavazzi, 2012).

Despite the increasing recognition of agroforestry in the Brazilian Amazon, technical assistance and extension services remain insufficient to meet the growing demand (Miller & Ramachandran Nair, 2006). This gap highlights the importance of Indigenous Agroforestry Agents as key facilitators of knowledge-sharing and capacity-building in remote communities. Their role extends beyond agricultural innovation, as they act as cultural mediators, ensuring that agroforestry practices remain aligned with Indigenous values and environmental stewardship. The following section explores the critical contributions of these Indigenous Agents and their impact on the socio-environmental management of Indigenous territories in the Amazon region(6).

4.1 Indigenous Agroforestry Agents: Bridging Traditional Knowledge and Sustainable Practices

The Brazilian Amazon witnessed the development of Indigenous scholar education programs in the 1970s through the educational training of the first Indigenous educators who adapted conventional school practices. Indigenous teachers utilized their peer education system to teach community members through this process. The Acre State Department of Education under government authority has maintained continuous support for Indigenous teacher training since the 1980s to develop educational skills in Indigenous groups (Bianchini, 2006).

The Acre State Pro Indigenous Commission (CPI-Acre) began its operations in 1979 to defend Indigenous rights regarding territory ownership as well as education access and healthcare delivery and natural resource protection. As a member organization the organization provides adult education and professional training based on the concept of self-determination so Indigenous peoples create their own educational materials (Bianchini, 2006). Indigenous health agents participated in their first teacher training course during 1983 as the program introduced future programs of Indigenous-led territorial and environmental governance (Bianchini, 2006).

In 1996 CPI-Acre began its Territorial and Environmental Management Program as environmental deterioration and territorial sustainability concerns continued to rise. The program focused on teaching land management skills alongside resource conservation ways and agroforestry practices to youth and adult Indigenous members. During 1996 CPI-Acre launched the Agroforestry Indigenous Agents (AAFIs) program as an initiative which united traditional Indigenous wisdom with responsible land-use practices(7). The first training cycle selected 15 agents who later led subsequent educational workshops that reached expanding numbers of participants. Between 2000 and 2003 the training program

accepted 38 agents directly and mobile learning sessions reached another 87 agents (Bianchini, 2006, p. 41). The Agroforestry Indigenous Agents numbered 143 by 2012 and covered 13 ethnic groups that operated across 28 Indigenous territories throughout Acre State (Gavazzi, 2012, p. 32). Community leaders chose mainly male agents between 18 and 45 years old to serve as agroforestry implementation leaders according to Gavazzi (2012).

The AAFIs program exists to unify natural resource preservation efforts with traditional knowledge recording and sharing activities (Gavazzi, 2012). The program provides Indigenous participants with tools to effectively study and deploy environmental information for strengthening sustainable land management practices. The program aims to boost Indigenous communities by combining economic strength with environmental sustainability to improve the quality of their lives (Bianchini, 2006, p. 42). Agents gain essential training in seven disciplines and two domains of knowledge which include literacy coupled with either foundation or agroforestry expertise alongside geography and ecology and cartography and mathematics and political organization and environmental law and surveillance and professional ethics (MMA, 2002). The training materials developed in the courses are stored at CPI-Acre's Rio Branco headquarters to support academic resource development and program assessment activities (MMA, 2002).

In 2001 the Acre State Government officially named these agents as 'forest workers' thus providing them financial support to continue their work. In 2002 the Association of Indigenous Agroforestry Agents established to give their workers access to financial resources and logistical support that would help them keep working (Gavazzi, 2012).

The inclusion of formal education between Indigenous agroforestry training and basic education received backing from the Acre State Education Council through EEC Resolution No. 236/2009 & EEC Council Resolution AC No. 101/2009. The state took a major step in 2017 by passing an act (Act 3.357/2017) which created a scholarship program designed to develop new Indigenous professionals in agroforestry(8).

These intermediaries function as knowledge intermediaries which facilitate agricultural technique and conservation strategy exchange between Indigenous communities and global world. Training program knowledge that students acquire is transferred back to their communities to teach sustainable agroforestry practices to members (Bianchini 2006, p. 82). As part of their duties they must both execute modern techniques and blend cultural understanding with contemporary ecological methods to build sustainable approaches based on both ancestral wisdom and contemporary techniques (Bianchini, 2006, p. 82). Through their initiatives these agents help communities participate in environmental management and secure the sustainability and biodiversity of their territories for the benefit of future generations (MMA, 2002).

4.2 Agroforestry Indigenous Agents: Pioneers in Sustainable Environmental Land Management

Environmental land management relies heavily on Agroforestry Indigenous Agents who protect biodiversity andiminister sustainability knowledge while serving as biodiversity stewards for their communities. Their work encompasses food production together with ancient ecological wisdom which combines with sustainable approaches to safeguard permanent Indigenous land possession. These land stewardship agents manage the territory by restoring damaged natural ecosystems and enhancing fertility while advancing forestry operations and optimizing water resources. The experts in agroecological practices help create land-use methods which unite sustainable lifestyle support with biodiversity conservation strategies thus avoiding deforestation consequences. Indigenous agroforestry techniques which agents apply enable them to repair damaged lands while sustaining natural production systems for the next generation. Agroforestry Indigenous Agents work to decrease global warming through an initiative that promotes both tree planting and the maintenance of diverse agroforestry systems as they capture more carbon than traditional farming systems(9).

Because Agroforestry Indigenous Agents establish connections between ancient wisdom and modern expertise they develop sophisticated governance methods to support environmental sustainability. The combination of Indigenous ecological teachings and technical skills in mapping along with environmental law and agroforestry science makes their training enable agents to produce detailed land management plans that balance conservation needs with community priorities. Environmental mediators use this interdisciplinary knowledge to build spaces where Indigenous communities meet with government institutions together with conservation organizations. Through the sharing of deeply traditional cultural-based knowledge the environmental management strategies become both profitable to the ecosystem and satisfactory to cultural values. The approach proves successful specifically within the Brazilian Amazon by delivering effective results despite the government's struggle to combine their approaches with indigenous viewpoint integration. The Agroforestry Indigenous Agents use their local knowledge of their territories to establish site-specific answers for problems such as illegal deforestation, land encroachment and unsustainable agricultural growth.

Agents contribute fundamentally to land management through their work in engaging communities while implementing participatory environmental governance procedures(10). The agents of Indigenous Agroforestry enable environmental policies which arise from local communities while ensuring sustained commitment to sustainability initiatives in contrast to standard external environmental mandates. The educational outreach programs of Indigenous Agroforestry Agents provide local communities training in sustainable farming while teaching soil conservation and ecosystem restoration so farmers can implement agroforestry systems which integrate their cultural practices and environmental setting. These agents conduct peer-to-peer learning sessions and workshops which allow traditional land management practices to be passed through generations while enabling them to adapt to contemporary environmental issues. Through their collaborative knowledge-sharing activities Indigenous groups achieved better adoption rates of agroforestry throughout their territories which validates community conservation approaches in sustaining environmental health.

Agroforestry Indigenous Agents play an important dual function to build sustainable food systems together with supporting economic stability of their communities. Indigenous communities led by these agents successfully promote agroforestry instead of harmful agricultural practices thus creating diverse crop systems which reduces their food imports and makes them stronger against food scarcity caused by climate change. The knowledge of Indigenous farmers about diverse cropping helps them produce different crops and plant varieties that deliver nutritional benefits and economic as well as ecological sustainability. Industry integration of agroforestry practices enables Indigenous communities to build sustainable value chains which link them to markets focused on ethical and environmentally friendly products(11). The economic autonomy along with sustainable biodiversity conservation drives effective land management strategies over extended periods.

Governmental institutions and other organizations now recognize Indigenous Agroforestry Agents as vital professionals in managing environmental lands which validates their key position in this field. Through the institution of the Association of Indigenous Agroforestry Agents in 2002 and state-funded scholarships and financial aid the agents received both institutional backing and necessary support to increase their reach. The progress in Indigenous-led environmental management initiatives persists while multiple obstacles like long-term financial stability and government policy alignment and institutional approval still exist. To resolve these obstacles the government should dedicate more money to Indigenous agroforestry programs while establishing legislation that incorporates Indigenous insights into national environmental approaches and building dialogue platforms for Indigenous participation in land management decisions.

5. Socio-Economic Impacts of Agroforestry on Indigenous Communities

Agroforestry plays a fundamental role in enhancing the socio-economic stability of Indigenous communities by fostering sustainable livelihoods, food security, and economic resilience. Unlike conventional agriculture, which often leads to environmental degradation and economic volatility due to reliance on monoculture and external markets, agroforestry promotes diversified production systems that generate multiple income streams. By integrating crops, trees, and livestock, Indigenous farmers reduce their dependence on a single commodity, making them more resilient to market fluctuations and climate variability. The ability to cultivate medicinal plants, fruits, timber, and non-timber forest products (NTFPs) alongside staple crops provides Indigenous families with both subsistence and commercial opportunities. Many Indigenous communities participate in local markets and cooperative networks, where agroforestry-based products such as Brazil nuts, açaí berries, and sustainably harvested timber are sold, strengthening rural economies while preserving cultural and ecological heritage. This economic diversification enables communities to achieve greater self-sufficiency, reducing reliance on external aid and government subsidies.

One of the most significant socio-economic contributions of agroforestry is its impact on food security and nutrition. The polycultural nature of agroforestry ensures a continuous and diverse food supply, mitigating the risks associated with crop failures that often occur in monoculture-based systems. Indigenous agroforestry practices support the conservation of native plant species, many of which hold nutritional and medicinal value. By maintaining traditional food sources such as cassava, plantains, legumes, and indigenous fruits, communities safeguard their dietary diversity, reducing malnutrition and dependency on imported processed foods. Furthermore, agroforestry practices enhance soil fertility and water retention, leading to higher crop yields over time without excessive reliance on synthetic fertilizers or pesticides(12). This contributes to long-term agricultural sustainability, allowing Indigenous farmers to cultivate

land continuously without degrading natural resources. In many regions, the integration of agroforestry with traditional fishing and hunting practices provides additional sources of protein, reinforcing nutritional security and maintaining a balanced ecosystem.

Beyond economic and food security benefits, agroforestry strengthens social cohesion and intergenerational knowledge transfer within Indigenous communities. The practice of agroforestry is deeply intertwined with cultural traditions, and its transmission from elders to younger generations ensures the preservation of Indigenous ecological knowledge and land stewardship practices. Many Indigenous communities have established collective agroforestry projects, where members work together to cultivate and manage forested landscapes, reinforcing a sense of community ownership and shared responsibility. This participatory approach fosters community resilience, as individuals collaborate to solve agricultural challenges, share resources, and innovate sustainable practices. Additionally, Indigenous Agroforestry Agents (AAFIs) play a crucial role in disseminating knowledge and training other community members in land management, agroecology, and environmental conservation. These educational initiatives empower Indigenous youth by providing them with vocational skills, increasing their opportunities for employment while encouraging them to remain in their communities rather than migrating to urban areas in search of work.

Agroforestry also presents significant opportunities for economic empowerment through sustainable resource management and eco-friendly enterprises. The demand for organic, fair-trade, and sustainably sourced products has opened new market avenues for Indigenous communities engaged in agroforestry. Certification programs for organic agroforestry products enable Indigenous farmers to access premium markets, where ethically produced goods command higher prices. Additionally, eco-tourism and agroforestry-based community enterprises have emerged as innovative sources of revenue, attracting visitors interested in learning about Indigenous environmental practices and participating in sustainable land-based activities. These ventures not only generate income but also serve as platforms for raising awareness about Indigenous rights, environmental conservation, and the importance of preserving traditional knowledge. By leveraging agroforestry as both an economic and cultural asset, Indigenous communities can strengthen their autonomy and negotiate better terms with external stakeholders, including governments, conservation organizations, and private sector actors.

However, despite the numerous socio-economic advantages, Indigenous agroforestry initiatives still face significant challenges. Many communities lack access to financial support, technical assistance, and secure land tenure, which limits their ability to fully benefit from agroforestry-based economic activities. Government policies often favor large-scale industrial agriculture, making it difficult for Indigenous farmers to compete in the market. Additionally, deforestation, illegal land grabbing, and climate change pose ongoing threats to agroforestry ecosystems, reducing the availability of fertile land and diminishing crop productivity(13). To overcome these barriers, there is a pressing need for greater policy recognition and institutional support for Indigenous agroforestry practices. This includes investment in training programs, financial incentives for sustainable land use, and legal frameworks that protect Indigenous land rights. Strengthening collaborations between Indigenous organizations, research institutions, and environmental NGOs can also help facilitate the scaling-up of successful agroforestry models, ensuring that these practices contribute to both local economic development and global sustainability goals.

6.Conclusion and Future work

The role of Indigenous-led agroforestry initiatives in Brazil has proven to be a sustainable, culturally rooted, and ecologically beneficial approach to land management. By integrating traditional ecological knowledge with modern agroecological practices, these initiatives not only enhance agrobiodiversity but also contribute significantly to food security, economic resilience, and environmental conservation. Agroforestry Indigenous Agents (AAFIs) have emerged as key actors in knowledge-sharing, sustainable land use, and climate adaptation, empowering Indigenous communities to manage their territories effectively while preserving their cultural heritage. Through their efforts, communities have been able to rehabilitate degraded lands, diversify agricultural production, and generate economic opportunities by tapping into markets for sustainable, organic, and fair-trade products. Furthermore, agroforestry practices have strengthened local food systems, reducing dependence on external food sources and ensuring greater nutritional security. Despite these significant achievements, challenges remain in terms of policy recognition, financial support, and institutional backing, which limit the full potential of Indigenous agroforestry models.

Moving forward, future research and policy development must focus on strengthening Indigenous agroforestry governance structures, ensuring that these communities have legal land security and access to financial incentives for sustainable land management. Capacity-building initiatives should be expanded to train a greater number of Indigenous

Agroforestry Agents, equipping them with the necessary skills in environmental monitoring, market integration, and climate adaptation strategies. Additionally, efforts should be made to establish stronger collaborations between Indigenous organizations, research institutions, and policymakers to develop evidence-based agroforestry models that can be scaled up and adapted to different ecological and socio-economic contexts. Another critical area of focus is technological integration, where modern tools such as GIS mapping, remote sensing, and digital platforms can be utilized to enhance land monitoring, improve resource allocation, and facilitate knowledge exchange between Indigenous communities.

Furthermore, future work should explore the economic potential of Indigenous-led agroforestry by developing sustainable value chains that link Indigenous farmers to ethical markets, eco-tourism ventures, and carbon credit initiatives. Creating fair-trade certification programs specifically designed for agroforestry products can provide Indigenous producers with greater market access and financial stability, incentivizing the expansion of agroforestry practices. Additionally, more research is needed to assess the long-term ecological benefits of agroforestry, particularly in relation to carbon sequestration, biodiversity conservation, and climate resilience. Governments and international organizations must also work towards integrating Indigenous agroforestry into national and global climate strategies, recognizing its role in sustainable development and carbon offsetting.

Ultimately, the future of Indigenous-led agroforestry depends on a multi-stakeholder approach that includes policy reforms, financial investments, capacity-building, and community empowerment. Strengthening Indigenous leadership in environmental decision-making will be key to ensuring the long-term success and sustainability of these initiatives. By supporting Indigenous agroforestry models, society can move towards more regenerative agricultural systems that not only combat climate change and biodiversity loss but also uphold the rights, knowledge, and cultural identity of Indigenous communities. As the world seeks solutions to pressing environmental and food security challenges, Indigenous agroforestry stands as a powerful example of how traditional knowledge and ecological stewardship can drive sustainable transformation for future generations.

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Conflicts of interest

The authors have no conflicts of interest to declare

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