

# Just transition towards a bioeconomy: Four dimensions in Brazil, India and Indonesia

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## Highlights

- A justice lens helps assess the social sustainability of the bioeconomy
- Justice has distributive, procedural, retributive, and restorative dimensions
- Bio-based production in Brazil, India and Indonesia has mostly augmented injustices
- Inclusive bioeconomy experiences can be just and help redress historical exclusion
- A just bioeconomy transition needs equitable biomass production and improved access

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## **Abstract**

The bioeconomy has been portrayed as a transformational change to replace fossil-based fuels and other goods such as plastics. It is to substitute those goods while promoting zero-waste circular economies, creating jobs, and valorizing biodiversity – an agenda that meets conservation, climate and socioeconomic goals. Yet, where and from whom such bioresources are to come are questions that often receive insufficient scrutiny. Starting from an understanding that equity and sustainability essentially depend on *how* and on whose terms bio-based production takes place, this article explores the social dimensions of bioeconomy promotion through a “just transition” lens. Using the experiences of Brazil, India and Indonesia as case studies, it examines their dominant bio-based production systems in terms of distributional, procedural, retributive, and restorative justice. The analysis shows that, while such a bio-based transition has been a boon for agribusiness, the bioeconomy has so far helped promote broadly unjust production systems – where benefits and burdens are unevenly distributed, procedural governance over landscapes and resource use tend to be exclusionary, and there is little accountability or redress for past and present damages inflicted upon traditional communities and local populations. This pattern highly contrasts with the bioeconomy’s lip service to socioeconomic betterment and rural livelihood support. Instead, this examination shows bio-based sectors are expanding on many injustices while creating new ones. The conclusion is that, alongside fossil fuel substitution, a just bioeconomy transition also requires sustainable farming and land use – as two transitions in one. Therefore, asking where bio-based goods are produced, how, and by whom is essential.

*Keywords:* Just transition, bioeconomy, inclusiveness, biofuels, social equity, governance

## 1. Introduction

The transition from a fossil-based to a bio-based economy (a bioeconomy) has been heralded as an imperative in the fight against climate change, marine plastic pollution and other environmental problems, as well as an agenda to spur innovation and sustainable development (Scordato et al. 2017; Dietz et al. 2018). Often, the bioeconomy is promoted as a near-panacea for addressing sustainability issues while also offering a “green” economic recovery path after the COVID-19 pandemic (Costanza et al. 2020; Farcas et al. 2021). However, as the bioeconomy transition is primarily approached from the perspective of fossil fuel substitution or resource renewability and circularity (see OECD 2009; European Commission 2018), comparatively less attention goes to the overall sustainability of expanding bio-based production (Bastos Lima 2018).

Controversies over biofuels — notably European renewable energy mandates for the transport sector and their incentives for oil palm cultivation in Southeast Asia — did raise flags about expanded demand for biomass, with the creation of sustainability criteria (Stattman et al. 2018). Nonetheless, as the bioeconomy agenda now ascends in full force, interrogations on amplified bio-based production re-emerge. The biofuels experience showed that emissions from land-use change for feedstock cultivation were not the only environmental issue at hand — important questions were also raised about social justice, the risks of expanding nature commodification, and the sustainability of corporate-controlled and input-intensive monocultures (Bastos Lima

2021a). Ultimately, there remains a critical question about how to reconcile sustainable agriculture and land use with the imperative of fossil-resource substitution.

In the context of that broader question, this article assesses the bioeconomy through an environmental justice lens, using the concept of “just transition.” Debates on ensuring a just transition started in the 1980s, when trade unions and labor movements voiced concern for the workers that would become unemployed in the fossil fuel sectors to be phased out (Abraham 2017; McCauley and Heffron 2018). Over the years, that banner grew to encompass structural equity issues in energy production systems (Heffron and McCauley 2018), broader political economy considerations in the fight against climate change (Newell and Mulvaney 2013), as well as other domains in need of major sustainability revamping, such as agriculture (ActionAid 2019). This article is, however, one of the first efforts to apply a just transition framework to the bioeconomy. In understanding inclusiveness and social equity concerns as core to sustainability — as currently captured in the 2030 Agenda’s commitments to “leaving no one behind” and to “reaching the furthest behind first” (UN General Assembly 2015) — this analysis explores what an environmental justice lens, in its various dimensions, can reveal about the bioeconomy transition to date and what it can propose in terms of ways forward.

Three case studies are examined: Brazil, India and Indonesia. All three are emerging economies with substantial agricultural sectors and pressing land-use sustainability issues, and which have put ambitious biofuel and bioeconomy agendas in place. The article overviews their main bio-based production strategies, key policies and justice issues that have emerged based on an assessment of primary sources from their governments, industry or civil society reports, and the scientific literature on each case. First, the next section elaborates on the concept of just

transition in relation to environmental justice scholarship and the bioeconomy. Then, the article examines multi-dimensional justice issues in each of the three case studies, followed by a comparative assessment. It concludes on how a sustainable bioeconomy requires two transitions in one — an energy *and* a farming and land-use transition —, with policy lessons and some recommendations for further research.

## **2. Just transition in the context of the bioeconomy**

The “just transition” is a concept in expansion as new dimensions of justice become recognized in the field of sustainability transitions. Such transitions are broadly understood as major socio-technical shifts — profound or radical transformations beyond mere incremental change, and generally involving technology and infrastructures as well as institutions and behaviors (Geels 2017; Kohler et al. 2019). Much of that work has focused on energy transitions and the “decarbonization” of society, such as through the phasing out of fossil fuels, greater deployment of renewables, and promotion of a bioeconomy (Geels et al. 2017).

Such major changes obviously impact people in important ways that are not always beneficial — a foundational observation at the heart of just transition discussions. In the 1980s, as environmental conservation concerns gained ground and governmental policy threatened the closure of water and air polluting industries, trade unions became concerned about unemployment implications; thus, the notion of “green jobs” became core to transition discussions (Abraham 2017). “Transition towns,” usually involving coal miners transitioning to greener jobs, have also helped emphasize the social justice dimensions of responding to climate change (Bulkeley and Newell 2010). Broadly, there is a growing understanding that strategies to

reduce greenhouse gas emissions and adapt to climate change must be just and consider equity implications (McCauley and Heffron 2018; Ivanova et al. 2020). Otherwise, purported cures might turn out worse than the disease, as unfettered biofuel expansion threatened to be (Doornbosch and Steenblik 2007).

But what does justice entail in the context of sustainability transitions? To date, most articulations have focused on elements of energy or climate justice, such as the need to address energy poverty while cutting on fossil fuels, debates on subsistence emissions vs. luxury emissions, or actions to protect the most vulnerable from climate change (Shue 1993; Newell and Mulvaney 2013; Heffron and McCauley 2018). However, as the bioeconomy becomes increasingly significant for addressing fossil-resource dependence, agri-food and land-use concerns come to the fore in a much more important way (Bastos Lima 2018). While those concerns were already present, for instance, regarding tree plantations promoted via the Clean Development Mechanism, or more significantly in actions for Reducing Emissions from Deforestation and Forest Degradation (REDD+) in developing countries (see Böhm and Dabhi 2009; Kröger 2014), the bioeconomy now places forestry and agriculture systems at the heart of climate and energy transition debates.

To be sure, although sustainability transitions scholarship has focused chiefly on decarbonization, in parallel analysts have long pointed to the need for major transformations in agri-food systems. Among others, conventional agri-food systems — largely based on input-intensive industrial monocultures, highly processed foods from a handful of commodities, and increasingly consolidated sectors — have been charged with driving tropical deforestation, freshwater depletion, and widespread pesticide contamination while eroding agrobiodiversity,

rural livelihoods and the rights of traditional populations (IAASTD 2009; IPES-Food 2016; IPES-Food and ETC Group 2021). Increasingly, these issues are attracting transitions research, too (see El Bilali 2019). Some, for instance, have warned against the perils of “climate-smart agriculture” and similar banners that focus on reducing emissions while silently expanding on corporate control (Newell and Taylor 2018). Others have advocated for a “just transition” also in agriculture to ensure inclusiveness and participation are a core part of the sector’s much-needed transformation towards sustainability (ActionAid 2019).

The bioeconomy, perhaps more than any other governance area, weaves together the debates on climate and energy on the one hand and land use and agriculture on the other. Most bio-based replacements for fossil products come from established forestry or agri-food systems (Bastos Lima 2018). With the bioeconomy, a few dominant “flex crops” such as soy, oil palm and sugarcane — which can deliver multiple commodities — have gained additional momentum (see Borras et al. 2016). Increasingly, their value chains become broader bio-based “value webs” that provide numerous interconnected goods, bringing substantive gains to those who control these systems (Scheiterle et al. 2018; Bastos Lima 2021b). Some have, therefore, pointed to the inequalities being amplified as such conventional agricultural systems expand at the expense of others (Backhouse et al. 2021), and many have wondered to which kind of bioeconomy we are transitioning and whether it is inclusive and sustainable (Hausknost et al. 2017; Gawel et al. 2019).

Just transition discussions on the bioeconomy could have several entry points, such as issues of resource control or power relations in bio-based production systems. From an environmental justice perspective, four key analytical categories — or types of justice inquiries — have been

popularly emphasized. They are: distributive, procedural, retributive, and restorative justice, which can arise in different ways in distinct bioeconomy contexts.

First, distributive justice is concerned with the allocation of benefits and burdens among actors (McCauley and Heffron 2018; see also Gupta and Lebel 2020). For it to be just or fair, such distribution needs to be even across members of society. It is to offer equal opportunities, except when to benefit the least advantaged (Rawls 1971). That principle is in line with the UN 2030 Agenda for Sustainable Development's commitment to "reaching the furthest behind first" (UN General Assembly 2015, p.3). It also speaks closely to political ecology and its concerns with resource access, (re)distribution, and the existence of winners and losers from environmental change or actions to address it (Bryant and Bailey 1997; Bastos Lima 2021a). In a sustainability transitions context, distributive justice requires prioritizing the needs of the poorest (Ikeme 2003) and allocating environmental costs fairly, especially away from the most vulnerable (Lazarus 1994; Gupta and Lebel 2020). It is in line with this view that some refer to fuel or energy poverty (i.e., lack of sufficient access to modern energy services in a world of abundance and even over-use of fuels) as a form of energy injustice (Walker and Day 2012). In the bioeconomy, distributive justice also includes issues of (bio)energy access (see McCauley et al. 2013), but it goes beyond that to involve the fair distribution of all benefits accrued from increased bio-based production as well as of its costs (Bastos Lima 2021a).

While distributive justice is primarily concerned with outcomes, procedural justice has to do with the processes that give rise to fair or unfair distribution — and with who decides what is "fair" or adequate in the first place. This second type of justice therefore relates to platforms of stakeholder engagement (especially most affected parties), to how inclusive and responsive they

are, and the extent to which they effectively serve as venues where to place justice demands (Acuna 2015; McCauley and Heffron 2018). In contexts of land use and agriculture sustainability, as well as specifically in the bioeconomy, multi-stakeholder boards have become common but do not always include vulnerable actors or heed to their concerns (Hospes 2014; Bastos Lima and Persson 2020). Procedural justice, therefore, has to do with transition governance and, ultimately, what kind of future is envisioned and how to get there (see Bosman and Rotmans 2016; Avelino and Grin 2017).

Retributive justice and restorative justice, finally, are sometimes understood as contrasting takes on how to remedy recent or historical harms (see Wenzel et al. 2008), yet they can arguably be regarded as complementary in some contexts. Retributive justice stems from the age-old notion that a transgression — understood as a violation of distributive or procedural norms — invites punishment as a form of compensation to the harmed parties or society as a whole, a concept that underscores much penal law (Wenzel et al. 2008). That aims in part at behavior control, i.e., deterring others from pursuing identical or similar transgressive actions (Vidmar and Miller 1980). In the context of sustainability, retributive justice relates, for instance, to the “polluter pays principle” or, more broadly, to holding actors accountable for doing environmental harm (Mason 2008; Searcy 2017). Underlying these principles is an understanding that proportional punitive action brings back the scales of justice to a state of balance (Carlsmith et al. 2002).

Restorative justice, in turn, goes a step further — and in a somewhat different direction — for seeking not tit-for-tat but an engagement that redresses caused harms through dialogue. It relies on a reiteration of shared values and consensual solutions, based on mutual (if belated)

acknowledgment of the problem in the first place (Wenzel et al. 2008). In a way, that was at the heart of the original just transition debates in the 1980s, when threatened workers sought the restoration of their present or upcoming job losses and that their grievances and concerns be duly acknowledged and jointly addressed by everyone (Stavis and Felli 2015; Abraham et al. 2017). The premise is that punitive action by itself does not sort out the harms done by an offender — there needs to be (also) some form of constructive, positive action ensuing (Wenzel et al. 2008). As Dorsey (2009) puts it, restorative justice provides public officials or corporate decision-makers with the opportunity not just to pay for but to rectify harms done, such as the disenfranchisement of a local community. For instance, Robinson and Carlson (2021) suggest that restorative justice is more engaging and effective than litigation (i.e., seeking punitive action or compensation) in addressing climate-related loss and damage.

While not exhaustive, Table 1 condenses some of this discussion on a just bioeconomy transition highlighting the key concerns and research questions linked to each justice dimension.

**Table 1.** Four dimensions of justice and the bioeconomy

<b>Dimensions of justice</b>	<b>Key concerns</b>	<b>Research questions concerning the bioeconomy transition</b>
Distributive	Fair allocation of benefits and burdens	<i>Who wins and who loses from different bioeconomy pathways? How does bioeconomy promotion (re)allocate resources among actors? How are the most vulnerable prioritized (or not)?</i>
Procedural	Participation, inclusiveness, voice	<i>Who decides how the bioeconomy should look like and what kind of transition is needed? How is the transition to a bioeconomy governed?</i>
Retributive	Accountability, law enforcement	<i>How are human or environmental damages accounted for? What accountability systems are in place to mitigate risks or dissuade actors from transgressive (unsustainable) behavior in bioeconomy promotion?</i>
Restorative	Redress	<i>What past or historical injustices among relevant bioeconomy stakeholders invite redress? How do (or could) bioeconomy institutions incorporate such restorative principles and actions in their design?</i>

### **3. Justice issues in emerging bioeconomies**

Brazil, India and Indonesia are emerging economies where bio-based sectors have played and are expected to play an increasing role. They have long had important agricultural and forestry sectors, experiencing colonial and post-colonial forms of extractivism, understood as a pattern of resource extraction through “production without reproduction” of the resources involved (Ye et al. 2019, p.3). Meanwhile, they have also had significant peasant and forest communities. Despite suffering historical neglect and exclusion, those communities remain socio-economically relevant and sometimes also politically so, when mobilized through rural social movements (Ariza-Montobbio and Lele 2010; Caroko and Pye 2013; Ye et al. 2019; Bastos Lima 2021a).

Now, as the environmental critique over business as usual becomes increasingly mainstream, novel forms of possible extractivism and new areas of contention are emerging. For instance, agroforestry — long heralded by grassroots movements and critical sustainability scholars as a typical manifestation of agroecological transition away from input-intensive monocultures — has recently become a contested field. Emptied of the original transformational intentions, forms of “agrobizforestry” or “agrodeforestation” (with tree plantations mimicking as forests) have become increasingly present (Ollinaho and Kroger 2021). Likewise, the “bioeconomy” as conceptualized by Georgescu-Roegen was meant as economic activity harmonized with the biosphere, within ecological limits (Vogelpohl and Töller 2021). Yet, it has quickly become predominantly an agenda for biotechnological developments, in what some have called a “hijacking of the bioeconomy” (Vivien et al. 2019).

Where do justice issues sit in this disputed arena of sustainable land use and biomass production? This section explores in detail the recent experiences of bioeconomy promotion in Brazil, India and Indonesia, notably with respect to biofuels — the largest ongoing “bioeconomy” sector aside from more conventional bio-based goods such as food. It will review the strategies, production arrangements, and analyze justice issues across those four dimensions (distributive, procedural, retributive, and restorative) in each country.

### *3.1 Brazil*

Brazil has had a long experience with biofuel and bioeconomy policies. They date as far back as the 1930s when the first ethanol blending mandates were introduced. As much as 85% of the country’s biofuels — which remain the chief bioeconomy sector worldwide — consist of

sugarcane-based ethanol from a highly consolidated agroindustry (EPE 2020). Sugarcane plantations have been a mainstay of Brazil's economy since colonial times. Historically, it has long been the world's top sugar exporter (Moreira 2007). Large-scale plantations, once reliant on slave labor, today count on mechanized harvesting and advanced agronomics, but their oligopolistic socio-economic structure remains (Hall 2009). If anything, Brazil's sugarcane sector has become *more* consolidated since the 2000s due to mergers and acquisitions by multinationals that now control the bulk of production (Bastos Lima 2021a). The sector's main change has been a deft reorientation away from an already saturated sugar market and increasingly towards bioenergy. Nowadays, as much as two-thirds of Brazil's sugarcane production is used for making ethanol and not sugar (EPE 2020).

A booming sugarcane sector, motivated partly by Brazil's encouraging biofuel policies, doubled its cropland area in the 2000s (CONAB 2021). Eager to dissociate itself from controversial Amazon deforestation, the sector has long pointed out that most sugarcane cultivation takes place thousands of kilometers away from that biome (see Jank 2011). Yet, some have pointed to indirect land-use change, suggesting that capitalized cattle ranchers have sold lands to the expanding sugarcane agroindustry in the country's south and moved to deforestation frontiers in the north (Sawyer 2008). Indeed, many smallholders (e.g., dairy producers) have been displaced by this booming bioeconomy sector (Novo et al. 2010). Finally, sugarcane cultivation has also encroached on indigenous lands in the Guarani-Kaiowá territory in the west of Brazil (Ioris, 2020; Backhouse and Lorenzen 2021).

Brazil's ethanol policy has provided ample incentives to conventional agribusiness. Thereby, it has reinforced some deep-seated injustices of the country's large-scale agriculture, including

the concentration of land ownership, smallholder displacement, and widespread pesticide contamination (Biondi et al. 2009; Bastos Lima 2021a). Tax breaks, facilitated credit, public investments in infrastructure and, most of all, an ethanol blending mandate creating a captive market for the sugarcane industry have been a boon for the sector, which now envisages all sorts of bioeconomy products from sugarcane such as bioplastics and others (Scheiterle et al. 2018; Bastos Lima 2021a). However, there is no envisaging of greater inclusiveness: Brazil's ethanol promotion contains no transformative elements to empower the rural poor or reduce inequalities (Backhouse et al. 2021). There is also little to no accountability for agribusiness impacts over traditional populations — let alone attempts at restorative justice of any sort for those negatively affected by plantation expansion (Ioris 2020). In short, Brazil's ethanol policy is essentially neglectful of social justice issues and, thus, has expanded on pre-existing inequities of the country's sugarcane sector.

The Brazilian government deliberately tried to fill a perceived social justice gap through its biodiesel policy. In 2004, the National Programme on the Production and Use of Biodiesel came into place with a clear rural development rationale (Marcossi and Moreno-Pérez 2018). Biodiesel industries would receive incentives to meet growing blending mandate targets, but as much as 80% of the market would be saved for those who obtained a “social fuel stamp” (*selo combustível social*), which required sourcing feedstock from smallholders and providing them with agricultural technical assistance (De Andrade and Miccolis 2011). The key feedstock was castor bean (*Ricinus communis*), a non-edible oil-bearing crop already grown for other purposes in the poor semi-arid regions being targeted (Gomes et al. 2010). Initially, such attempts at smallholder inclusion were met with setbacks: castor returned meager yields; smallholders lacked sufficient

organizational skills to uphold supply contracts; and private companies failed to offer competitive prices for the feedstock or to provide adequate technical assistance (César and Batalha 2010; Zapata et al. 2010). In time, private biodiesel companies would flee and abandon their suppliers in the face of uneconomical supply chains — often leaving farmers with crops they could neither eat nor necessarily sell elsewhere (Gomes et al. 2010). Brazil's growing biodiesel consumption mandates would end up being met using primarily soy oil and, to a lesser extent, animal fat from the country's large meatpacking conglomerates (Bastos Lima 2021b).

A policy revision, however, turned the tide of smallholder inclusion for a while. First, the government created Petrobrás Biofuels, a public company, to lead on smallholder contracting. It started supplying higher quality castor bean seeds and exploring alternative feedstocks, such as sunflower. Second, Petrobrás Biofuels also improved technical assistance and fostered the creation of smallholder cooperatives to enhance organizational capacity. Third, the government started promoting mixed food-and-feedstock cultivation, limiting the latter to prevent exacerbated exposure to market price volatility and food security risks. Fourth, the revised policy started requiring that smallholder contracts always be approved by a representative collective organization (e.g., a rural social movement or rural workers union) to make the negotiation more even and safeguard against smallholder vulnerability (Zapata et al. 2010; Bastos Lima 2021a). Rural development outcomes improved significantly. Between 2008 and 2010, the number of participant smallholder households grew four-fold to more than 100 thousand, while biodiesel industries (including Petrobrás Biofuels) quintupled the amount invested in feedstock acquisition from smallholders to about BRL 1.2 billion (about USD 635 million at the time) (Gomes et al. 2010). Both distributive and procedural justice saw marked improvements.

Rural social movements were instrumental for those achievements, which were part of a broader agenda of smallholder support that already included governmental food-purchase programs such as the Food Acquisition Program (*Programa de Aquisição de Alimentos – PAA*) introduced in 2003 and the National School Meals Program (*Programa Nacional de Alimentação Escolar – PNAE*) in 2009. That these gains happened during the Workers' Party (PT) governments (2003-2016), historically linked to rural social movements, reveals the crucial role of grassroots mobilization for such political achievements.

Some smallholders were in line to climb up to the value-added stages of production (e.g., seed-oil extraction on-site rather than selling raw produce) when changing Brazilian governments since 2016 moved away from such a social justice agenda and altered the inclusion instruments. Smallholders would virtually disappear from a biodiesel policy now entirely focused on soy and animal fat feedstocks, from some of Brazil's largest agribusiness entities (Bastos Lima 2021b). As such, the bioeconomy has come to be associated with deforestation, resource grabbing, and smallholder eviction driven by the expansion of soy monocultures and cattle ranching, with scant retributive or restorative justice to speak of (see França et al. 2021; Russo Lopes et al. 2021). Still, Brazil's earlier biodiesel experience shows that elements of a just bioeconomy transition can materialize when smallholders are included under fair and empowering terms.

### 3.2 *India*

Although more recent than Brazil's, India's engagement with the bioeconomy has followed a similar strategy. On the one hand, an established sugarcane agroindustry has received tax, credit and market incentives to produce ethanol — initially only from molasses, a by-product of sugar,

but later with permission to use cane juice (taking it away from sugar production) on surplus years (Ravindranath et al. 2011). On the other hand, the government has sought to expand the cultivation of non-edible feedstock for biodiesel production. That has focused primarily on *Jatropha curcas* and other crops that allegedly can be grown commercially on marginal lands — “wastelands” in the language of India’s biofuel policy (see MNRE 2009, GOI 2018). Given the country’s large dependence on edible oil imports, it is important not to divert domestic supplies away from food for biofuel making.

As India’s fuel-ethanol program works as an add-on to its pre-existing sugarcane agroindustry, there is little structural change on the production side. Unlike Brazil’s, the Indian sugarcane sector relies on five to six million smallholder suppliers — usually working in contracts with privately-owned mills that now enjoy an additional (captive) market and add value to their products (Bastos Lima 2021a). The industry generally claims that such economic opportunities trickle down to smallholder suppliers, but the latter in fact depend on government-set minimum purchasing prices that India’s private sugar mills constantly try to deregulate (see Bisht 2012). The ethanol agenda has no policy instruments to address structural inequalities; rather, millions of sugarcane cutters remain as they are, now contributing to a bioeconomy but sticking to work sometimes described in India as “arduous and inhuman” (Ashwani and Brahm 2011) while financial benefits accrue to the private industry.

The main change on the ground arising from India’s bioeconomy transition stems from its biodiesel policy — a highly ambitious government endeavor to cultivate up to 13 million hectares (Mha) of what it identifies as “wastelands” with *Jatropha curcas* and other non-edible feedstock crops (see MNRE 2009; GOI 2018). A package of regulatory and economic incentives (e.g., tax

reductions, credit provision through national banks, facilitated access to land) has come into place to incentivize private and public companies to enter contract farming schemes with smallholders and rural communities (MNRE 2009; Kumar et al. 2009; GOI 2018). Government agencies, scientists, and other jatropha promoters initially praised jatropha's supposed ability to grow under suboptimal conditions, without water or fertilizer inputs, and resist pests (see Silitonga et al. 2011; Jain and Sharma 2010). The reality, however, has proven different. First, jatropha deployment conflicted with local land uses the government had disregarded (e.g., livestock grazing; see Bastos Lima 2021a). Land tenure insecurity was critical to smallholder vulnerability to what some civil society organizations quickly described as land grabbing for India's bioeconomy (Lahiri 2009). Second, the many smallholders that did get persuaded to replace their traditional cultivation for jatropha soon found themselves in dire straits once the crop's yields proved disappointing — and, ultimately, uneconomic — to the contracting companies. As such, many rural communities suffered from heightened food insecurity as well as social and financial setbacks due to broken contracts (Ariza-Montobbio and Lele 2010), akin to what initially happened in Brazil.

Hardly any biodiesel has come to be blended in India — as of 2018 it had replaced as little as 0.14% of the country's fossil diesel consumption (Aradhey 2019). Meanwhile, a 5% ethanol blending mandate has been in place, but therefore providing (bio)energy only to those who already had access to gasoline and motorized vehicles. That falls on the face of widespread energy poverty that affects hundreds of millions of rural people without access to modern energy in India, and it shows the emptiness of the government's use of rural energy poverty as a rationale for bioeconomy promotion (see MNRE 2009; GOI 2018). Some rural communities would have

welcomed involvement in planning for bio-based production directed at local energy use, but such participation and bottom-up rural development focus has not in practice been on the mainstream agenda (Bastos Lima 2021a).

Despite those failures, in 2018 a new National Biofuels Policy reasserted India's ambition to cultivate non-edible feedstocks on marginal lands. This time, the government has pointed to the role of research and development on crop yield improvements and input packages, but without acknowledging the injustice issues or producing any equity-oriented incentives (see GOI 2018). Instead, now as many as 26 Mha of "wastelands" have been identified as available to be targeted for "landscape restoration" initiatives — which include the cultivation of such feedstock crops (GOI 2019). A broader bioeconomy policy has also come to place, but without acknowledging the critical resource access issues for India's more vulnerable groups; instead, only biotechnological applications for industry actors are discussed (BIRAC 2019). It becomes obvious that justice issues in multiple forms are heightened when they are ignored.

### 3.3 Indonesia

Indonesia, too, has sought to transition to a bioeconomy chiefly by producing ethanol from sugarcane and biodiesel from *Jatropha curcas* — both without success. As such, the country has turned to its abundant and ever-increasing cultivation of oil palm. Several regulatory and economic incentives have come to place to foster biodiesel production from this crop and, thus, reduce Indonesia's reliance on (imported) petroleum. Those incentives have included tax exemptions, subsidies to biodiesel industries, and facilitated investment conditions, such as the fast-tracking of land-use permits and longer concessions to cultivate feedstock crops such as oil

palm and sugarcane (Caroko et al. 2011). Still, no commercial fuel-ethanol production has taken place in Indonesia as its sugarcane production is limited to supplying for sugar and other ethanol markets (e.g., industrial applications) (Rahmanulloh 2019). Cassava was initially envisaged as a smallholder crop for ethanol, but it did not take off (Slette and Wiyono 2010). *Jatropha* endeavors, meanwhile, ran into the same issues as in India: economically unviable yields and, thus, abandoned smallholder suppliers. In hindsight, some have blamed a hype based on overestimations that left Indonesian farmers worse off (Afiff 2014). The country thus started tapping exclusively on palm oil as a biofuel feedstock, in what is now a burgeoning biodiesel industry focused evermore on the domestic market as sustainability restrictions surface elsewhere (e.g., US, EU) due to the deforestation impacts of oil palm expansion (see Hospes 2014; Bastos Lima 2021a).

Since 2010, Indonesia has framed oil palm plantations — and others such as sugarcane — as “food and energy estates,” conceiving them as multipurpose crops dedicated as much to food as to other bioproducts (Ginting and Pye 2013). Although nearly half of Indonesia’s biodiesel production was being exported as recently as 2018, that is expected to decrease as the EU has classified palm-based biodiesel as “high risk” due to tropical deforestation (Rahmanulloh 2019). Indonesia’s palm-based biodiesel production has not diminished — on the contrary, it has increased but is now directed to meeting higher blending mandates in the domestic market. As of 2020, a 30% biodiesel (B30) mandate was in place, with higher mixtures (B40 and later B50) being envisaged (Bastos Lima 2021a).

More than half (about 55%) of Indonesia’s oil palm plantations are owned by private companies, with 10% managed by the government and 35% run by smallholders (Suwastoyo

2018). However, the latter are not autonomous, bottom-up endeavors. Oil palm cultivation has high start-up costs (e.g., for crop saplings) that Indonesian smallholders can hardly afford. Moreover, the plant takes about four years before bearing fruit and bringing revenues. Therefore, its cultivation generally takes place under so-called “nucleus-plasma schemes.” The “nucleus” refers to the larger share of land (usually 70-80%) that a company purchases from rural communities. Due to a government regulation (the so-called “plasma obligation”), smallholders retain plots in the remaining 20-30% of the land, where they then receive company assistance to grow oil palm and supply fresh fruit bunches (FFB) to its mills under a contract (Feintrenie et al. 2010a; Bastos Lima 2021a).

Such a nucleus-plasma arrangement was envisaged in part to reduce recurrent conflicts between oil palm companies and rural communities in Indonesia (McCarthy et al. 2012). Generally, smallholders tend to be broadly satisfied for escaping poverty even if they usually wish that (a) the plasma share was larger, (b) the company paid them more for the land and for the fruit, and that (c) the land returned to them after a concession period (Rist et al. 2010; Bastos Lima 2021a). With the company as a guarantor, smallholders receive bank loans to withstand the four-year crop-maturation period, after which they pay back their debt as a fixed percentage of what they earn selling FFB to the company (Feintrenie et al. 2010a, b; Rist et al. 2010). Private mills then process FFB into crude palm oil, widely used by the food industry and, increasingly, in Indonesia’s broader bioeconomy. The latter currently includes primarily biodiesel, but myriad novel applications also from other parts of the plant (e.g., palm kernel oil, from the fruit’s core, or cellulosic ethanol based on oil palm leaves) have been explored (Bastos Lima 2021a).

So far, Indonesia's biodiesel industry and broader bioeconomy have thus come not as a transformative transition in land use or farming but as an add-on to an already established and thriving oil palm sector. The impacts of this ongoing business-as-usual model have been mixed. On the one hand, increasing petroleum replacement by palm-oil biodiesel has dampened Indonesia's reliance on fossil fuel in a country that experiences growing demand for energy. On the other hand, however, oil palm expansion remains connected to rampant tropical deforestation and peatland degradation, as well as disregard for traditional populations' land rights and rural conflicts at expansion frontiers such as Papua (McCarthy et al. 2012).

For the negatively impacted stakeholders, grievance mechanisms have hardly been functional. UN special rapporteurs on human rights and the right to food have issued high-level critiques about unfettered plantation expansion in Indonesia (see UN General Assembly 2018). Still, there have been no significant policy changes towards greater justice (Bastos Lima 2021a). As for the integrated oil palm smallholders, they tend to find it advantageous to their previous (neglected) circumstances, as they earn a regular income above what most other crops would provide and with a tree crop that demands relatively little labor (Feintrenie et al. 2010a; Rist et al. 2010). Yet, an uneven allocation of benefits remains as the palm oil industry captures all value-added that has arisen from bioeconomy promotion. Smallholders adjust to a company's terms without much option or say in the setup process and price negotiation (which they commonly aggrieve), revealing a marked power imbalance and participatory governance deficit (see Bastos Lima 2021a). As such, and in stark contrast with the tenets of procedural justice, vulnerable and hitherto neglected actors are brought into very uneven and top-down arrangements as the only option

really on the cards (besides continued poverty and exclusion). Table 2 summarizes some of these issues from a justice perspective in the three countries.

**Table 2.** Justice issues in emerging bioeconomies

Dimensions of Justice	Brazil	India	Indonesia
<b>Distributive justice</b>	<ul style="list-style-type: none"> <li>▪ Economic incentives, tax breaks, bank credit and public investments disproportionately benefit large, established agribusiness, which also benefits from captive (bioproduct) markets and all value-added.</li> <li>▪ Smallholders broadly excluded, except for a temporarily successful experience with biodiesel chains.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Maintenance of uneven sugarcane agroindustry structures; private mills capture the benefits of new markets and value-addition while cane-supplying smallholders remain where they are.</li> <li>▪ Broad resource dispossession of India’s rural poor for large-scale <i>Jatropha curcas</i> cultivation by public or private companies.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Smallholders receive minor benefits from a booming palm oil-based bioeconomy. The “plasma obligation” ensures them land plots where they work as company suppliers, but becoming dependent on that single buyer. Financial benefits broadly directed to oil palm plantation companies. Traditional populations not included in these arrangements lose out.</li> </ul>
<b>Procedural justice</b>	<ul style="list-style-type: none"> <li>▪ Bioeconomy strategy broadly designed as an add-on to established agribusiness. Weaker stakeholders included in bioeconomy governance only during the social inclusion years of biodiesel (2009-2015).</li> </ul>	<ul style="list-style-type: none"> <li>▪ No recognition of local land users or uses in what the government regards as “wastelands.” Top-down view of India’s countryside as ready for “landscape restoration” initiatives that include promotion of non-edible bioproduct feedstock cultivation.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Expanding oil palm plantations as the unquestioned flagship of Indonesia’s bioeconomy. Room for smallholder in governance only through the oil palm farmers association (Apkasindo), but no inclusion of other local stakeholders.</li> </ul>
<b>Retributive justice</b>	<ul style="list-style-type: none"> <li>▪ No accounting for the social and environmental impacts of deforestation or of agribusiness encroachment on local community territories and indigenous lands for bio-based production.</li> </ul>	<ul style="list-style-type: none"> <li>▪ No grievance mechanism or overall accountability for the harms caused to rural populations through the failed large-scale deployment of <i>Jatropha curcas</i> and broken supplier contracts.</li> </ul>	<ul style="list-style-type: none"> <li>▪ No accountability for social or environmental impacts from expanding oil palm plantations (often at the expense of peatlands, tropical forests, or local community lands).</li> </ul>

<p><b>Restorative justice</b></p>	<ul style="list-style-type: none"> <li>▪ No restorative justice in bio-based production from large-scale soy or sugarcane plantations.</li> <li>▪ Positive discrimination favoring smallholders in biodiesel chains has helped redress historical exclusion.</li> </ul>	<ul style="list-style-type: none"> <li>▪ No restorative justice in sugarcane-based bio-product chains.</li> <li>▪ Widespread fuel poverty and energy injustice unaddressed.</li> </ul>	<ul style="list-style-type: none"> <li>▪ No restorative justice in the dominant oil palm-based bioeconomy, except for income creation to smallholder farmers that are otherwise left in poverty. However, that income is provided at a high cost and under uneven terms.</li> </ul>
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#### 4. Discussion: Key gaps and needs for bioeconomy justice

##### 4.1 *Blindness to justice increasing injustices in the bioeconomy transition*

The no-discrimination principle discussed earlier demands a form of “blind” justice — as in the archetypical figure of Lady Justice with her blindfolded eyes — except when to benefit the least advantaged. The scales and sword usually present in the symbolic image suggest there is to be an assessment of doings and punishment if need be. Such deliverance is not a purely administrative task: it embodies an ethical choice and a political project enshrined in the 2030 Agenda, among others, to address historical exclusion and lift people out of poverty. Critically, to be procedurally just such inclusion must involve stakeholders from the start, not in a paternalistic but in a genuinely inclusive process.

To date, however, the bioeconomy transition appears marked not by the delivery of justice in its multiple forms but by general blindness to justice issues. Distributive, procedural, retributive and restorative concerns are all found wanting but in rhetoric. Developing countries typically emphasize the social aspects of sustainability, which has not been different in their attempt to promote a bioeconomy. The policies of Brazil, India and Indonesia have allegedly aimed as much

at domestic renewable energy production as at rural development co-benefits in the form of employment creation and poverty reduction. Energy access, job creation and rural development concerns have been used to underscore and “justify” bioeconomy promotion, but such social justice concerns have been present more in words than in deed.

The three cases illustrate how lack of attention for land-use and agri-food equity issues aggravates injustices under the guise of promoting sustainability through fossil-product substitution. Instead of sustainable development, the bioeconomy transition has so far engendered an expansion of extractivism. It has been characterized by ambitious fossil fuel replacement targets, blending mandates, and incentives to established agribusiness; despite references to rural poverty, they have seldom taken its complexity into account or included instruments to promote structural change. The plantation jobs created hardly tackle inequality but rather promote the expansion of conventional, corporate-dominated systems such as palm oil and sugarcane production. Meanwhile, the top-down experimentation with jatropha and castor on smallholders under risky contract terms broadly led to “adverse incorporation,” i.e., the worsening of their vulnerability and suffering (see Hickey and Du Toit 2007).

Three key gaps appear particularly critical. First, there is the broad issue of non-recognition, i.e., failure to identify and acknowledge the concerns, views, or even the very existence of weaker stakeholders (Jenkins et al. 2016; see also Bastos Lima and Kmoch 2021). That is at the heart of justice debates in the context of the energy transition (Williams and Doyon 2019, Van Bommel and Hoffken 2021), with some regarding recognition as an aspect of distributive justice and others as a distinct type of justice in its own right (see Jenkins et al. 2021). Here, non-recognition appears as a crosscutting issue compromising both distributive and procedural justice, as marginalized

rural communities, smallholders and indigenous peoples are left out of bioeconomy governance as much as of the benefits of expanded bio-based production. Such weaker stakeholders have seldom been consulted in the planning or designing of bioeconomy policies, either, let alone in decision-making about trade-offs. The only exception was Brazil's earlier experience with smallholder inclusion in biodiesel chains, thanks in great part to the recognition and the agency of strong rural social movements linked to the then-ruling Workers' Party. That experience highlights the value of grassroots mobilization, advocacy, and organizational capacity to become politically influential.

The second gap has to do with the fair distribution of benefits and burdens. So far, bioeconomy benefits and incentives accrue mainly to well-established agribusiness or urban consumers. The rural poor, in turn, are primarily allocated with higher burdens from monoculture expansion and environmental risks, in flagrant distributive injustice. As seen, the bioenergy produced in Brazil, India or Indonesia has hardly been used to address persistent rural energy poverty; it goes instead to drivers that already had access to fuel, mostly in urban areas. Indonesia's case, where smallholders are integrated into oil palm conglomerates and thus lifted out of poverty, is an example of trickle-down thinking as rural dwellers obtain something in economic terms. However, that often hides very uneven benefit and burden sharing among actors. Brazil's smallholder inclusion experience was fairer, as smallholders were safeguarded against risks and benefited substantially. It was a clear example of positive discrimination to help the least advantaged or to "reach the furthest behind first" (UN General Assembly 2015, p.3). That emerged from a desire to redress pre-existing social injustices and exclusion in Brazil (Bastos Lima 2021a) and thus represented a form of restorative justice between government, the private

sector, and the country's historically marginalized rural populations. That experience showed that a fair distribution is possible, but only if positive-discrimination redress instruments are built into bioeconomy policy design.

The third fundamental justice gap relates to a lack of accountability for harms done through bioeconomy promotion. Plenty of indigenous and other local populations (e.g., the Guarani-Kaiowá indigenous people facing sugarcane expansion in Brazil, on Papuans pressed by oil palm plantations in Indonesia) are excluded and bear the brunt of the negative environmental impacts of expanding feedstock cultivation. Yet, there is little retributive or restorative justice to speak of regarding those violations. That follows the broader pattern of land-use change in the tropics, where violations frequently go unanswered (McCarthy et al. 2012; Russo Lopes et al. 2021). Instead of helping counter it, the bioeconomy's sustainability rationale has added societal legitimacy to mainstream large-scale agriculture and, thus, heightened the risks of resource dispossession (Bastos Lima 2021b).

#### *4.2 Conceiving of a just bioeconomy transition*

If, as some authors have suggested, bioeconomy promotion is a political project (Goven and Pavone 2015), a just transition is concerned with the social quality of that agenda. But why should vulnerable local actors, such as historically marginalized rural communities, engage with bioeconomy agendas in the first place? It is important to take a step back and assess whether (even supposedly beneficial) changes are not being externally imposed, in violation of procedural justice principles. A just bioeconomy transition requires, first, a bottom-up process of prioritization and agenda-setting.

Here, an important reflection is on the scope of what counts as “bioeconomy.” Although strictly speaking it includes all bio-based economic activity, policy-makers, industry actors and part of the scientific community have chiefly emphasized capital-intensive, biotechnological developments as being “the bioeconomy” (Vivien et al. 2019). That, however, risks openly or covertly advancing a business agenda with its associated framings, institutions, value-system, and the power relations therein (e.g., the preeminence of market relations, privatized intellectual property, the commodification of nature) (Goven and Pavone 2015; Bastos Lima 2021b). Procedural justice requires acknowledging and opening for debate such tenets, substituting tacit acceptance for inclusive deliberations.

A local community may, therefore, legitimately choose to engage with the broader bioeconomy by producing diverse, healthy and nutritious foods instead of (lower-value) fossil fuel replacements. The former may be more relevant to impoverished regions and in line with local cultures than energy production, which anyway has shown to mostly favor the needs of wealthy consumers. Moreover, a reality check may be in order: bioenergy hardly creates a dent in fossil fuel consumption — it is expected to account for a mere 3% of the global electricity production and 4% of the energy used in transport in 2023 (IEA 2018). Therefore, it is unlikely that the broader problem of fossil-resource dependence can be addressed solely with bio-based substitutes, without other significant economic changes (e.g., de-growth) and additional energy sources. A narrow focus on fossil fuel substitution misses the point that the bioeconomy can have various other, complementary objectives (e.g., biodiversity conservation, healthy food systems, poverty elimination). It boils down to thinking of the bioeconomy transition not only in terms of expanding on it — as in a re-engineered old economic growth agenda — but crucially in terms

of assessing also the bio-based economic sectors already in place, notably forestry and agriculture. Rethinking farming and land use systems towards greater justice and sustainability can be as crucial as replacing fossil resources in a bioeconomy transition. In short, we may need to conceive of it not only as a transition *to* but also as a transition *of* the bioeconomy.

Just bioeconomy promotion thus starts with recognition, not only of existing injustices (e.g., hunger, energy poverty) but generally of local stakeholders and their views on rural development. Enduring more protracted discussions and longer negotiations with local people may feel slow and frustrating to certain industry actors, but it can be vital to achieving justice goals. Governments, in turn, may want to avoid grand top-down plans that fail to take local stakeholders' views into account — as has happened in India's biodiesel policy for “wastelands.” As seen, participation may be important for social justice as much as for the overall sustainability of the outcomes.

This comparative assessment offers other practical lessons for improving on procedural and distributive justice: (i) The mixing of feedstock with food production, to safeguard food security, reduce vulnerability and strengthen existing livelihoods rather than replace them; (ii) the empowering of smallholders by having social movements at the negotiation phase when setting contract farming terms; and (iii) provisions for having smallholders gradually ascend in the bio-based value chain (or web), with capacity building for local value-addition (e.g., seed-oil extraction). Notably, that requires the development of suitable technologies for small-scale settings. Moreover, bioenergy may not always be the favored choice: farmers may be better off producing high-quality foods or other valuable bio-based goods such as aromatics or cosmetics (see Ollinaho and Kröger 2021 for various agroforestry examples). Admittedly, private

agribusiness or even state-owned companies may not always be willing to let go of their control over the value-added stages of production, as that could lower their short-term profits and increase their expenditures on purchases from smallholders. Yet, redress instruments built into policy as conditions for market or regulatory incentives may provide an adequate balance of carrots and sticks.

Finally, preventing further injustice is insufficient in contexts of historical marginalization. Longstanding issues such as unrecognized land rights, skewed resource access, or inequitable agri-food systems call for retributive and restorative measures. The bioeconomy transition offers a chance to redress persistent energy poverty issues as well as uneven access to land and broader questions of socio-economic exclusion. Retributive and restorative justice need not wait for additional grievances to surface. The bioeconomy transition can become an entry point for more comprehensive agri-food system transformation and land-use sustainability, and the four dimensions of environmental justice indicate paths forward.

## **5. Conclusions**

This comparative assessment demonstrates how and why a just bioeconomy transition crucially depends on transforming unsustainable farming and land use alongside fossil fuel dependence. In practice, that means pursuing two transitions at once: on the one hand, an energy and broader industrial transition, replacing fossil resources for renewable and biodegradable alternatives while spurring novel value chains (or webs); on the other hand, a transition in farming and agriculture, away from conventional monocultures and towards more diverse, inclusive and

equitable production systems. Experience shows that aiming for the first one while neglecting the second is poised to aggravate injustices and undermine sustainability.

A just bioeconomy transition entails: (i) stakeholder recognition, inclusive governance, and respect for traditional resource rights (procedural justice); (ii) equitable distribution of benefits and burdens (distributive justice); (iii) accountability for harms eventually caused, such as deforestation or rights violations (retributive justice); and (iv) policy instruments to redress new or historical injustices (restorative justice). The cases examined here show, however, that justice does not spontaneously arise — it must be actively pursued. Further research can investigate how transition acceleration and other concepts can be combined with social improvements in the bioeconomy case, as well as how to make sense of and govern such multipurpose transitions.

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