Mairon G. Bastos Lima

The Politics of Bioeconomy and Sustainability

Lessons from Biofuel Governance, Policies and Production Strategies in the Emerging World

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Preface

Critical global interdependencies are becoming increasingly exposed in the 2020s. Human health and environmental issues are showing their transnational facets ever more bluntly, while political decisions in one country attract worldwide attention for how their impacts unfold everywhere. As governments gear up for economic recovery after the worst pandemic in over a century, questions about the best ways to do so proliferate. As "green economy" gained ground in the aftermath of the 2008/2009 financial crisis, the bioeconomy today is among the policy ideas that most gather attention.

How to think critically albeit with enthusiasm about bioeconomy promotion is the subject of this book. It draws on a large amount of literature, in-depth research in Brazil, India and Indonesia, and over 100 key-informant interviews with experts to whom I am grateful for their time and insights. While appreciating the particularities of each place, it was fascinating to discover some of the common trends across the globe. (If only I could bring some of those stakeholders, particularly the most vulnerable ones, into one single conversation.) Sometimes, what was obvious to actors in one context seemed completely alien to those in another, even if some of the issues and concerns were the same. If anything, conducting the work for this book revealed to me the enormous "yield gap" remaining to be filled in South-South collaboration. Not just intergovernmental, but most especially between civil societies.

Those, however, are insights for another book. Here, what has become clear is the resilience and power of the bioeconomy as an idea whose time has come—as Victor Hugo would have it. Although biofuels were heavily critiqued (particularly in Europe) earlier in this century, the broader bioeconomy agenda now resurfaces under new clothes. It is fundamental that the lessons be learnt, and that is a central mission of this work.

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a grant that allowed me to complete the work on this book. It is dedicated to all those who might benefit from it.

Stockholm, Sweden Mairon G. Bastos Lima
November 2020

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About the Author

Mairon G. Bastos Lima started working on bioeconomy governance in 2008. He has since obtained a Ph.D. in environmental studies from the VU University Amsterdam (2014) and published extensively on various themes of environmental politics, particularly in relation to agriculture, social sustainability and the Global South. Working in Latin America, Sub-Saharan Africa, South and Southeast Asia, he has collaborated in different occasions with the UN Development Programme, the UN Research Institute for Social Development, among others. A passionate globe-trotter, Mairon has travelled to over 100 countries. He currently lives in Stockholm, Sweden.

Abbreviations

ANP	National Agency of Petroleum, Natural Gas and Biofuels (Brazil)
APKASINDO	National Oil Palm Farmers Union (Indonesia)
ASTM	American Society for Testing and Materials
B2	2% blend of biodiesel in fossil diesel
B3	3% blend of biodiesel in fossil diesel
B5	5% blend of biodiesel in fossil diesel
B10	10% blend of biodiesel in fossil diesel
B20	20% blend of biodiesel in fossil diesel
B100	Pure biodiesel
BNDES	Brazilian Development Bank
BRL	Brazilian reais (currency)
CBD	United Nations Convention on Biological Diversity
COP	Conference of the Parties
CPO	Crude Palm Oil
E5	5% blend of ethanol in gasoline
E10	10% blend of ethanol in gasoline
EMBRAPA	Brazilian Agricultural Research Corporation
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FFB	Fresh Fruit Bunches
G8	Group of Eight
G20	Group of Twenty
GAPPERINDO	National Plantation Farmers Union (Indonesia)
GBEP	Global Bioenergy Partnership
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HGB	“Right to build” (Indonesian permit)
HGU	“Right to cultivate” (Indonesian permit)
IAA	Sugar and Alcohol Institute (Brazil)
IBF	International Biofuels Forum
IDGEC	Institutional Dimensions of Global Environmental Change
IDR	Indonesian rupiah (currency)

IEA	International Energy Agency
INR	Indian rupees (currency)
IPCC	Intergovernmental Panel on Climate Change
ISPO	Indonesian Sustainable Palm Oil
MEMR	Ministry of Energy and Mineral Resources (Indonesia)
MIFEE	Merauke Integrated Food and Energy Estate (Indonesia)
MPP	Minimum Purchasing Price
MSPO	Malaysian Sustainable Palm Oil
NAFTA	North American Free Trade Agreement
NGO	Non-Governmental Organization
NREGS	National Rural Employment Guarantee Scheme (India)
OMC	Oil marketing company
OPEC	Organization of the Petroleum Exporting Countries
Planalsucar	National Programme of Sugarcane Improvement (Brazil)
PNPB	National Programme on Biodiesel Production and Use (Brazil)
R&D	Research and Development
REDD	Reducing Emissions from Deforestation and Forest Degradation
RFS2	United States Renewable Fuel Standards 2
RSB	Roundtable on Sustainable Biomaterials
RSPO	Roundtable on Sustainable Palm Oil
TIMNAS BBN	National Team for Biofuel Development (Indonesia)
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNRISD	United Nations Research Institute for Social Development
US	United States
USD	US dollars (currency)
US EPA	United States Environmental Protection Agency
WHO	World Health Organization
WTO	World Trade Organization

Chapter 1
Introduction: Political Dimensions of the Bioeconomy

Abstract A seemingly inevitable transition to a bioeconomy is underway, raising expectations as well as important social and environmental questions. Climate change, ocean plastic pollution and other ecological issues have made the phase-out of fossil resources an imperative. Still, greater global reliance on biomass alternatives poses as many opportunities as risks. Ensuring that such a transition delivers sustainable development—with the inclusion of marginalized groups, addressing inequalities, and eradicating poverty in line with the Sustainable Development Goals rather than aggravating these problems—is a daunting task, yet a fundamental one. For that, more attention is needed on governance, on the political dynamics that have steered bioeconomy promotion, and on the often-overlooked social dimensions of sustainability. This introductory chapter discusses the concept of bioeconomy, its tenets, goals, potentials, and key risks. It presents an initial critical inquiry into the political ecology of bioeconomy promotion and then outlines this book's in-depth assessment focused particularly on emerging economies. As these actors increasingly come to shape the fate of global sustainability in the twenty-first century, the bioeconomy reveals to be an essential domain in which to analyze sustainable development politics in large democracies of the Global South.

Keywords Environmental governance · Biofuels · Social equity · Political ecology · Sustainable development · Ecological modernization

1.1 Rescuing the Social Pillar of Sustainable Development

Something goes missing when anyone describes sustainability as a win-win strategy. If the concept is three-dimensional, at least a third win should be there, including the ecological, economic, and social aspects.

People are strongly impacted by environmental degradation and the different strategies adopted to avoid or cope with it. Yet the social dimensions of sustainable development remain understudied, obfuscated, and at times ignored. The United Nations' (UN) 2030 Agenda and its Sustainable Development Goals (SDGs) have duly recognized social aspects of inclusiveness, justice, and poverty alleviation. However, these issues arguably remain marginal in most sustainability assessments,

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generally focused on reconciling the ecological and economic pillars (Barnett 2001; Lehtonen 2004; Robinson 2004; Cook and Smith 2012). Sometimes such social equity dimensions are treated as supplementary (see UNDP 2011). But such social objectives are inherent to the sustainability concept (WCED 1987; UNCED 1992; UNCSD 2012) as much as they are fundamental to understanding and addressing environmental issues (Berkes and Folke 1998; Ostrom 2005; UNRISD 2012).

Social dimensions are critical to sustainable development, as the 2030 Agenda highlights (UN General Assembly 2015). Improvements to basic living standards, inclusiveness promotion, and poverty eradication have long been significant tenets of "development" (Sachs 1979; UNCED 1992). Yet, already before the shock of the COVID-19 pandemic, about 821 million people worldwide were undernourished (FAO 2019), 2.1 billion lacked access to clean and safe drinking water (WHO/UNICEF 2019), and 860 million lived without electricity (IEA 2019).

At least three rationales would underscore more substantive actions to change such a reality. First, we may regard poverty eradication and social equity promotion as an ethical or moral imperative. Principles of justice, solidarity, and empathy for others are present in most philosophical or religious traditions—as in the so-called "golden rule" to seek for others the same as for oneself (Blackburn 2001; Singer 2002). Second, these goals also have a legal nature, as they are enshrined in democratic values and international law. Such laws include the Universal Declaration of Human Rights, the Rio Declaration on Environment and Development, as well as non-binding legal instruments such as the SDGs (UN General Assembly 1948; UNCED 1992; Bastos Lima 2009; Gupta et al. 2010; Gupta and Lebel 2010; UN General Assembly 2015). Those international commitments request universal access to essential resources and the opportunity for political participation, as well as the right to equitable development that prioritizes the needs of the least advantaged (UNCED 1992; Rawls 2001, p. 149). The 2030 Agenda makes this principle explicit aiming to "reach the furthest behind first" (UN General Assembly 2015, p. 3). Finally, equity is crucial to social welfare, as poverty and inequality compromise a wide array of other human development and social quality indicators. Poverty curtails both individual and collective potentials for intellectual and cultural expression (UNRISD 2010). Inequality, in turn, is often linked to low levels of social trust, high rates of violent crime, lower educational performance, and higher incidence of physical and mental health issues (WHO 2008; Wilkinson and Pickett 2009). Notably, these are issues that affect unequal societies as a whole—not just the poor.

Social aspects are also crucial in dealing with environmental issues. Values, principles, norms, and other institutions are fundamental to understanding how—and why—human activities impact nature and society itself (Finnemore and Sikkink 2001; Conca 2006; Biermann et al. 2009, p. 72). A Foresight Report of the United Nations Environment Programme (UNEP) has identified "Aligning Governance to the Challenges of Global Sustainability" as the most pressing environmental issue for the twenty-first century (UNEP 2012). It suggests that there needs to be considerably more attention to the role of institutions and governance mechanisms built to orientate human activity, hence on the social and political dynamics that shape them. Likewise, the social impacts of environmental degradation and responses created to address it need to be well understood. Lack of attention to these dimensions can easily lead to strategies that overlook or even aggravate social problems, such as inequitable approaches to biodiversity conservation or climate change adaptation that end up excluding weaker stakeholders, deepening poverty, and creating further injustice (Fairhead et al. 2012).[1]

Social equity is an imperative not only within societies but also on the global level. In recent decades, half of all income systematically went to the wealthiest 10% of the world population, leaving the poorest 10% to live on 0.7% of it (Milanovic 2006). By the start of the 2020s, the richest 1% together possessed twice as much combined wealth as 6.9 billion people (Coffey et al. 2020). Notably, the World Bank observes that as much as 70% of income disparity can be attributed to international (inter-country) inequalities, rather than variation within each country (Milanovic 2006). Domestic imbalances have been pressing in some countries. Still, no single country is more unequal than the world (Milanovic 2016), which is recognizable given that nearly all those who still lack access to food, water, or electricity live in Africa, Asia, or Latin America. Therefore, bridging the North-South divide that separates developed and developing countries is a significant step not to be overlooked in addressing poverty and inequality on a global scale. That thus remains an essential dimension of sustainable development.

This book examines such social dimensions of sustainability from a political perspective. It focuses on bioeconomy governance, a novel, promising, and arguably necessary emerging sector where attention to equity is vital, for bioeconomy development may either become a way to redress injustices and eradicate poverty or perpetuate—possibly aggravate—existing problems. An assessment of what has been done with biofuels before and now under the bioeconomy umbrella is timely. It can unravel the sort of strategies and pathways being promoted, and which may either be adjusted or gain even more traction in the future. The next section describes the rise of the bioeconomy and some critical questions of environmental politics it poses. This introductory chapter then turns to the approach, boundaries, and scope of the research behind this book, before presenting its structure.

1.2 Environmental Crises and the Rise of the Bioeconomy

The United Nations has regarded climate change as the defining challenge of the twenty-first century (Ki-Moon 2007). The Intergovernmental Panel on Climate Change (IPCC) reports have consistently suggested that it has been human-induced and has already affected temperatures, rain patterns, and marine and terrestrial ecosystems worldwide. Climate change impacts human societies both directly (e.g., heat waves) and indirectly, due to damage to natural systems. That includes water

[1] See the special issue of *Global Environmental Change* on "Adding Insult to Injury: Climate Change, Social Stratification, and the Inequities of Intervention", edited by Marino and Ribot (2012).

scarcity, a higher prevalence of tropical diseases, and significant losses in rain-fed agriculture—all of which disproportionally affect the poor (Roy et al. 2018, p. 451).

There is a growing sense the world must urgently move away from CO_2-intensive fossil fuels such as oil, coal, and natural gas toward renewable energy sources. However, most renewables replace only power and not the liquid fuels still largely used in transportation, a sector that accounts for 14% of all anthropogenic greenhouse gas (GHG) emissions (IPCC 2014). Electric automobiles have been on the rise and rapidly conquered increasing market shares in Europe, with some European countries already setting deadlines to ban diesel cars. Yet, as of 2020, combustion-engine vehicles remained vastly dominant globally, while the shipping industry and aircrafts remained reliant on liquid fuel. Liquid biofuels (i.e., renewable fuels produced from biomass resources) have worked as an effective alternative to fossil energy. Biofuels manufacturing technology is well-established, easily replicable, and can be scaled up using many different feedstocks (raw materials). Their adoption requires only relatively minor to no changes in vehicle engine technology and existing transportation infrastructure. As a result, for the first decades of the twenty-first century, they have been regarded as more cost-competitive vis-à-vis fossil fuels than other technologies, and this may remain the case for some time in most of the world (Pacala and Socolow 2004; Mathews 2007; Bastos Lima 2018).

Despite the outcry and political opposition to biofuels, their global production has mainly remained unabated. An initial international enthusiasm raised annual biofuel production from 4.4 billion liters (bl) in 1980 to 18bl in 2000 before it increased eight-fold to 153bl in 2018 (Koh and Ghazoul 2008; UNEP 2009; REN21 2019). In 2020, the International Energy Agency forecast continuous growth in the sector and a 25% increase in output by 2024 (IEA 2020). This production consists primarily of ethanol, an alcohol that can either replace gasoline or be blended with it, and biodiesel, which can be used in blended or pure form to substitute fossil diesel. In 2018, ethanol and biodiesel production respectively stood at 111.9bl and 41.3bl (REN21 2019). By 2028, the Organisation for Economic Co-operation and Development (OECD) and the UN Food and Agriculture Organization (FAO) project that those annual outputs will continue increasing to reach respectively 143bl and 44bl and coming mostly from production based on conventional feedstocks (OECD/FAO 2019). That is perhaps a glimpse of what the world may look like in terms of liquid bioenergy when the 2030 Agenda meets its deadline.

More recently, in light of political setbacks against biofuels in some places (particularly in Europe), they have been increasingly framed within a broader *bioeconomy* umbrella. Although the bioeconomy does not have a single, unambiguous definition, it generally refers to biomass-based economic sectors and value chains (Bugge et al. 2016; Bastos Lima 2018). Many aim to replace fossil fuels and other fossil-based products (e.g., plastics, chemical oils). However, the bioeconomy has sometimes been promoted simply as an avenue to spur sustainable development based on biological resources (Scordato et al. 2017). There is much enthusiasm that biofuels may be only the tip of the iceberg. Numerous bioproducts can emerge, aided by biotechnology development, to sustain greener societies (see European Commission 2018). That could help address global climate change and other environmental issues such as biodiversity loss (which in part owes to its currently unrecognized economic value) and growing plastic pollution, most notably of the oceans (Scordato et al. 2017).

As some authors have long recognized, biofuels may not be the ultimate renewable energy technology but rather a stepping-stone towards more advanced and efficient ones in the future (Pacala and Socolow 2004). In the long run, biomass sources may no longer be significant fuel providers, but they will undoubtedly supply chemical components for many industries. This aim is best captured in the concept of *biorefineries*. It suggests industrially processing (i.e., refining) biomass to extract and separate its various (bio)chemical compounds that can substitute what today is made primarily from oil, such as plastics, solvents, and lubricants (Lynd et al. 1999; Kamm and Kamm 2004; Langeveld et al. 2010). Energy does not have to be the primary output but just one possible application, among many others. These other applications include bulk or commodity products of high volume and comparatively low value (e.g., industrial oils, adhesives, surfactants, solvents, and biopolymers for biodegradable fibers and plastics) as well as low-volume high-value chemicals for the food and pharmaceutical industries (Sandun et al. 2006; Langeveld et al. 2010; Aiking 2011). Economically, although only a small share of petroleum is used for non-energy purposes, its market value is approximately equal to what is used as fuel (Langeveld et al. 2010). Biorefineries thus present an enormous potential to provide renewable industrial feedstocks and create development opportunities. They have also led some to prefer to speak of *value webs* instead of (single) chains, as the same biomass feedstock can enter several downstream paths (Scheiterle et al. 2018).

However, it should not go unnoticed that if the broader bioeconomy follows biofuels' footsteps—as the forecasts expect it to do (OECD/FAO 2019)—the bulk of this new production will derive from agriculture, with significant ecological, socio-economic, and political implications. In the case of biofuels, despite more than a decade of eager (and over-optimistic) projections about "next-generation" feedstocks, virtually all commercial production remains consistently based on conventional sources. Ethanol is mainly from crops rich in either starch (e.g., corn, cassava) or sugar (e.g., sugarcane, sugar-beet). At the same time, biodiesel is produced chiefly from vegetable oils (e.g., soybean, rapeseed, palm oil). On a global scale, about 12% of all vegetable oil supplies are used for making biodiesel, and 18% of all sugar crops go to ethanol manufacturing. By 2028, industries may use 14% of the global corn and 24% of worldwide sugarcane production for biofuels (OECD/FAO 2019).

It is crucial to notice how a small set of crops has increasingly dominated production—even before any nominal bioeconomy pretensions. These crops (notably corn, soy, sugarcane, and oil palm) have sometimes been called "flex crops" and championed for their versatility, allowing for possibly meeting the demands of various downstream markets (Alonso-Fradejas et al. 2016; McKay et al. 2016; Oliveira and Schneider 2016; Bastos Lima 2018). They have two complementary features that seemingly make them unique: *multipleness* and *flexibleness* (Borras et al. 2016). Multipleness refers to the different uses these crops can have, including a large variety of co-products and by-products. In turn, flexibleness relates to producers' ability to easily switch from one utilization to another (e.g., sugarcane for sugar or ethanol making) based on economic and policy assessments. In other words, producers can choose—and regularly adjust their choices—of which commodities to produce from those crops, selecting among different downstream markets depending on which one is most attractive at a given moment. These potentials can be a boon for flex-crop producers, but the bioeconomy's foundation on agriculture has broader implications.

Ever-larger reliance on agriculture means, first, that increased demand for liquid biofuels and other bioproducts provides a growing market and thus an incentive to cultivate those particular feedstock crops. As such, the bioeconomy becomes connected to the whole range of ecological and socio-economic issues related to agriculture: impacts on soil and water quality, deforestation, but also the creation of employment and income in rural areas. Globally, liquid biofuels already sustain more than two million jobs, more than any other renewable energy sector besides solar photovoltaic (REN21 2019). Second, the utilization of crops—or resources such as arable land and freshwater—for biofuel manufacturing or other novel uses means that these uses compete directly or indirectly with food production, thus impacting food supplies, food market prices, and possibly food security. Rather than deny or polemicize such a competition, the key might be to understanding how different objectives can be sustainably balanced—as required, not the least, by the SDGs. Third, expanded dependence on agriculture means that social groups, regions, countries, and even continents with this sector as a significant economic activity can become new energy and bioproduct providers, potentially altering political power structures from local through to the global level. As such, the bioeconomy has dimensions that go beyond conventional debates around renewable energy.

The fact that biofuels over the past decades and bioeconomy as of today have become so appealing to public and private interests does not, however, mean that these necessarily are sustainable endeavors. What it demonstrates is, instead, that such innovations have successfully captivated the actors whose interests and decisions shape the development agenda at domestic and international levels. This agenda is far from being uncontroversial or free of risks, as seen widely in the biofuels' case when some asked whether the cure was not worse than the disease (Doornbosch and Steenblik 2007; FAO et al. 2011; see also Chapter 2). There remain fears that, in trying to address the climate crisis, production on a larger scale could trigger other environmental problems related to deforestation or excessive freshwater consumption. Much evidently depends on *how* the bioeconomy is pursued (Bastos Lima 2018). Therefore, assessing the political and institutional factors that have shaped biofuel policy agendas and directed bioeconomy governance to date is timely.

1.3 The Political Ecology of the Bioeconomy

1.3.1 Ecological Modernization and Its Limits

Today's dominant strand of environmentalism and sustainability approach arguably is the ecological modernization paradigm (Adams and Jeanrenaud 2008; Foster 2012).

The early environmental critique in the 1960s and 1970s pointed to the damages caused by new technologies and the Earth's limited carrying capacity in the face of post-war aspirations for unlimited "progress" (Meadows et al. 1972; Dunlap and Van Liere 1978). In turn, ecological modernization contends that economic growth and technological development can advance hand-in-hand with conservation (Hajer 1995; Buttel 2000; Janicke 2008). Indeed, it argues that *further* economic growth is needed to address environmental issues through the development of cleaner and more resource-efficient technologies, industrial transformation, and new market mechanisms (e.g., ecological impact accounting, payment for ecosystem services, carbon markets) (Buttel 2000; Olsthoorn and Wieczorek 2006; Baker 2007; Pataki 2009). As an "ecological rationality" emerges in society, those issues become drivers of innovation, market opportunities, and potential sources of competitiveness and profit (Giddens 1998; Mol 2002; Beck 2010). Ecological modernization can thus be understood as a pro-industry, technology-based, and market-oriented approach to environmental policy (Weale 1992; Janicke 2008).

That makes ecological modernization different from "end-of-pipe" environmental management, as it promotes "preventive innovation" (Milanez and Buhrs 2007) instead of remedial solutions (see also Mol 2000; Cohen 2006). It also contrasts with more radical approaches to sustainability that aim at more profound—and more difficult—changes in human behavior or the industrial capitalist system. Instead, ecological modernization adopts a reformist approach, proceeding through incremental changes from within (Mol 2000, 2002; Pataki 2009). In practice, this means fostering an enabling institutional environment and gradually shifting production and consumption patterns towards sustainability. It proposes "reflexive modernity," one that continuously assesses the (ecological) risks it creates and evolves by responding to them (Mol and Spaargaren 1993, 2000; see also Beck 1992).

The relatively conservative stance of ecological modernization on social issues has been a significant source of criticism. Critics have perceived it as an approach that pays little attention to structural inequalities and tacitly maintains the socio-economic and political status quo (York and Rosa 2003; Foster 2012). First, on a conceptual level, ecological modernization tends to detach the social dimensions of environmental issues. It sidelines reflections on equity and ethics to promote eco-efficiency as a solution instead, taming—or, in reality, co-opting—the initial environmental critique on modern industrial societies (Levy 1997; Langhelle 2000; Martinez-Alier 2002; York and Rosa 2003; Baker 2007; Foster 2012). Environmental issues are thus regarded as technocratic problems to be addressed through the market and technological fixes. Meanwhile, the notion of sufficiency is replaced by renewed support to modernity premises such as unlimited economic growth and a consumerist view on human welfare (Christoff 1996; Baker 2007; Blühdorn 2011; Foster 2012).

Second, ecological modernization routinely overlooks social inequalities, politics, and power relations (York and Rosa 2003; Foster 2012). It assumes a conflict-free, harmonious society without political interests or domination structures. All actors supposedly are equally affected by environmental problems, and "there is no ecological proletariat" (Beck 1995, p. 3; Pataki 2009; Foster 2012). Therefore, it can be said there is only limited reflexivity (Eckersley 2004; Warner 2010; Foster

2012). Ecological modernization may revise particular policies or technologies, yet it offers a "discourse of reassurance" to the underlying political and socio-economic institutions in place, and thus to the inequalities they create (Dryzek 2005; Baker 2007).

Third, ecological modernization primarily promotes capital-intensive solutions, making business entrepreneurs, industry, and technology developers the primary agents of change (Christoff 1996; Baker 2007; Warner 2010; Blühdorn 2011). This bias is particularly attractive to wealthier, highly industrialized countries, which have a greater capacity to invest in such "solutions," thus minimizing the need for socio-cultural changes, such as their disproportional consumption patterns (Baker 2007; Blühdorn 2011). And fourth, ecological modernization uncritically advances (Western) scientific rationality as the one dominant knowledge system, with all its assumptions, prevailing norms, and related power structures (Cohen 1997; Pataki 2009). Governance guided by the ecological modernization paradigm usually offers little space for alternative, contrasting views. Such a lack of diversity, in turn, has shown to hinder reflexivity further and often give rise to purported sci-tech solutions full of unappraised impacts (Santos 2020).

These shortcomings have been observed, not the least, in the dominant approach to agri-food sustainability. There has been a clear focus on technical and biotechnological improvements such as crop hybridization and genetic modification instead of more systemic approaches based on agroecology. It builds on large-scale farming and appears to hold an unquestioned, nearly exclusive focus on improving yields and increasing production (IAASTD 2009; Horlings and Marsden 2011; Hardeman and Jochemsen 2012). This mainstream agenda has recently fallen under the aegis of "sustainable intensification," yet without challenging the problematic "hegemony of monoculture agriculture" and its persistent impacts, such as tropical deforestation (Sunderland et al. 2019). Moreover, more broadly, little attention is paid to access dimensions of food security, the impacts of dietary change, inequality in food distribution, or a broader set of environmental issues such as agrobiodiversity loss or pesticide use (Bastos Lima 2008; Horlings and Marsden 2011). Ecological modernization in agriculture has also overlooked the increasing dominance of corporate power in agri-food governance (Fuchs and Clapp 2009) and widespread cultural losses (Kneen 1995; Altieri et al. 2012).

Such a narrow focus and its disregard for equity dimensions was a key reason behind civil society organizations' skepticism—when not outright rejection—of the "green economy" banner, which draws heavily from ecological modernization (see ETC Group 2011; Wapner 2011; Jacobi and Sinisgalli 2012; Onestini 2012; Cook et al. 2012). The green economy has emphasized the need for an *economic* transition from a "brown economy" that depletes the environment into one that sustains it (Pearce et al. 1989; Barbier 2009; UNEP 2011; Brockington 2012). The concept jumped to the fore in the wake of the 2008 financial crisis initially as a strategy for global economic recovery (Barbier 2009; Brockington 2012), before becoming a core theme of the 2012 UN Conference on Sustainable Development (UNCSD, the "Rio+20"). To be sure, UNEP (2010, p. 5) defines it broadly, presenting the green economy as one means to sustainability, as an economy "that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities."[2] This broad scope, encompassing all three pillars of sustainability, is reaffirmed in the final UNCSD declaration, "The Future We Want," which sets several green economy principles that include, for instance: closing technology gaps between developed and developing countries, promoting social inclusion and equitable development to overcome poverty and inequality, and enhancing the welfare and empowerment of smallholders, indigenous communities, and other poor and vulnerable groups (UNCSD 2012, paragraph 58).

However, there is a contrast between these all-inclusive definitions and how the green economy concept is generally understood, with a narrower focus on only reconciling ecological issues and economic growth (see Brockington 2012). As such, a significant concern is that such a more limited understanding of sustainability inspired by ecological modernization may end up supplanting sustainable development as an ideal—if not in theory, at least in policy and practice. Although arguments have been made for not conflating the two concepts (see Langhelle 2000; Wright and Kurian 2010), they are most often bundled together, with ecological modernization usually taken as *the* approach to sustainability.[3]

Bioeconomy offers a lucid illustration of the above. For example, the European Commission's strategy explicitly highlights that "A sustainable European bioeconomy supports the *modernization and strengthening of the EU industrial base* through the creation of new value chains and greener, more cost-effective industrial processes" (European Commission 2018, p. 6, emphasis in the original). The choice of words could not have made its intellectual origins clearer. Sustainability assessments, in turn, have focused on economic, ecological, and technological aspects while generally overlooking issues of social equity, power relations, or conflicts among different actors in governance (Sanz-Hernández et al. 2019). It has become increasingly clear that there are different visions in society about what the bioeconomy represents and what it should mean (Bugge et al. 2016), yet governance and other socio-political dimensions remain relatively little studied.

There are at least two crucial gaps in knowledge that are only starting to be addressed. There is little understanding of how policy design relates to the distributive outcomes and social impacts of the bioeconomy. Even the few studies that generally discuss equity issues do not connect them to the particular institutional frameworks in place (see Ariza-Montobbio and Lele 2010; and German et al. 2011). There is consensus on paying attention to *how* the bioeconomy is gaining shape (see Sagar and Kartha 2007; Koh and Ghazoul 2008; FAO 2008; UNEP 2009). However, there is not enough clarity as to what institutional arrangements may work best under what circumstances—particularly concerning social sustainability issues (Bastos Lima 2018).

Moreover, there is little analysis of bioeconomy governance at national and international levels, especially on agency. There is insufficient attention to how different

[2]This definition has been embraced by other UN agencies, too. See un-page.org.

[3]See Baker (2007) for an analysis of how the European Union uses "sustainable development" or "sustainability" in its terminology while promoting essentially ecological modernization.

actors influence (and possibly steer) bioeconomy expansion and its related policy-making process (Dietz et al. 2018). Even studies that have dealt with bioeconomy strategies have rarely considered the broader political contexts in which policies are inserted (Santos 2020). As a consequence, many policy recommendations have made little sense in the real world. For instance, those who simply call for not using food crops in biofuel production may be disregarding the political importance of agricultural interests as a driver—and the fact that many countries have engaged with biofuel production primarily to benefit their farmers. Therefore, addressing these knowledge gaps contributes to a better understanding of bioeconomy governance and making useful policy recommendations.

Finally, although most assessments have focused on domestic contexts, there is also a global dimension to the bioeconomy. Ecological modernization has long been critiqued for tending to focus on local and national experiences while overlooking "leakages" of environmental impacts elsewhere (York and Rosa 2003; Salleh 2010; Foster 2012). This argument is frequently illustrated with the so-called "Netherlands fallacy," the false belief that such an advanced economy has emerged while maintaining a relatively clean and integral environment—when in reality most of the resources it consumes come from abroad (see Ehrlich and Ehrlich 1990; York and Rosa 2003; Foster 2012). Biofuels expansion, in particular, raised alarm bells when it appeared that developing countries could become major biomass feedstock providers for developed countries to become greener (Smith 2010). Recently, bioeconomy strategies may have become far more home-focused—creating jobs and expanding the domestic industrial base. Yet, in an increasingly economically and ecologically interconnected world, the global dimensions of bioeconomy promotion remain. Ecological modernization advocates have responded by paying increasing attention to global commodity chains and "ecological flows," which transcend national jurisdictions (see Mol 2007, 2010). However, there are also questions about how one region's bioeconomy pathway affects another and how the bioeconomy is governed on the international level—or left in a state of non-governance (see Bastos Lima and Gupta 2013).

1.3.2 Political Ecology

This book draws on political ecology insights in its approach to the bioeconomy. Although political ecology lacks a consensual definition, it is generally understood as a politicized view on environmental issues (Blaikie 1985; Bryant and Bailey 1997; Martinez-Alier 2002; Peet and Watts 2004; Forsyth 2008; Warner 2010). In other words, these issues are not seen as technocratic but instead placed in a broader socio-economic and political context, where there are likely to be winners and losers as well as various competing views and interests at stake (see Bryant and Bailey 1997; Forsyth 2008).

Bryant and Bailey (1997, pp. 28–29) identified three central tenets of political ecology:

1. The benefits and burdens associated with environmental change tend to be distributed unequally among actors;
2. Such an unequal distribution generally alters existing social and economic inequalities, reducing or reinforcing them;
3. That has political implications to the extent that it affects the relative power of different actors and, thus, their capacity to pursue agendas and control or resist others' actions.

Such inequalities have both material and immaterial dimensions. They may relate, for instance, to wealth creation or impoverishment due to improved or reduced access to natural resources, but they may also relate to whose norms and discourses become dominant (Peet and Watts 2004; Mann 2009).

This volume is among the first efforts to utilize such a political ecology approach to examine not a case of environmental degradation but an emerging ecological modernization strategy now being promoted under the bioeconomy paradigm. Its research analyzes and draws lessons from over 15 years of biofuel promotion policies to explore the overlooked socio-political and governance dimensions of the expanding bioeconomy. This examination is relevant not only because of the biofuel sector itself, which continues to grow, but also because biofuel policies and production strategies may be setting the pace and potentially creating path-dependencies for all further bioeconomy development. Therefore, this examination may help clarify the social needs and the political challenges of aligning governance to sustainability in these new sectors. It may help understand the determinants of international regime formation on the bioeconomy. It may also help unravel social equity's relevance to other governance issues such as vulnerability and agency.

1.3.3 Objectives & Scope

This study draws from an in-depth assessment of over a decade of biofuel production and governance strategies as a case to unravel the socio-political dimensions of the bioeconomy. In particular, it analyzes how biofuels have been produced and governed internationally, as well as in selected case study countries, to shed light on why specific production patterns have prevailed.

The objectives of this book are to: (1) map out ecological, socio-economic, and political issues related to biofuels and bioeconomy to understand what is at stake; (2) describe how selected case study countries have consolidated certain production patterns; (3) assess how biofuel governance institutions at international and domestic levels steer biofuel production, as a case within the broader bioeconomy; (4) investigate the distributive outcomes and social impacts of such prevailing biofuel production patterns; (5) analyze who the key agents are and how agency has been exercised in biofuel governance at national and international levels; (6) examine the relationships between institutions, distributive outcomes, and agency; and (7) offer recommendations for institutional (re)design.

The book focuses mainly on *liquid* biofuels (namely, ethanol and biodiesel). Their production has skyrocketed globally, accounting for most investments, political attention, praise, and criticism on the bioeconomy to date. Also, the research addresses essentially the so-called “first generation” technologies based on conventional crops. This pathway has consistently accounted for the lion’s share of global biofuel production despite long ongoing talk of next-generation biofuels (OECD/FAO 2019). The commercial viability of these more advanced technologies, such as cellulosic ethanol production, may still need improvement and remains debatable (see Robertson et al. 2008; Paul and Ernsting 2007; Raghu et al. 2006). Although the impacts of an eventual mainstreaming of more advanced technologies would certainly be worth investigating, to date the debates on their sustainability remain mostly forecasts, and they do not (yet) reflect the way the bioeconomy has made inroads in the real world.

Finally, given the book’s attention to equity issues, there is a justifiable focus on the rural poor in assessing social impacts. They are the most vulnerable actors that have been involved in biofuel production, meaning real-world bioeconomy implementation, and they usually carry the highest stakes. Focusing on weaker actors is in line with a political ecology approach (Bryant and Bailey 1997; Peet and Watts 2004). Moreover, bioeconomy advocates frequently flag local development opportunities as a rationale and moral backdrop (Dietz et al. 2018), akin to what promoters of agriculture biotechnology have long done. While those earlier promises have revealed to be mostly rhetorical and unfulfilled (see Jansen and Gupta 2009), it is critical to understand how the bioeconomy might repeat or avoid the same path.

1.4 A Focus on Emerging Democracies

Emerging countries have recently reshaped the global economy, changed the international political order, and muddled polarized divisions of the world that seemed comparatively clear-cut by the end of the twentieth century—between the Global North and South, developed and developing countries. Although most emerging economies continue to be identified—and to identify themselves—as developing countries (and therefore as part of the Global South), the distinctions between them and their less-developed counterparts have become increasingly visible and harder to ignore.

Emerging countries have been characterized primarily by high economic growth rates and increasing political relevance at the international level, as suggested by their alternative labels as “emerging *markets*” or “emerging *powers*” (The Economist 2008; OECD 2009; Hurrell and Sengupta 2012). For instance, thanks largely to them, the participation of developing countries in international trade more than doubled between 1994 and 2008, revealing their ascension not only in absolute but also in relative terms (Hanson 2012). Having navigated the 2008 financial crisis comparatively well, emerging economies strode further in getting the upper hand (Schmalz and Ebenau 2012), even if countries such as Brazil later succumbed to economic crises that were only aggravated by the impacts of the COVID-19 pandemic (UNCTAD

2020). Regardless, their political ascension in an increasingly multipolar world has continually made the G20 a new key forum for world leaders (Cammack 2012). Overall, there is a clear realization that contemporary processes of global environmental, socio-economic, and political change can no longer be sufficiently understood or addressed without reference to emerging countries (Hurrell and Sengupta 2012).

Three emerging economies are taken as in-depth case studies in this book: Brazil, India, and Indonesia. All three are major agricultural countries that have de facto embraced the bioeconomy and pursued the quick adoption of biofuels on a large scale. Sometimes, their feedstock-crop choices have even been similar—in some cases, identical. They all have targeted sugarcane as the primary ethanol feedstock and attempted to produce biodiesel from non-edible oilseeds (castor bean in Brazil, jatropha in India and Indonesia). The crops being more or less the same, there has been more room for analyzing other variables such as their particular policy frameworks and production strategies. All three countries have also experienced rapid economic development in recent decades while still facing severe poverty and inequality. Inquiries on distributive issues, therefore, become most relevant. That is especially true in the case of bioeconomy, as the production of biofuels and bioproducts increases the competition for key resources that remain inaccessible to significant parts of the population, such as water and food (see Table 1.1).

As emerging democracies, Brazil, India and Indonesia also offer novel contexts for the analysis of bioeconomy politics. They have been far less studied than developed countries in terms of bioeconomy governance or overall sustainability politics. Moreover, being functional—if imperfect—democracies, they are likely to experience more meaningful competition among different views and actors than in more authoritarian emerging countries such as Russia or China.

At the international level, too, North-South issues of the bioeconomy or particular to biofuel expansion have been studied almost exclusively concerning the global impacts of developed-country policies (e.g., Dauvergne and Neville 2009; Smith 2010). This book is amongst the first efforts to comparatively discuss the internal bioeconomy politics of various developing countries, regarding them as actors and global agents, not merely subjects of what developed countries decide to do. This investigation may also help understand whether emerging economies follow a pattern regarding bioeconomy sectors such as biofuels or sustainability more generally—and, if yes, what that pattern looks like.

The book applies a comparative case study methodology for this assessment. Case studies are useful empirical inquiries on complex and contemporary real-world contexts, serving both exploratory and explanatory purposes (Yin 2003). Each has relied on multiple sources of evidence and data-collection methods that are then cross-checked—or "triangulated"—to draw inferences. Four main sources of evidence have been used for this study: the scientific and grey literature on the specific countries; primary documents such as laws, policies, and company memos; key-informant interviews with a total of 104 policy-makers, NGOs, researchers, industry representatives, farmers and grassroots organizations in the three countries; and direct observations

Table 1.1 Socio-economic profile of the case study countries

	Brazil	India	Indonesia
Size and population			
Area (Km^2)[a]	8,514,877	3,166,414	1,904,569
Population (2020)[a]	213 million	1,380 million	258 million
Population density (people/Km^2)[a]	25	464	151
Economic data			
GDP (billion USD)[b]	1,869 (9th)	2,726 (7th)	1,042 (16th)
GDP per capita (USD)[b]	8,921 (70th)	2,010 (137th)	3,894 (110th)
Annual real GDP growth rate after the 2008 financial crisis (2008–2012 average)[c]	3.2%	6.5%	5.9%
Population on less than (PPP) USD 1.90/day[d]	4.8%	21.2%	5.7%
Distribution of family income—Gini coefficient[e]	0.54	0.38	0.39
Social indexes of access			
Human Development Index[d]	0.76 (79th)	0.65 (129th)	0.71 (111th)
Undernourished population[f]	13 million (<2.5%)	194.4 million (14.5%)	22 million (8.3%)
Population without improved access to safe drinking water[g]	4 million (2%)	82 million (6%)	21 million (8%)
Population without access to electricity[h]	0.4 million (0.2%)	74.5 million (5.4%)	4.39 million (1.7%)

[a]UN DESA (2019); [b]World Bank (2020, nominal 2018 data); [c]World Bank (2020); [d]UNDP (2019); [e]World Bank (2020, latest data from 2011 in India, 2018 in Indonesia and Brazil); [f]2016–2018 average (FAO 2019); [g]WHO/UNICEF (2019, 2017 data); [h]IEA (2019, 2018 data)

including field visits to feedstock cultivation and biofuel production areas where social impacts could at times be witnessed first-hand.

1.5 Book Structure

The remainder of this book is structured into two parts, followed by a conclusion chapter. Part I addresses the challenges raised by biofuels promotion and bioeconomy development globally, including how to approach it from a governance perspective. Chapter 2 reviews biofuels and bioproducts' sustainability, appraising the various ecological and socio-economic issues associated with their large-scale expansion. Chapter 3 develops a conceptual and analytical framework, drawing on scholarship on access, allocation, power and agency, institutions, and overall earth system governance. Chapter 4 then uses this framework to assess biofuels' international policy context as a proxy for what exists to date on bioeconomy governance.

Part II contrasts bioeconomy promotion in the contexts of Brazil (Chapter 5), India (Chapter 6), and Indonesia (Chapter 7). These chapters will present in-depth analyses of the governance arrangements and political strategizing in each of these emerging countries—their institutional frameworks, distributive outcomes, and the role of agency. Chapter 8 then compares the three cases to identify patterns and draw lessons on biofuel production and bioeconomy governance while paying particular attention to emerging economies' characteristic features.

Chapter 9 concludes the book with its core messages, explaining why certain biofuel production patterns have prevailed. It discusses the importance of changing course early on to improve sustainability outcomes as bioeconomy pathways gain traction. The chapter draws various recommendations for institutional redesign and further research, and reflects on the vital importance of social dimensions for avoiding the bioeconomy's capture by narrow political agendas.

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Part I
Biomass Sustainability and the Emergence of a Bioeconomy World

Chapter 2
The Contested Sustainability of Biofuels in a North-South Context

Abstract Biofuels have provided the earliest large-scale experience of bioeconomy deployment on the globe. Biofuel controversies, therefore, represent early bioeconomy contestations. Besides providing a state-of-the-art overview of biofuel technologies and production pathways, this chapter reviews various ecological and social issues related to bioeconomy promotion. It shows that, despite replacing fossil fuels or other fossil-based products, the sector's environmental sustainability is far from straightforward. From ecological issues (e.g., climate change mitigation, biodiversity conservation, freshwater consumption) to socio-economic ones, such as the food vs. fuel debate, the chapter reviews the potentials for rural development promotion through the bioeconomy and examines it also in terms of North-South equity. It characterizes strategies that help bridge the North-South gap and contrasts them with bioeconomy approaches that fail to address that gap—or which widen it (neocolonialist approaches). While advancing the concept of *equalizing development* to qualify strategies that help close that global gap, this overview expounds on the breadth of sustainability issues linked to biofuels and the bioeconomy. That is an essential step towards a critical understanding of what is at stake and of the multiple contestations in this policy area.

Keywords Bioeconomy · Equity · North-South · Environment · Equalizing development · Agriculture

2.1 Early Bioeconomy Contestations

The bioeconomy might dominantly present a good face in most settings, yet in practice this has not always been the case. The widespread promotion of biomass-based energy since the early 2000s has shown that, in reality, the bioeconomy is highly contested. Its real sustainability has received much scrutiny, particularly seen in liquid biofuels—the most prominent form of bioeconomy to date. Although biofuels have been promoted mainly under a climate change mitigation discourse (see Chap. 1), the issues and controversies they have raised go far beyond the climate debate. Besides other environmental issues, biofuel promotion has also raised critical socio-economic debates, including North-South equity and how such novel sectors may

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either disproportionately benefit developing countries or exacerbate their existing problems.

This chapter provides an overview of liquid biofuel production and utilization with a state-of-the-art assessment of the main environmental issues raised. It first discusses the nature, technologies, and production pathways of biofuels before addressing their production's ecological issues and key socio-economic debates. Finally, the chapter synthesizes why this constitutes such an important area of governance for sustainable development. If anything, this overview shows that, despite replacing fossil fuels, the sustainability of the bioeconomy is far from being straightforward.

2.2 The Nature of Biofuels, Technologies, and Production Pathways

2.2.1 From Traditional to Modern Biofuels

It might be useful to start with some definitions. Biofuels correspond to all fuels derived from organic matter (i.e., biomass), such as wood, vegetable oils, animal fats, or compostable wastes. Such energy has a biological origin and is also referred to as bioenergy. The biological raw material used to produce energy (also called the feedstock) can be used directly as a fuel (e.g., wood-burning to produce heat) or after different processing stages, as in biodiesel or ethanol production. The final product can be solid, gaseous or liquid, and their applications are many. They range from heat production to electricity generation to gasoline or diesel substitution in transportation.

The most traditional uses of biomass as fuel have been the combustion of wood and animal wastes for heating, cooking, lighting, or protection from insects (Sagar and Kartha 2007). These biofuels have been used for millennia. Although they have been replaced in much of the world, they still represented 10% of the global energy supply by the first decade of the twenty-first century (Goldemberg and Coelho 2004). They are of particular importance in developing countries. The International Energy Agency (IEA) estimates that over 2.5 billion people—a whole third of the global population—still rely on traditional biomass as their primary fuel for cooking, as much as 43% of the population in developing Asia and 80% of the people in Sub-Saharan Africa (IEA 2017).

However, such traditional biofuel uses pose environmental and health risks (Domac et al. 2005; Naughton-Treves et al. 2007; Goldemberg et al. 2008). The demand for fuelwood and charcoal from a growing population in the developing world has sometimes represented an important deforestation driver (Naughton-Treves et al. 2007). Moreover, the burning of biomass on cookstoves or open fires creates indoor air pollution. As women are often responsible for cooking with their children frequently nearby, this group becomes particularly vulnerable to health risks (Sagar and Kartha 2007). As the World Health Organization (WHO) puts it, indoor smoke from biomass combustion is a "dangerous cocktail" of pollutants. They include carbon monoxide, nitrogen oxides, formaldehyde, and more than a hundred others, responsible for acute respiratory infections, chronic pulmonary disease, asthma, lung cancer, cataracts, and tuberculosis (WHO 2006).[1]

There have been significant efforts to replace traditional with "modern" biofuels, which can be produced on large industrial scales (Goldemberg and Coelho 2004; WHO 2006; Agoramoorthy and Hsu 2008). Modern biofuels are produced from a range of sources and technologies. There are several fuel types, and sometimes the same one can be produced using different feedstocks and processing methods. The next sections provide an overview of some of the most important biofuels and their production pathways.

2.2.2 Modern Fuel Uses of Solid Biomass: Pyrolysis and Electricity Cogeneration

Modern technologies have allowed for the use of solid biomass as a fuel in cleaner and much more varied and efficient ways. They include, for instance, pyrolysis for heat production and technologies for electricity generation from biomass.

Pyrolysis, in contrast to combustion, consists of burning biomass in the absence of oxygen. There are traditional pyrolysis pathways (by burning biomass and covering it with soil to avoid reaction with oxygen) that have been used by Amazonian indigenous communities for centuries (Lehmann et al. 2006). However, technology has allowed for more efficient processes such as "fast pyrolysis," in which biomass is heated to around 500 °C for only a few seconds or even less (Bridgwater 2003; Kim 2015). The result usually consists of bio-oil, vapors, and a solid product called *biochar*. While the vapors can be used in heating, bio-oil can be used as a replacement for liquid fossil fuels, though it has the disadvantage of being incompatible with petroleum products (Bridgwater 2003). The cost-effectiveness of the process also needs further improvement (Bridgwater 2012; Kim 2015). Finally, biochar is a cleaner form of charcoal, as it avoids the harmful emissions from conventional combustion. It has been regarded as a useful soil additive that stores carbon, improves water retention, ensures the bioavailability of nutrients, and reduces the need for fertilizer applications (see Lehmann et al. 2006; Lee et al. 2017).

Another significant utilization of solid biomass is in cogeneration, i.e., generation of both heat and electricity. It consists of bringing agricultural residues such as corn stalks, crushed sugarcane, or other biomass into a boiler at high temperatures to produce steam, which can flow into a turbine generator to produce electricity (Purohit and Michaelowa 2007). This power can be used either locally or exported into a grid, or both. The most prominent example of this pathway is the so-called

[1]In contrast, however, there are anecdotal suggestions that indoor smoke may in some cases help prevent malaria and other insect-borne diseases, though the evidence for this remains weak (see Biran et al. 2008).

"bagasse cogeneration," which utilizes the fibrous remains of sugarcane crushed for sugar or ethanol. This utilization has allowed many sugar mills in Brazil to become not only self-sufficient in energy but also to sell it into the power grid and improve the sector's economic performance (Goldemberg et al. 2008).

2.2.3 Gaseous Biofuels: Methane and Synthesis Gas

The use of gaseous biofuels dates back to the early 1900s, with biogas as a replacement for kerosene in rural areas (Buswell and Boruff 1933). Biogas is a methane-rich gas produced from the anaerobic decomposition of biomass such as animal manure, agriculture residues, or organic household wastes. This process naturally occurs in landfills, but it can also be utilized for energy production using biogas digesters—sealed airless containers where anaerobic bacteria ferment the organic matter and produce methane gas (Sagar and Kartha 2007; Agoramoorthy and Hsu 2008). The gas is then used to generate heat or electricity, thus working as a fossil fuel replacement.

Another way biomass can replace fossil energy is through syngas production (for "synthesis gas"). This gas consists of a mixture mostly of hydrogen and carbon monoxide, resulting from the combustion of feedstock at temperatures of about 500 °C (though newer methods using plasma reactors at 1700 °C have been sought) (Mozaffarian et al. 2004; Van Oost et al. 2008). The syngas can be used as a replacement for natural gas, for the same purposes (e.g., heating) and utilizing the same infrastructure (Mozaffarian et al. 2004). This process, called thermo-chemical gasification, is not new—it has been used for decades with coal as a feedstock (Beychok 1975). The novelty, however, is the utilization of biomass feedstocks as a substitute. As the conversion technology is well established, there is potential for existing infrastructure to be adapted (Worldwatch Institute 2006; Koh and Ghazoul 2008), though the utilization of different biomass feedstocks still poses challenges (Dayton et al. 2019).

2.2.4 Liquid Biofuels: Ethanol

Ethanol is an alcohol conventionally made by the fermentation of carbohydrates extracted from plants rich in either starch (e.g., corn, cassava) or sugar (e.g., sugarbeet, sugarcane). The production from sugar feedstocks includes milling, pressing, fermentation, and distillation of the crop, while starchy plants require first converting starch into sugar (Sagar and Kartha 2007). More advanced pathways can utilize any cellulosic biomass, such as grass, wood, straw, or other agricultural residues. Since cellulose (a primary constituent of plant biomass) is, in fact, an insoluble carbohydrate, it can be broken down through enzymatic hydrolysis and utilized in the same way as sugar crops (Field et al. 2008). This cellulose processing allows for utilizing all parts of the plant, thus making better use of the feedstocks. Most importantly, it allows the use of feedstocks that are not used for food production, such as grasses or wood pellets, thereby reducing food vs. fuel competition. However, these more advanced technologies still need to become more cost-effective before they can be further scaled up and mainstreamed.

Once produced, ethanol can be blended with gasoline or even replace it entirely, depending on the engine. A 10% ethanol blend with gasoline is often used, as this generally does not require engine changes (IEA 2006, p. 389). In that form, ethanol replaces not only a fraction of gasoline but also the additives commonly used to enhance its performance (e.g., antiknock agents, octane enhancers, oxygenates) (Solomon et al. 2007; Sagar and Kartha 2007).

2.2.5 Liquid Biofuels: Biodiesel (FAME and HVO)

Biodiesel is conventionally produced through the chemical conversion (transesterification) of animal fats or vegetable oils into compounds called *fatty acid methyl esters* (FAME), which receive the commercial name of "biodiesel" due to their chemical resemblance with petroleum-based diesel.

These methyl esters can be blended with or replace conventional diesel completely in various applications, such as vehicles and stationary engines used for heat or electricity generation. Most commonly, plant oils are (chemically or mechanically) extracted from seeds and then mixed with an alcohol and a catalyst for the reaction, resulting in biodiesel and glycerin. After a cleaning process, biodiesel can be utilized with very little or no modification in conventional combustion engines (Agarwal 2007). Various lipid feedstocks can be used and mixed, but fuel quality may vary. Usually, producers seek specific standards of viscosity and concentration of certain compounds (e.g., iodine) for the sake of engine performance and durability. For example, biodiesel produced purely from animal fats may revert to its denser form at low temperatures and compromise engine function. Therefore, feedstock mixing is sometimes a way to achieve "ideal" physicochemical standards (see Karmakar et al. 2010).

Over the past years, a different chemical compound, *hydrotreated vegetable oil* (HVO), has been increasingly used due to closer similarity with fossil diesel and superior fuel performance. Its (costlier) processing consists of treating oily feedstocks with hydrogen to remove oxygen and synthesize a diesel analog (Chiong et al. 2018). Chemically distinct from FAME, HVO is at times referred to as "green diesel" to distinguish it from conventional biodiesel, but its biological origins and end-uses are the same. (This book refers to both as biodiesel, as is frequently done, e.g., REN21 2019. The specific type is pointed out only when a distinction may be needed.)

As of 2020, most biodiesel production (of either type) came from edible vegetable oils (e.g., rapeseed, sunflower, soybean, and palm oil). However, non-edible vegetable oil crops (e.g., castor bean, *Jatropha curcas*) have also been used to a lesser extent, and so have microalgae. Microalgae can grow rapidly, and many of them have very high oil content (Chisti 2007). They can potentially grow in non-potable or industrial wastewater, and they would not directly compete with food production (Gouveia and Oliveira 2009; Wu et al. 2012). However, high production, harvesting and oil-extraction costs currently have limited the economic competitiveness of this pathway (Baicha et al. 2016), and doubts concerning the engine performance of fuels from microalgae remain (Piloto-Rodríguez et al. 2017).

2.2.6 Liquid Biofuels: Aviation Fuels

Although nearly all biofuels have been used for road transportation, aviation also has received increasing attention. The European Commission, the International Air Transport Association, as well as public and private actors in the US and Brazil have all launched initiatives for R&D and adoption of aviation biofuels (Rosillo-Calle et al. 2012; Boeing et al. 2013).

Aviation contributes to 2% of all anthropogenic GHG emissions, and these emissions are forecast to triple by 2050, reaching 3% in relative terms, despite expected fuel efficiency improvements (Boeing et al. 2013). Among various aviation fuels, the focus has been replacing *jet fuels*, which are oil-based hydrocarbon combinations akin to diesel and used in the combustion-turbine engines of most commercial aircraft. As in the biodiesel case, research and development efforts have focused on "drop-in" replacements, i.e., biofuels that can be used by conventional engines without modifications (Boeing et al. 2013). Such aviation biofuels are important because hydrogen-, solar-powered, and other more advanced aircraft types are not expected to become commercially viable until "well after 2050" (IRENA 2017, p. 2).

Several production pathways exist, but only a few have been approved by the ASTM International[2] (a US-based organization that sets technical standards for commercial jet fuels) and commercially tested. One is a thermo-chemical pathway that converts syngas (from biomass gasification) through a Fischer-Tropsch and fractioning process. Yet most aviation fuels used to date follow a hydroprocessing pathway akin to biodiesel (IRENA 2017). This lipid conversion, breaking large hydrocarbon molecules of vegetable oils or animal fats into smaller ones that can replace conventional jet fuels, is cheaper and considered technically simpler than existing alternatives (Rosillo-Calle et al. 2012; Boeing et al. 2013). Generally, however, feedstock costs still are comparably high (vis-à-vis fossil fuels); there is uncertainty in the industry regarding upcoming sustainability requirements on aviation fuels, and limited availability of suitable feedstocks (Pearlson et al. 2013; Gegg et al. 2014). Despite long-standing aims of producing jet biofuels from advanced feedstocks such as algae or cellulosic biomass, their fledgling production has utilized mainly the same feedstocks as biodiesel (e.g., palm oil, jatropha, soy oil) (Bailis and Baka 2010; IRENA 2017). The technology and the technical potential are generally

[2]Originally the American Society for Testing and Materials, but its spelled-out name has been dropped in favor of ASTM International.

there, yet economic viability and other sustainability concerns remain (Prussi et al. 2019).

2.3 Biofuels and the Environment

2.3.1 Climate Change Mitigation

Most scenarios in line with the 1.5 °C or 2 °C climate targets foresee substantive reliance on biomass (Daioglou et al. 2017), but does the substitution of fossil fuels for biofuels indeed reduce greenhouse gas (GHG) emissions? This question has been central to many biofuel sustainability assessments, but it has no easy answer. In principle, all biofuels provide emissions reductions because the carbon they emit when burnt equals what they absorbed from the atmosphere during plant growth—or what has been referred to as the carbon uptake credit (Searchinger et al. 2008). This cycling would make biofuels, in theory, carbon neutral. However, the reality is that at least three significant factors may alter that picture, putting into question the "cleanliness" of large-scale biofuel production.

First, most biofuel production relies on chemical-intensive monocultures that have large carbon footprints. Heavy utilization of pesticides and nitrogen fertilizers (which use fossil energy in their production), in addition to transportation and processing, entail substantial GHG emissions (McElroy 2006). In practice, the emissions savings from fossil fuel replacement may be much smaller than in principle. Although there is variation depending on the calculation methodology used, most assessments suggest that corn-grain ethanol, for example, achieves only minor emissions reductions (12–19%) due to fossil-energy use in its production chain (Hill et al. 2006; Farrell et al. 2006; Groom et al. 2008). Sugarcane-based ethanol, in turn, appears to be more efficient, reducing emissions by 70% or more (Hill et al. 2006; Farrell et al. 2006; Groom et al. 2008). More advanced biofuels such as grass-based cellulosic ethanol could also achieve good results, particularly if little or no chemical inputs are used (see Tilman et al. 2006). In some cellulosic-ethanol cases, GHG emissions reductions may exceed 80%, but this can vary depending on the adopted land management practices (Qin et al. 2018).

Second, climate impact assessments must include other GHGs such as methane (CH_4) and nitrous oxide (N_2O) emitted from feedstock cultivation. These gases are far more potent than CO_2 in their contribution to the greenhouse effect and are a crucial concern related to industrial agriculture and livestock farming (Lesschen et al. 2011; Reay et al. 2012). N_2O emissions, in particular, seem very much linked to the widespread utilization of N-fertilizers in agriculture (Park et al. 2012). As such, some authors have argued that an increase in other GHG emissions can hamper or even negate savings from replacing fossil fuels (Melillo et al. 2009; Crutzen et al. 2007). These other GHGs have shown to be important not only for biofuels based on agriculture but also for microalgae biodiesel's life cycle (Frank et al. 2012).

Finally, there are major concerns about emissions from land-use change, particularly the conversion of carbon-rich areas such as tropical forests or peatlands for agriculture. These significant upfront emissions can create a vast "carbon debt" that biofuel utilization may take decades (or even centuries) to pay off (Searchinger et al. 2008; Fargione et al. 2008). The most problematic cases are those of rainforest conversion and peatland degradation. Fargione et al. (2008) calculated, for instance, that palm-oil biodiesel produced in converted peatland rainforest areas could require as long as 423 years before providing any net benefit in terms of emissions savings. Accounting for indirect land-use change makes matters even more complex. For instance, some authors have suggested that although Brazilian sugarcane is grown far from the Amazon, it frequently displaces cattle ranching, which in turn may cause deforestation (Nepstad et al. 2008; Sawyer 2008).

Producing an accurate overall GHG-balance estimation, therefore, is a challenging task. Besides the above, it would also have to include the offsets provided by the co-products of biofuel crops (Farrell et al. 2006). In the end, there is no easy answer, and it is wise to treat conclusions with caution. What is clear is that the potential of biofuels to reduce emissions largely depends on: (i) what land-use changes are (directly and indirectly) caused by feedstock cultivation; (ii) how much fossil energy input is required per bioenergy output; and (iii) the overall emission of various GHGs, not only $CO_{2.}$ Considering these three factors, it seems that Brazilian sugarcane performs best among the dominant commercial technologies, mostly because of its high productivity and comparatively small demand for fossil-energy inputs (Groom et al. 2008; Goldemberg et al. 2008; Pereira et al. 2019).

Finally, one approach that has gained increased attention as part of an emerging debate around "negative emissions" is bioenergy with carbon capture and storage (BECCS). This process has been applied mostly to solid biomass (e.g., wood pellets). Plant growth takes carbon from the atmosphere (as usual), but then the emissions from its utilization as energy are captured and stored. This process could significantly enhance the possibilities of staying within the 1.5 °C or 2 °C target (Azar et al. 2010). However, there are pending questions regarding the viability of deploying BECCS at scale, as well as its economic and broader environmental impacts (Muratori et al. 2016).

2.3.2 Air Pollution

Aside from its broader impacts on the climate, biofuels utilization can reduce air pollution. At the consumption stage, different studies have shown that 10% ethanol blends (E10) reduce carbon monoxide (CO) emissions by 25–32%, and they also lower emissions of other pollutants such as hydrocarbons (e.g., benzene and 1,3-butadiene, known carcinogens) and particulate matter (Goldemberg et al. 2008; Coelho et al. 2006; Fulton et al. 2004). As ethanol works as an octane enhancer for gasoline, it reduces air pollution by replacing conventional fuel additives such as lead or MTBE, both well known for their toxicity (Fulton et al. 2004, pp. 120–121).

Similar results have been obtained from biodiesel blended and pure uses. The US Environmental Protection Agency (EPA) has found that the higher the percentage of biodiesel blended into the fuel, the higher the reduction in CO, particulate matter, and hydrocarbons emissions. As such, pure biodiesel achieves the best results. It can reduce CO and particulate matter emissions by almost 50% when compared to fossil diesel, in addition to an almost 70% reduction in hydrocarbon emissions (EPA 2002).

However, for air pollution impacts, it is necessary to look at the whole fuel life cycle. For instance, in Brazil's sugarcane cultivation, some harvesting is still done manually after burning the crop to facilitate the process. These fires release large amounts of CO, sulfur oxides (SOx), N_2O, lead (Pb), ozone (O_3) and particulate matter in those sugarcane-producing regions, resulting in severe health impacts and offsetting air pollution reduction benefits obtained through gasoline substitution (Goldemberg et al. 2008; Machado et al. 2008).

2.3.3 Land Use and Biodiversity Conservation

There are three major dimensions where biofuels intersect with biodiversity conservation: (i) increased demand for industrial agriculture, strengthening it as a driver of deforestation and land-use change; (ii) enhancement of environmental impacts from (within) industrial agricultural systems; and (iii) introduction of potentially invasive species as novel feedstocks.

There is a fair degree of consensus that biofuels' demand for land will depend mainly on feedstock choices, agricultural efficiency, and the technologies used (Dornburg et al. 2010). Currently, most biofuel production occurs either by diverting existing crops from other uses ("crop-use change") or through land-use change, i.e., by deploying feedstock cultivation on lands previously under non-agricultural or other agricultural uses. For instance, during the biofuel boom of the 2000s, the area planted with sugarcane in Brazil quickly increased from 5.6 to 8.2 million hectares (Mha) just between 2004 and 2008, with about half of it dedicated to ethanol production (MAPA 2013). That area has since remained more or less stable, at 8.5 Mha in 2019, but this is partly because biofuel manufacturing captures an increasingly larger share of the crop. Only 35% of the 2019/2020 sugarcane harvest in Brazil was used for sugar production (CONAB 2019; see Chap. 5). India, in turn, alone targeted 13.4 Mha for biofuel feedstock cultivation (see Chap. 6). On a world scale, some projections of a business-as-usual scenario estimate as much as 650 Mha—or nearly half of the world's arable land—might be under feedstock cultivation for making biofuels and other bioproducts by 2050 (Murphy et al. 2011; Higson and Aylott 2012).

The risk of increasing pressure on conservation value areas, leading to further loss of biodiversity, has therefore been one of the most debated issues around biofuels (see Fitzherbert et al. 2008; Koh and Wilcove 2008; Fargione et al. 2008). Biofuel production already provides a powerful additional incentive to expand agriculture, which by itself is historically a significant driver of land clearing (Nepstad et al.

2008; Butler and Laurance 2008). Moreover, most areas suitable for feedstock agriculture are near biodiversity hotspots (e.g., the Cerrado in Brazil, Southeast Asia's rainforest), heightening the risks (Koh 2007). Finally, biofuel production expansion occurs largely in the developing world, where infrastructure, monitoring capacity, and funds available for conservation programs are limited. As such, the implementation of ecosystem protection strategies tends to become even more challenging (see Boyd 2008; Bastos Lima 2018). Biofuels might thus be intensifying pressures on particularly sensitive areas that are both valuable and vulnerable.

Given this pressure on biodiversity, there have been many estimations of how much land could be *sustainably* used for biofuels (see Hoogwijk et al. 2003; Cai et al. 2011). For decades this has been an object of debate. Some indicate that an additional 250–800 Mha of rain-fed land are available, most of it in Africa and Latin America (Fischer 2008), while others suggest more than 1100 Mha available, combining pasturelands, idle lands, and grass and shrublands of marginal productivity (Cai et al. 2011). These broad estimates tend to assume a more extensive use of feedstocks that can grow on marginal soils and under water stress, such as jatropha or perennial grasses used for cellulosic ethanol production (see Achten et al. 2008; Tilman et al. 2006). However, the Food and Agriculture Organization of the United Nations (FAO) has warned that yields on such lower-quality lands are also expected to be low. Therefore, it may not be commercially viable in some cases (FAO 2008, p. 67). Besides, many authors have asked for caution when looking at those estimates of land availability that do not consider social and political aspects (Rhodes and Keith 2008; Cotula et al. 2008).

The impacts of biofuel production on land and biodiversity also largely depend on the agricultural system being promoted. It is well known, for instance, that chemical-intensive monocultures degrade the soil and reduce its fertility and biodiversity (Ye and Van Ranst 2009; Tilman et al. 2002). Regardless of its purpose, such conventional industrial agriculture has created serious ecological problems through nitrogen deposition, soil acidification, ecosystem eutrophication, and habitat contamination from toxic chemicals used as pesticides (Altieri 2000; Tilman et al. 2002). Those contaminants are directly detrimental to human health (WHO 1990). Moreover, industrial agriculture has severely eroded agrobiodiversity, which is crucial for maintaining ecosystem services and the very genetic base on which crop breeding depends (Altieri 2000; Tilman et al. 2002; FAO 2004). Biofuels may, therefore, add to those impacts if they are produced under such conventional systems (Bastos Lima 2018). It may also aggravate soil degradation in case crop residues are taken as feedstocks, as this would reduce the availability of organic matter (Muller 2009; Langeveld et al. 2010a). In a comparison among crops, sugarcane tends to perform somewhat better than corn, soybean or rapeseed, partly because sugar-mill and distillery wastes typically are used to help replenish soil nutrients (IEA 2006, p. 393). Also, sugarcane requires less pesticide use than corn or soybean cultivation, and it also causes less soil erosion (Goldemberg et al. 2008). Generally, agricultural practices such as crop rotation, riparian vegetation maintenance, and conservation tillage or no-till agriculture can improve environmental performance. However, these techniques just reduce impacts; they do not eliminate them (Robertson et al. 2008).

Alternatively, biofuels could help ignite a transition to more sustainable, high-biodiversity systems (IAASTD 2009; Bastos Lima 2018). For instance, biomass and other bioeconomy markets can help increase the economic viability of agroforestry or mixed farming systems rich in biodiversity (Groom et al. 2008; Sagar and Kartha 2007). Communities living in or near forests can diversify their activities through feedstock cultivation, obtain additional income, and be better able to maintain their livelihoods without resorting to forest degradation (Cunha et al. 2007). They could also produce (bio)energy locally (Kuik et al. 2011). These strategies may help keep local communities as forest custodians, meeting both conservation and socio-economic needs. Moreover, agroecology research has extensively shown that high-diversity agriculture and mixed farming systems *can* be combined with high yields (see Tilman et al. 2006; Altieri and Toledo 2011; Altieri et al. 2012).

Finally, although most issues seem related to how biofuels may augment or reduce pre-existing impacts from agriculture, they can also raise new concerns about introducing exotic species. For instance, some of the most promising second-generation feedstocks, such as switchgrass or *Miscanthus spp.*, coincidentally have the same typical invasive species traits. They include C4 photosynthesis, long canopy duration, no known pests or diseases, high water-use efficiency, and rapid growth in the spring to outcompete weeds (Raghu et al. 2006). The ecological risks of introducing such new species as feedstocks should not be underestimated. Such an invasive potential is very well illustrated by *Imperata cylindrica* in Southeast Asia, a single grass species that has dominated about 30 Mha of what used to be tropical rainforest (Nepstad et al. 2008).

2.3.4 Water Use

Biofuel expansion requires not just more land but also more freshwater, as the latter is at least used for feedstock processing, if not for irrigation. Water footprints vary enormously. They depend on the crop, its yields in a specific region, as well as the type of cultivation and processing technology used.

In general, most assessments point to large water footprints from biofuel production (De Fraiture et al. 2008; Gerbens-Leenes et al. 2009; Mulder et al. 2010). One estimate suggests that biofuels utilize between 70 and 400 times more water than any other primary energy source, excluding hydropower (Gerbens-Leenes et al. 2009). Others have suggested that biofuels are 10–100 times less water-efficient than fossil fuels (Mulder et al. 2010). Probably, the most critical question is how much biofuel production relies on rainwater or requires additional freshwater withdrawals. For example, De Fraiture et al. (2008) estimated that one liter of US corn-ethanol (mostly rain-fed) uses an average of 400 L of irrigation water. In comparison, the same corn-ethanol in China (where irrigation is more prevalent) needs 2400 L of irrigated water per liter of fuel. As such, biofuel production may work well in rain-fed regions, but it is likely to aggravate present and future water scarcity in water-sensitive regions

Table 2.1 Biofuel share in the world consumption of key agricultural commodities

	2010–2012	2016–2018	2028 (est.)
Coarse grains (%) (corn and other cereals, excluding wheat and rice)	11.9	13.4	12.3
Vegetable oils (%) (e.g., palm, soy, rapeseed)	12.5	12.5	12.6
Sugar (%)	17	21	22

Data sources OECD/FAO (2013, 2019)

or regions that depend on irrigation (De Fraiture et al. 2008; Mulder et al. 2010; Hoekstra 2020).

Biofuel production may also threaten water quality with chemical-input runoffs or wastewater discharges from crop processing. For instance, palm oil mill effluents are known to create water pollution when discharged without treatment (Marti 2008; McCarthy and Zen 2010; Stichnothe and Schuchardt 2011). Similarly, sugarcane mills produce acidic wastewater (*vinasse*) that can be used in small amounts as a fertilizer, often overused, leading to water pollution (Cruz et al. 2008; Goldemberg et al. 2008).

2.4 Socio-Economic Issues and North-South Dimensions

2.4.1 Agricultural Commodity Prices and Food Insecurity

The most controversial socio-economic outcome of biofuel expansion is its feared impact on global food security. The Food and Agriculture Organization of the United Nations (FAO) estimates that about 821 million people are food insecure, i.e., they suffer from chronic hunger or undernourishment, and 98% of those are in developing countries (FAO 2019). Meanwhile, many key commodities—cereals, vegetable oils, and sugar—have been used to make biofuels instead of providing human nutrition. Table 2.1 shows that the share of such agricultural commodities captured by the biofuel industry is substantive. In absolute terms, that use is unequivocally rising. However, as a percentage of food availability and consumption, it has been relatively stable and is expected to remain so for the near future.[3]

However, food insecurity is not usually a problem of food scarcity, but rather lack of economic access to food (Sen 1982; World Bank 1986). Therefore, the main fear has been that heightened demand for liquid biofuels can raise the prices of agricultural commodities that also provide staple foods. Given that many developing countries, particularly in Sub-Saharan Africa, are net food-importers dependent on global food

[3]It should be noted that a much larger share of the world's coarse grains and oilseeds (e.g., soy) is used as animal feed by the livestock industry.

markets, biofuels could worsen food insecurity by making food less affordable to the poor (Runge and Senauer 2007).

Global food prices indeed rose sharply over the past decades, most notably after 2005 up to a peak in 2008 (The Economist 2007; OECD/FAO 2013). As this happened alongside an increase in biofuel demand, the "food vs. fuel" debate gained momentum. The contention was perhaps best captured by the declaration of Jean Ziegler, then UN Special Rapporteur on the Right to Food, calling biofuels "a crime against humanity" (Ferrett 2007). In 2008, a leaked World Bank report suggested that biofuels were responsible for as much as 75% of all the increase in global food prices (see Mitchell 2008). Later many analysts attempted to assess the role of biofuels in affecting food prices, and most of their findings suggest that, although biofuel demand plays an important role, it has taken a disproportionate share of the blame (Baffes and Haniotis 2010; Banse et al. 2008; FAO 2008; Ajanovic 2011; Persson 2015; Tomei and Helliwell 2016).

It has become clear that many other factors were significant, such as short-term weather-related shortfalls in production and the sharp rise in international oil prices during the 2008 food-price crisis (Baffes and Haniotis 2010; Shrestha et al. 2019). Moreover, financial speculation on agricultural commodities can substantially contribute to food price volatility (Clapp 2009). As some have put it, the "food vs. fuel" frame may provide an "emotive and powerful message" to critique biofuels on ethical grounds and in an appealing way. However, it masks the multitude of uses that agricultural commodities have had. Their prices have long experienced interlinkages with other variables such as land availability and chemical-input costs (Tomei and Helliwell 2016).

After the significant volatility seen between 2007 and 2014, agricultural commodity prices stabilized (OECD/FAO 2019). The trumpets may have been too quick to declare "the end of cheap food," given that production continues to significantly expand—even if, problematically, often at the cost of natural ecosystems of high conservation value. Food prices were, in fact, on a gradual downward trend by the time the COVID-19 pandemic brought the global economy to a standstill in 2020 and again shook agricultural commodity markets (UNCTAD 2020).

The discussion on prices and food insecurity may, however, need more nuance. For instance, it must be asked why some developing countries have become so dependent on food imports and vulnerable to international food price volatility (Clapp 2009). Besides, higher agricultural commodity prices are a double-edged sword; it is legitimately a concern, but it may benefit countries and sectors of the economy involved in agriculture. More directly, higher prices could potentially help rural populations, which make up three-quarters of the world's poor (World Bank 2008). If done in socially inclusive ways, biofuel production and other forms of bioeconomy promotion may help tackle rural poverty by creating income for smallholders, increasing their purchasing power, and improving local food security (Von Braun and Pachauri 2006; Börner et al. 2017; Bastos Lima 2018). If the bioeconomy indeed is inevitable in a world without fossil fuels (and without a climate breakdown), these questions on reconciling it with food security promotion are paramount.

2.4.2 Rural Development and Biofuel Value Chains in a North-South Context

The promotion of rural development has been a powerful argument for biofuel expansion—anticipating its use as a rationale for the broader bioeconomy (see European Commission 2018). Feedstock cultivation can boost the agricultural sector, create jobs for rural workers, improve smallholder incomes, and spur economic development while meeting renewable energy and other demands (Von Braun and Pachauri 2006; Mathews 2007; Goldemberg et al. 2008; Altenburg et al. 2009; Elbehri et al. 2013; Börner et al. 2017). Moreover, biofuel and other bio-based value chains can foster scientific and technological development, as they usually require substantial R&D (Van Dam et al. 2005; Langeveld et al. 2010b).

Such a bioeconomy development is of particular relevance to developing countries for two main reasons. First, there is an understanding that such countries are better endowed to produce feedstocks due to biophysical and economic comparative advantages (Mathews 2007; Sawyer 2008). Tropical areas have soils and climates that favor biomass growth year-round (Mathews 2007). They also have the crops that—with current technologies and on a large commercial scale—still obtain the highest ethanol and biodiesel yields per hectare (sugarcane and oil palm, respectively) (Goldemberg et al. 2008; Koh 2007). Next-generation technologies such as gasification and cellulosic ethanol can suit different feedstocks (i.e., they are not dependent on a specific crop), so they, too, may gain from the higher biomass productivity of the tropics (Sagar and Kartha 2007). The potential is even more considerable for other bio-based industries, as tropical countries are richer in biodiversity. Finally, those countries tend to have cheaper land and labor available, reducing production costs, and making business more attractive (Mathews 2007).[4]

Second, the developing world has more benefits to reap from biofuel production (Vasconcellos and Vidal 2004; Mathews 2007). Those countries have large rural populations in need of development opportunities to provide them with better access to income, basic resources, and services (Kuik et al. 2011). Also, developing countries have a North-South gap to bridge—in line with Sustainable Development Goal 10, aiming to reduce inequalities within and among countries. Much of the global income inequality owes to the skewed distribution of roles in commodity chains, which tend to concentrate value-added activities in developed countries and leave most low-value, natural-resource intensive stages to developing countries (Arrighi and Drangel 1986; Wallerstein 2009; Brewer 2011). Biofuel production may thus contribute to greater equity by promoting local or domestic value-added, which is key to economic development (UN-Energy 2007; UNIDO 2011; Stamm and Von Drachenfels 2011; Elbehri et al. 2013). As a country moves up on the value chain, knowledge and technological innovations also become more critical (Lall 2003). Therefore, biofuels

[4]Algae are an option that could dismiss many of these factors that give developing countries an advantage. Its commercial production on a larger scale would likely have a number of different requirements, but abundant sunlight throughout the year would be certainly an asset, and this is again to the advantage of tropical regions.

and other bioproducts can play another vital role because endogenous innovations are generally better able to ignite sustainability transitions than technology transfers (Berkhout et al. 2011). Endogenous innovations are frequently cheaper (Doranova et al. 2010) and are usually more connected to the local economy, local knowledge production, and more socially appropriate (Franco et al. 2011; Fu and Gong 2011). Consequently, rather than being static technology in the form of equipment or machines, those innovations generally lead to an increase in actual technological capability that spills over to local industries and continues to evolve (Franco et al. 2011).

Nevertheless, it must be noted that most social and ecological impacts of biofuels or other bioeconomy production happen at local and regional levels—particularly from feedstock cultivation. While climate change mitigation brings global benefits, and the reduction in pollutant emissions (at the combustion stage) from fossil fuel substitution is to the benefit of consumer regions, eventual socio-environmental costs such as natural resource depletion or ecosystem contamination from chemical-intensive agriculture are all borne locally. Ecosystem conservation might be of value to all, but their loss burdens local dependent populations more than others (Bryant and Bailey 1997; Peet and Watts 2004). Furthermore, if traditional farming systems are disrupted, or if rural peoples are evicted from their lands and sent forth to swelling city slums, or if food security is negatively affected, the price is to be paid mostly by more impoverished populations in the developing world. Therefore, biofuels offer a sharp double-edged sword to the Global South.

The mixed evidence in the literature thus far suggests that a critical question is *how* rural people have been incorporated or not in biofuel production systems, and the quality of that inclusion (Bastos Lima 2012; Clancy 2013). This observation means looking beyond the number of jobs created and examining what livelihoods or traditional economic activities may have been replaced. There are cases where employment in industrial feedstock plantations or smallholder farmers' integration in biofuel production chains has created perceived welfare improvements to local populations (Rist et al. 2010; Zapata et al. 2010; German et al. 2011). However, many large-scale land investments—driven partly by biofuels—in the developing world have frequently displaced customary landowners and traditional populations (what has been sometimes referred to as "land grabbing") (Cotula et al. 2011; Fairhead et al. 2012; Borras and Franco 2012). Also, there are cases where health-degrading work on plantations or problematic incorporation of smallholders leads to significant livelihood losses and local food insecurity, which worsens rural poverty (Ariza-Montobbio and Lele 2010; Schoneveld et al. 2011). From a global North-South perspective, the main risk is that biofuel production strategies may fail to reap sustainable development opportunities and become established in a way that provides renewable fuel to Northern consumers at the cost of further socio-environmental damage in the South—what has led some critics to call biofuel production a neocolonial strategy (Smith 2010). All these stakes become higher as a broader bioeconomy is promoted.

Based on such risks and opportunities appraised in the biofuels case, it is possible to develop a typology of bioeconomy development based on its socio-environmental performance and economic features that may help developing countries catch up with

Table 2.2 A typology of bioeconomy development from a North-South perspective

	Little to no value-added, insignificant technological development in the South; most economic benefits accrued to developed countries	Value-added, scientific and technological development, and significant economic benefits in developing countries
Positive socio-environmental performance	*Sound maintenance of the international status quo* Environmentally sound bioeconomy, but the North-South gap remains—opportunity costs to developing countries.	*Sustainable (and equalizing) development* Both absolute sustainable development benefits *and* relative gains to developing countries, sustainably closing the N-S gap
Negative socio-environmental performance	*Neocolonialism* Exploitation of developing countries through unsustainable biofuel production which benefits the North, thus widening international inequalities	*Unsustainable development* Economic development and reduction of the N-S gap, but at the cost of domestic social inequity and environmental degradation, which may hit back in the long run

developed ones. Development that contributes to bridging the North-South gap thus is here referred to as *equalizing development*. This term is useful because biofuel production may be sustainable at the local to the national level but preserve international discrepancies by accruing as many—or more—benefits to developed countries in the process. In other words, bioeconomy value chains may provide some absolute gains to developing countries but still fail to deliver any relative ones. In that case, they would fall short of their potential to address inequalities among countries and help close the North-South gap. Alternatively, equalizing development may occur at the cost of domestic inequities or environmental degradation and, therefore, be unsustainable (see Table 2.2).

2.5 Conclusions

This chapter has shown that the sustainability of biofuels, as the prime early example of bioeconomy development, is far from straightforward. The ecological, socio-economic, and eventually political impacts of biofuels depend invariably on *how* they are produced, and therefore governance has a crucial role to play. It involves deciding not only on the crops and processing technologies but also on the setup of production systems and bioeconomy value chains.

Unlike environmental governance areas focused primarily on conserving particular resources, the bioeconomy is mostly about *sustainable production.* In a way, the imminent—and perhaps inevitable—transition from a fossil-based economy to a bio-based one creates an opportunity for transformation (not only of technologies but crucially also of the socio-economic structures that keep inequalities in place). This chance, however, carries significant risks. While most of the biofuels debate has focused on climate and food security impacts, this chapter has shown that sustainability concerns also include a range of other issues, from freshwater use to North-South equity (see Table 2.3). Understanding the multi-faceted nature of bioeconomy sustainability is critical, as biofuels promotion continues at pace and other novel bioproducts increasingly join them. It is the task of governance to tease out *how* to mitigate the risks while harvesting the benefits, for avoiding a transition is not likely an option.

Table 2.3 Key sustainable development dimensions of biofuels expansion in the context of the bioeconomy

	Potentials	Risks
Atmosphere	• GHG emissions reduction through fossil fuel substitution • Air pollution reduction through cleaner fuel combustion in transport	• Increase in GHG emissions due to land-use change for feedstock cultivation; high use of fossil energy in biofuel life cycles; or emissions of other GHGs (e.g., methane) • Increase in air pollution from emissions during feedstock production (e.g., crop burning)
Land and biodiversity	• A stimulus to agroforestry or mixed farming that can reduce conversion pressure over natural areas	• Increased conversion of forests, savannas, or other natural ecosystems to agriculture • Expansion of industrial monocultures, aggravating agrobiodiversity loss • Introduction of potentially invasive species as novel feedstocks
Freshwater	–	• Increasing water demand for irrigation and feedstock processing • Pollution from agricultural inputs or wastes
Socio-economic development	• Job and income creation in rural areas, developing local economies, infrastructure, and access to services • New downstream industries linked to agriculture and endogenous technological innovations	• Undue displacement of local populations for the expansion of feedstock cultivation (“land grabbing”) • Erosion of traditional livelihoods, replaced by menial jobs in industry- or government-owned plantations, possibly under unsafe labor conditions
Food security	• Additional income for the rural poor, improving their access to food	• Increase in agricultural commodity prices, reducing access to food by net-consumers (e.g., the urban poor, import-dependent countries)
North-South equity	• Development of bio-based industries in the Global South using its comparative advantages	• Greater vulnerability of developing countries to adverse ecological and socio-economic impacts of unfettered bioeconomy expansion

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Chapter 3
Governance: Solving or Reproducing Inequalities

Abstract Socio-economic and political inequalities in the world are not fortuitous. They usually are the product of inequity, i.e., structural causes that unevenly attribute roles, distribute benefits and burdens, and create skewed conditions of access to resources. Understanding the workings of governance—how institutions operate, how actors can exert power, and how allocation patterns take shape—behind the reproduction of inequalities is key to solving them. This task is particularly imperative in sustainable development governance (or any specific sector therein, such as the bioeconomy), where the promotion of social equity is a principled part of it. Drawing from institutions theory and studies on power and distributive justice, this chapter develops a conceptual framework to analyze how (in)equity gains shape. It advances the idea that short and long feedback loops link various elements of governance. Agent power configurations are related to the institutional milieu, as are the distributive outcomes of governance and agents' material capabilities that, in turn, help them shape institutions in their favor. The chapter unpacks each of these governance elements to show why inequality is so hard to address, while also offering a lens to analyze and eventually tackle its "lock-in" nature.

Keywords Equity · Institutions · Power · Agency · Access and allocation · Governance architectures

3.1 The Inequity of Inequality

As income and wealth inequalities rise to their highest levels in decades in OECD countries—while persisting in much of the developing world—fairness debates have become increasingly common in the social sciences and beyond. As an illustration, Oxfam has noted that the combined wealth of the world's 22 richest men is larger than that of all the women in Africa (Coffey et al. 2020). Relative easiness to measure makes income a common focus of attention, but inequalities are multi-dimensional. There are social inequalities related to differences and imbalances across genders, races or classes, cultural inequalities between social groups, and political inequalities in terms of capacity to influence social norms and decision-making processes. There are also other dimensions of economic inequality, besides those of wealth and income,

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related to direct access to material resources such as land and water (Rueschemeyer 2004; Earth System Governance Project 2018).

However, inequality should not be mistaken with diversity, which refers to plurality. Inequality, instead, suggests the (due or undue) predominance of some in the face of others, a skewed distribution of advantages and disadvantages (Faist 2010). Such inequalities arise out of unfair procedures in society and biased governance—or, in other words, inequality broadly results from inequity (Charlton 1997). Equity and equality are at times used interchangeably, but they are not identical in meaning. While (in)equality refers to a status, a situation, (in)equity refers to the structural processes through which things happen. These processes include political as well as economic and social mechanisms.

When are such differences justified, if ever? Without venturing too far into what can otherwise be a prolonged and possibly inconclusive philosophical debate, it is useful to resort to Rawls' (1971) principles of difference and redress. The "difference principle" contends that uneven treatment is acceptable only when it is to benefit the least advantaged in society, while the "principle of redress" posits that undeserved inequalities call for redress, that is, for efforts to correct them (Rawls 1971, 2001). Core to both principles is an understanding of society's responsibility to acknowledge its often unjust structures and improve them. Thus, equality can be improved through equity. Generally, inequality is not addressed in discrete episodes of reallocation, but rather through solutions "built into the system". Such solutions can first eliminate structural features that sustain and augment inequalities, and then build in structures that create unequal outcomes that benefit the least fortunate (as in various "pro-poor" policies, when they are so more than just in name).

None is more key to equity than sustainable development governance, because it has a double effect on social affairs. On the one hand, as reminded in Chapter 1, sustainability includes a social pillar that requires it to address poverty and environmental inequalities, such as in access to resources or vulnerability to impacts. On the other hand, purported solutions to environmental problems often carry social consequences not to be overlooked, for they otherwise can lead to cures that may be worse than the disease. The bioeconomy is a recent case in point, as its very *raison d' être* involves the duty to address socio-environmental issues. At the same time, it can easily become a driver of further inequality and exclusion if equity is not at its core (Bastos Lima 2018).

Therefore, it is crucial to understand how governance takes place, its workings, and eventually how to best adjust it to meet ecological, economic, and social needs (Biermann 2007; UNEP 2012). This imperative has become even more pressing—if more complex—in an increasingly politically, economically and socially interconnected world, when the impacts of human activities often reach a planetary scale. The COVID-19 pandemic has offered an acute and somber realization of that, but processes of environmental change, as well as policies adopted to address them, routinely have long-distance impacts that remain overlooked (Meyfroidt et al. 2018; Bastos Lima et al. 2019). Some have argued that we have entered a new geological epoch defined by the magnitude of anthropogenic environmental impacts: the Anthropocene (Crutzen and Stoermer 2000; Zalasiewicz et al. 2010; Dryzek and

Pickering 2019). There is growing recognition of the need to align governance to global sustainability challenges to prevent, address, and adapt to those (socio-) environmental changes (UNEP 2012; Kim and Bosselmann 2013; Dryzek and Pickering 2019). However, for these institutional responses to be socially beneficial, there is a need to understand how governance determines equity in various instances and how to improve it.

This chapter dissects key dimensions of governance to have a conceptual framework to analyze developments around the bioeconomy. It first addresses institutions as an analytical problem, then discusses how social equity may be effectively analyzed, and finally elaborates on the concepts of agency and power, critical to understanding how issues of social sustainability are dealt with in governance. The chapter concludes with an integrated framework for analyzing these elements in the bioeconomy or other areas.

3.2 Understanding Governance and Institutions

3.2.1 Defining Institutions, Regimes, and Governance Architectures

The concept of institutions is central to examining societal challenges and human-environment relations. Simply put, institutions are artifacts created to steer social practices (Young et al. 1999/2005). Their exact definition has varied across disciplines (e.g., North 1990; Mearsheimer 1994/1995; Ostrom 2005), but those different definitions often share a common core (Underdal 2008). Young et al. (2008, p. xxii) define institutions as "cluster[s] of rights, rules, and decision-making procedures that give rise to social practices, assigns roles to the participants in the practices, and guides interactions among occupants of these roles." Institutions thus are not to be mistaken with organizations, which are material entities, usually with offices, personnel, budget, etc. (Young 1989; North 1990; Young 2008a). Organizations are players, while institutions are the rules of the game (Young 2008a, p. 13). However, institutions can include organizations.

Institutions may operate alone or within a broader framework, such as a regime. While also offering useful definitions of key types of institutions, Krasner (1982, p. 186) described regimes as,

> [S]ets of implicit or explicit principles, norms, rules, and decision-making procedures around which actors' expectations converge in a given area of international relations. Principles are beliefs of fact, causation and rectitude. Norms are standards of behaviour defined in terms of rights and obligations. Rules are specific prescriptions or proscriptions for action. Decision-making procedures are prevailing practices for making and implementing collective choice.

Regimes, therefore, refer to structured sets of institutions that establish some consensus on substantive elements (e.g., principles, rights, obligations, and rules) and procedural aspects (e.g., procedures for decision-making, enforcement, and dispute settlement) (Dimitrov et al. 2007). At the international level, regimes are generally assumed to lead to a process of learning conducive to convergent policies (Haas 1989, p. 377). They are expected to promote rule-consistent behavior from governments and non-state actors (Rittberger 1993, p. 11).

Several competing or synergistic regimes may co-exist in the same issue-area (e.g., biodiversity, climate change), possibly based on different norms and involving different actors (Biermann et al. 2009a). This observation has drawn research to a broader level of analysis, that of governance architectures (Biermann et al. 2009b). Architecture refers to the whole interlocking web of institutions at all levels in a given issue-area, possibly comprising several regimes (Biermann et al. 2009b, p. 31). Alternatively, there may be issue-areas where no regime has been formed (Dimitrov et al. 2007). Furthermore, there may be instances of "non-governance", where no institutions have been agreed upon and concerted behavior does not exist (Bastos Lima and Gupta 2013).

In order to identify such instances, however, it may be necessary first to define governance. Although it has no single, consensual definition, governance generally implies managing collective affairs beyond only governments only and including non-state actors.[1] The Commission on Global Governance (1995, p. 2) stated that

> Governance is the sum of the many ways individuals and institutions, public and private, manage their common affairs. It is a continuing process through which conflicting or diverse interests may be accommodated and cooperative action may be taken.

Thus, unlike regimes, governance does not necessarily require consensus—it can have room for many social actors making competing rules. Still, it can be argued that governance refers to a qualified type of institutional framework, not just any institutional landscape. Rosenau (1992, p. 4) has argued that both government and governance

> [R]efer to purposive behaviour, to goal-oriented activities, and to systems of rule, but government suggests activities that are backed by formal authority whereas governance refers to activities backed by shared goals that may or may not derive from formally prescribed responsibilities and do not require police powers to ensure compliance.

That argumentation is in line with the definition of earth system governance, described as

> [T]he interrelated and increasingly integrated system of formal and informal rules, rule-making systems, and actor-networks at all levels of human society (from local to global) that are set up *to steer societies towards preventing, mitigating, and adapting to global and local environmental change* and, in particular, earth system transformation, within the normative context of sustainable development. (Biermann et al. 2009b, p. 4, emphasis added)

[1] See Biermann and Pattberg (2008) for a review of the concept and a variety of meanings.

As such, governance can be understood as settings where there is steering towards a shared purpose and some degree of collective issue-management and accommodation of different interests. Hence, it is possible to analytically distinguish governance from instances of non-governance, and the latter from non-regime cases. Non-governance will always imply no regimes, but the absence of a regime does not necessarily mean there is no governance.

3.2.2 Analyzing Institutions and Human-Environment Relations

As human constructs put in place to steer behavior, institutions can play significant roles in determining the outcomes of social practices and human-environment interactions (Young et al. 1999/2005). For instance, the typical example of the "tragedy of the commons" depicts a situation where the complete absence of rights and rules can lead to self-interested overexploitation and depletion of common-pool resources (Hardin 1968). Therefore, much research has attempted to understand how social practices are modified, fostered, restrained, or regulated by institutions (Schelling 1978; Young 2008a). Unlike other environmental change drivers, institutions are human artifacts that can be objects of conscious building, reform, and replacement (Young et al. 1999/2005, p. 147). Moreover, research on institutions also allows assessing response strategies and learning how these strategies can become more effective (Young et al. 1999/2005; Young 2008a).

There are frequently three research foci in analyzing institutions and environmental change: *causality*, *performance,* and *design* (Young 2008a).

3.2.2.1 Causality

Causality is concerned with whether, to what extent, and how institutions matter in a given context of human-environment relations (Young et al. 1999/2005). However, to influence environmental change processes, institutions must first operate on human activity (Mitchell 2008). Thus, it is possible to distinguish at least three steps in this causation chain: *outputs*, *outcomes*, and *impacts* (Underdal 2008). Outputs are the closest steps to institutions in the causal chain; they refer to formal signs of compliance, such as domestic laws following an international agreement or a change of regulations in a public bank due to a national policy. Outcomes refer to perceived changes in the human activity in question (e.g., industrial fishing). Finally, impacts refer to ultimate changes in environmental quality (e.g., fish stocks) (Underdal 2008).

According to Mitchell (2008), the most appropriate level to analyze institutions' effect is human activity (outcomes). First, this is because formal follow-up (outputs) does not necessarily ensure actual shifts in social practices that lead to environmental change. Second, it is often hard to draw a valid causal link between institutions and environmental quality changes, which may owe to many biophysical or other causes not related to human activity. Third, the only way institutions can affect the environment is by influencing human behavior (Mitchell 2008).

This observation raises two research questions: (a) *what* can be attributed to institutions (or to one particular institution) in processes that cause or address environmental issues (Young et al. 1999/2005, p. 37); and (b) *how* that occurs, i.e., the mechanisms or pathways through which institutions make a difference (Underdal 2008). Later in this book, we will look at the norms, rules, and decision-making mechanisms that have been in place for biofuel governance as a likely prelude for broader bioeconomy governance. Specific case study chapters will examine what policy instruments have been created and how such institutional settings have influenced biofuel production in different countries.

3.2.2.2 Performance

While *causality* assesses whether an institution makes a difference, *performance* assesses whether it achieves particular objectives (Mitchell 2008). That implies analyzing an institution and its effects against certain standards or specific criteria (e.g., transparency, equity, sustainability). As such, there is a clear normative dimension in *performance* that is not present in the analysis of *causality* (Young 2008a).

If the first question is "how does the institution perform?" concerning specific standards, then the second is what factors strengthen or hinder institutional effectiveness in meeting those expected standards. It means examining both endogenous (the design features of institutions) as well as exogenous (contextual) elements that affect institutional performance (Young et al. 1999/2005). This examination is essential for attempts to improve institutional performance in the subsequent step of *design.*

3.2.2.3 Design

Once institutional causality has been demonstrated and its performance assessed, a third question is how it can be improved (Young et al. 1999/2005). In reality, design is often a *re*designing exercise, based on how the institution(s) under analysis can be changed. There is no general recipe that can be applied indiscriminately through different contexts; instead, redesigning depends on a case-by-case diagnosis to evaluate each specific institution concerning its features and context. Only after such a diagnosis can it become clear what changes and designs could improve performance (Young 2008b).

3.3 Analyzing Distributive Outcomes and Social Impacts

3.3.1 Allocation and Access as Proxies for Social Equity

Distributive policy and governance issues are treated under different denominations, such as equity, fairness, or social justice (Biermann et al. 2009b, p. 59). They generally include two objects of analysis: allocation and access. Allocation refers to distributing material and immaterial benefits and burdens, such as natural resources, rights, or responsibilities (Biermann et al. 2009b). Allocation is, therefore, essentially a relative concept to compare the treatment dispensed to different actors. Access, in turn, captures the absolute dimensions of social equity, such as access to resources to allow "meeting the basic needs of humans to live a life of dignity" (Biermann et al. 2009b, p. 60; see also Chowdhury et al. 1992). However, this can also be analyzed in relative terms by contrasting different actors' levels of access. Moreover, access can include other important material resources such as technology and finance, as well as access to social processes such as systems of justice or policy- and decision-making (Gupta and Lebel 2010). As some development agencies argue, the most chronic form of poverty is often the "poverty of power" (UN ESCAP et al. 2007, p. 29), which relates precisely to these immaterial forms of access.

From an analytical perspective, allocation patterns represent institutional *outcomes*, i.e., effects on human activities. In contrast, the influence of these activities on the ultimate conditions of access represents social *impacts*. As such, allocation is not treated here as an afterward deed after basic needs have been met, as a matter of "what to do with the rest" (see Gupta and Lebel 2010). Instead, allocation is considered a means through which access is maintained, reduced, or improved. Three core dimensions would, therefore, be critical in an analysis of allocation and access in the bioeconomy:

- The distributive outcomes and social impacts of bioeconomy governance and production processes;
- The pathways and mechanisms through which *allocation* takes place, improving or restraining *access*;
- Possibilities for reallocation, i.e., ways to redress perceived injustices and improve access conditions through institutional redesign (see Biermann et al. 2009b, p. 61).

3.3.2 Insights from Agrarian Political Economy

Much of the environmental governance literature has traditionally focused on common-pool resources (e.g., water, forests, ecospace; see Gupta and Lebel 2010). The domains more closely related to the bioeconomy are a little different. Although some view it as something potentially more holistic (Bugge et al. 2016), the bioeconomy arguably is primarily about *produced* resources. In such cases—as with energy or agri-food governance—equity concerns go far beyond the establishment of access rules or allocating responsibilities for resource maintenance.

In production sectors, a purely transactional view of allocation and of "who gets what" would be too narrow and arguably insufficient to analyze the structural causes of poverty and inequality. Allocation may also be about "who owns what", i.e., the allocation of property and control rights, and of "who does what" in organizational settings or production chains, as functions or roles might be allocated in ways that benefit certain actors more than others (Bernstein 2010; UNRISD 2010; Helmsing and Vellema 2011). These discussions are present, for instance, in energy studies in assessments of how the transformation of consumers into renewable energy producers—"prosumers"—changes power relations and equity (see Gailing 2016). Questions on how production processes are organized have long been present in agrarian political economy concerning agricultural production. They arguably become all the more relevant in its restructuring now to accommodate for an emerging bioeconomy.

Bernstein (2010), condensing this perspective, proposes four leading questions to understand social equity in a given setup, which can be translated into analytical problems using the language of allocation.

- *Who owns what?* (Allocation of rights, encompassing not only ownership but also usufruct rights derived from leasing and other forms of control)
- *Who does what?* (Allocation of roles, particularly in terms of positions in bio-based production chains and participation—or not—in policy- and decision-making)
- *Who gets what*? (Allocation of benefits and burdens, both directly from the policies and from biofuel production systems)
- *What do they do with it?* (Not related to a specific form of allocation, but it can shed light on some of the broader societal and political implications of resource ownership and control patterns)

Analyzing equity in bioeconomy governance presents an additional challenge because it affects not only one but several resources. Analyses on access or allocation usually are centered on a single or primary resource (Gupta and Lebel 2010). However, even to consider the impacts of biofuel production (an energy resource), one must examine how it affects not just energy itself but also other vital resources such as land, water, and food. Both land and water have other uses with which biofuel production competes. Meanwhile, access to food can be positively or negatively impacted due to crop substitution, diversion from food to fuel, rising prices, or by providing farmers with additional incomes that help improve their purchasing power. Such a multiplicity of foci is an inherent challenge to adequately examine equity in the bioeconomy or other produced resources' governance.

3.4 Agency as the Strategic Use of Power

3.4.1 Agency and Institutional Entrepreneurship

Agency somehow populates the governance milieu. Institutional architectures always operate in relationship with actors' behavior (Giddens 1984; Wendt 1992; Archer 2003; Biermann et al. 2009b). This relationship, known in the social sciences as the "agent-structure debate", makes agency and architecture two co-evolving sides of the same coin (Biermann et al. 2009b; Earth System Governance Project 2018). On the one hand, agency is embedded and shaped by existing conceptions, institutions, and other ideational structures. On the other hand, these structures, being human artifacts, only exist because they were created, i.e., because of agency (Wendt 1992; Seo and Creed 2002).

There are multiple definitions of agency. Giddens (1984, p. 14) defined it as "the ability to take action and make a difference over a course of events". In the context of earth system governance, Biermann et al. (2009b, p. 38) relate agency to authority and describe agents as authoritative actors, i.e., as those in a position to prescribe behavior. Alternatively, other theories may deal with agency issues using different concepts, such as institutional entrepreneurship or advocacy coalitions (Sabatier 1988; Weible et al. 2011). This book uses a broad definition of agency, more along the lines of Giddens, not to miss any action that might be relevant to governance.

Institutional entrepreneurship, in particular, offers useful insights to policy domains where different visions coalesce—as in the bioeconomy (Bugge et al. 2016; Scordato et al. 2017). DiMaggio (1988) originally defined institutional entrepreneurship as the strategic action of organized actors with sufficient resources creating new institutions in order to realize their interests. Later works have also recognized the dominant role of organized actors engaged in maintaining existing institutions (Fligstein 2001; Zilber 2007), changing them (Kingdon 1995; Meijerink and Huitema 2010), or utterly destroying them (Maguire and Hardy 2009). The underlying observation is that policy and governance frequently become stabilized and dominated by a paradigm or institutional framework that reflects and reproduces specific ideas, norms, and conceptions (Cox 1987; Baumgartner and Jones 1991; Levy and Scully 2007; Meijerink and Huitema 2010). As such, some actors may work to preserve an existing setting while others attempt to change it. As Levy and Egan (2003, p. 806) put it, dominant structures are maintained "through an alignment of material, organizational and discursive formations which stabilize and reproduce relations of production and meaning" (see also Cox 1987; and Gill 1991). Therefore, actors wishing to change such structures may have to work on all those three dimensions simultaneously (Levy and Newell 2002).

This understanding of actors as operating in a dialectical relationship with institutions does not match well with simplistic rational-actor models that assume generalized self-interest as a driver of action (Mutch 2007; Weik 2011). Instead, institutional entrepreneurship has, from the start, attempted to go beyond it (see DiMaggio 1988). Although the study of motivations has remained underexplored in the institutional entrepreneurship literature (Weik 2011), it is useful in this respect to refer to Sabatier's (1988) concept of *policy beliefs*. He has argued that conflicts in policy-making and governance do not owe simply to opposing self-interests, but rather to differences in perceptions, ideas, and visions of how to go about certain issues (Sabatier 1988). This understanding does not rule out self-interest as a potential motivation. However, it acknowledges that its role, when present, is played not apart from but enmeshed in a subjective patchwork of conceptions, preferences, and views that, together, will compose certain policy-related beliefs rather than others.

Institutional entrepreneurs thus come to the fore as skilled individuals or collective actors targeting policies, norms, or concepts that surround them (Leca et al. 2008; Garud et al. 2007; Battilana 2006). They may engage in *norm entrepreneurship*, trying to create new or to shift existing norms and social understandings, possibly to their benefit (Finnemore and Sikkink 2001). Such norms can have determinant effects on governance as they shape how decision-making takes place, order priorities, and select among possible pathways (Barnett and Finnemore 1999; Conca 2006; Bastos Lima and Persson 2020). However, entrepreneurs may also target more tangible elements seeking a *policy change*. Usually, this means a major (or radical, or paradigmatic) policy change, which goes beyond incremental modifications (Sabatier and Weible 2007; Meijerink and Huitema 2010).

Finally, there is the question of the means and strategies used to create, replace, modify, or eliminate institutions. As reviewed by Weik (2011), it is well established in the literature that institutional entrepreneurs: (i) mobilize material resources (Battilana 2006; Garud et al. 2007; Levy and Scully 2007); (ii) mobilize other actors (Fligstein 2001; Garud et al. 2007; Leca et al. 2008); and (iii) create meaning (Garud et al. 2007; Rao and Giorgi 2006; Zilber 2007). These strategies are very much interrelated, as entrepreneurs may mobilize other actors to expand their material capabilities. The mobilization of other actors may, in turn, depend on creating meaning for them, i.e., on framing issues and marketing solutions in a compelling way (Leca et al. 2008). The specifics will vary in each case (see Huitema et al. 2011). What is clear is that, first, institutional entrepreneurs seldom succeed alone; they typically find allies and build coalitions (Fligstein 2001; Leca et al. 2008; see also Sabatier 1988). Second, change needs a direction, and alternatives are more likely to become credible and win support after being tested. In other words, it is essential to conceive consistent alternatives and demonstrate their performance (for instance, through pilot projects) (Huitema et al. 2011). Third, it is useful to detect and exploit windows of opportunity when institutional change may be (more) feasible (Kingdon 1995; Meijerink and Huitema 2010). Fourth, it is useful to "shop" for—and eventually manipulate—fora and decision-making venues to bypass resistance and have the best circumstances to advance one's claims, framings, and views (Huitema et al. 2011).

Thus, if the success of agency can be measured as the extent to which one's views, preferences and policy-related beliefs are represented, institutionalized, influence decision-making, and eventually affect the course of development, then agency can be broadly understood as the strategic use of *power* in governance. The following section explores this concept in further detail.

3.4.2 The Three Faces of Power

Power is a core concept in politics. There is *power to* and *power over* (Biermann et al. 2009b, p. 67). The former relates both to material capabilities and issues of access, i.e., power as the capacity to meet needs and fulfill wants, without necessarily affecting the behavior of others. This conceptualization of power goes back to Hobbes' *Leviathan* and has been widely referred to in the literature (Dowding 1996; Flyvbjerg 1998; Biermann et al. 2009b), including on the need to "empower" the poor (UNRISD 2010).[2] This understanding, however, becomes more complex once considered in light of its different dimensions, such as those generally applied to *power over*.

Power over refers to power relations among actors, and it can be understood as being expressed in three different forms—sometimes called the "three faces" of power (Lukes 1974/2005). Dahl (1957, p. 203) gave power a straightforward definition, suggesting that "A has power over B to the extent that he can get B to do something that B wouldn't otherwise do." This type of direct action of one actor over another has been referred to as the first face of power (Bachrach and Baratz 1962; Lukes 1974/2005) or as instrumental power (Clapp and Fuchs 2009).

However, Bachrach and Baratz (1962, p. 948) contended:

> Of course power is exercised when A participates in the making of decisions that affect B. But power is also exercised when A devotes his energies to creating or reinforcing social and political values and institutional practices that limit the scope of the political process to public consideration of only those issues which are comparatively innocuous to A. To the extent that A succeeds in doing this, B is prevented, for all practical purposes, from bringing to the fore any issues that might in their resolution be seriously detrimental to A's set of preferences.

This second dimension of power affects the institutional milieu and not directly another actor. It includes agenda-setting efforts to limit the range of issues, views, perspectives and choices considered, or whose visions count (Bachrach and Baratz 1962). For instance, this is responsible for the exclusion of certain actors from decision-making processes, for "non-decisions" on certain issues, for overlooking individual claims while overemphasizing others, and thus also for "decision-less decisions". Overall, this form of power aims at shaping the structure of governance to lean it towards certain outcomes, approaches, and courses of action while overlooking or downplaying alternatives (Bachrach and Baratz 1962; Barnett and Finnemore 1999; Conca 2006). This exercise has been described as structural power, for power becomes institutionalized and engraved in settings and designs that can, in turn, reinforce one's capabilities while limiting the range of action of other actors (Clemens and Cook 1999; Clapp and Fuchs 2009).

Finally, there is a subtler, third dimension of power that needs to be considered. All the above recognize that less powerful actors may be limited in their actions,

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[2] In this regard, some authors also speak of "power from within" (Rowlands 1997, p. 111) as an earlier step, in reference to developing a sense of one's own value and of confidence in the possibility of change — a dimension often found weak in disadvantaged populations, particularly those in developing countries which experienced colonization (see also Freire 1970; McEwan and Bek 2006).

but not that others may have purposefully shaped their very views and wants. Lukes (1974/2005), therefore, has called attention to this "third face of power", a more insidious mechanism, a usually hidden form of power exercised through the purposeful manipulation of other actors' interests and wants in order to obtain their consent. As he puts it,

> A may exercise power over B by getting him to do what he does not want to do, but he also exercises power over him by influencing, shaping or determining his very wants. Indeed, is it not the supreme exercise of power to get another or others to have the desires you want them to have — that is, to secure their compliance by controlling their thoughts and desires? (Lukes 1974/2005, p. 23/27)

Actors may thus work on ideational structures to change the milieu where decision-making takes place and restrict the agency of others. Likewise, they also manipulate the institutional environment to change other actors and obtain their voluntary support, without conflict. In these contexts, the task of the researcher therefore is to "denaturalize dominant constructions, in part by revealing their connection to existing power relations", and "to unmask these ideational structures of domination and to facilitate the imagining of alternative worlds" (Finnemore and Sikkink 2001, p. 398).

This third face of power evokes the concept of discourse, which draws from the idea that reality is not apprehended in itself, but rather through the lens of subjectivity (Foucault 1982). As such, social, environmental and governance issues—or any issue for that matter—are not viewed or communicated objectively, but rather through a frame of ideas, preferences, and conceptualizations that often have the aim of persuading others into adopting, voluntarily or unconsciously, the same perspective (Hajer 1995; Dryzek 2005). As Dryzek (2005, p. 9) puts it,

> A discourse is a shared way of apprehending the world. Embedded in a language, it enables those who subscribe to it to interpret bits of information and put them together into coherent stories and accounts. Discourses construct meanings and relationships, helping to define common sense and legitimize knowledge.

Therefore, discourse can be understood as a form of agency aimed at creating, shifting, or maintaining ideational structures—as a way of framing issues, influencing social norms, and exerting power over others.

3.4.3 Operationalizing an Analysis of Agency in Governance

There are multiple ways to analyze the work of actors in governance. In light of the discussions on power and agency, three steps seem nevertheless important. First, map out and characterize the actor landscapes—be it at the international level or in more specific settings, as done to selected case study countries later in this book. However, it would be exceedingly complex to track in detail the perspectives of every single agent and examine how they individually play through in the policy process. Instead, focusing on *coalitions* makes the research more manageable and allows recognizing relationships among actors and their forms of coordination (Sabatier 1988). Later chapters will characterize existing coalitions by identifying their *policy-core beliefs* (i.e., primary normative and prescriptive preferences) and *secondary aspects*, comparatively minor beliefs that are, therefore, easier to change (Sabatier and Weible 2007). These secondary aspects may relate, for instance, to beliefs on how to best implement a policy or on the effectiveness of particular policy instruments.

A second step is to analyze how agency takes place. It means analyzing the utilization of resources and the strategic uses of power in its various forms (instrumental, structural, and discursive) to concretize policy beliefs. This task includes examining: (a) coalition behavior and how coordination among actors takes place; (b) institutional entrepreneurship per se, such as forum shopping and attempts to create, change or eliminate particular institutions; and (c) action aimed directly at other actors, such as to destabilize or undermine the capabilities of adversaries.

Finally, an important third step is to provide recommendations on how to pursue institutional changes found wanting from the analyses on architecture or allocation and access. These recommendations can then accompany any on institutional redesign, realizing that the latter cannot come about without agency.

3.5 Conclusions: Feedback Loops and Power Spirals

Each of the governance elements discussed in this chapter can be analyzed in isolation, but in reality they are functionally interconnected and very much integrated. It is therefore useful to acknowledge, unravel, and study the links between them. Doing so is essential to understanding social equity in any given setting. However, it is particularly crucial for the governance of emerging areas—such as the bioeconomy—where new sectors are being constituted, and allegedly as a "force for good" to move the world towards greater sustainability. This aura of the bioeconomy as a set of sectors that take sustainability at heart arguably makes the equity imperative even stronger.

As seen, the agent-structure debate in governance emphasizes the institutional milieu when appraising the determinants of actor behavior. Nevertheless, the latter can also be influenced by material dimensions, i.e., allocation and access patterns. There is a dialectical relationship not only between agents and institutions, but also between actors' material capabilities and the patterns of access and allocation in governance. As seen most clearly (though not exclusively) in self-serving policy lobbying, agency often is performed with an eye on the allocation and access patterns that will arise out of the institutions being put in place. Meanwhile, such distributive outcomes will profoundly influence the ability of various actors to become effective governance agents, and thus a feedback loop—and potentially a power spiral—are created.

Tackling "the inequity of inequality" is historically challenging precisely because powerful actors systematically retain most benefits. They use their power to allocate the most advantageous roles to themselves and end up keeping inequitable structures—and thus inequalities—in place even if accruing some minor benefits to their

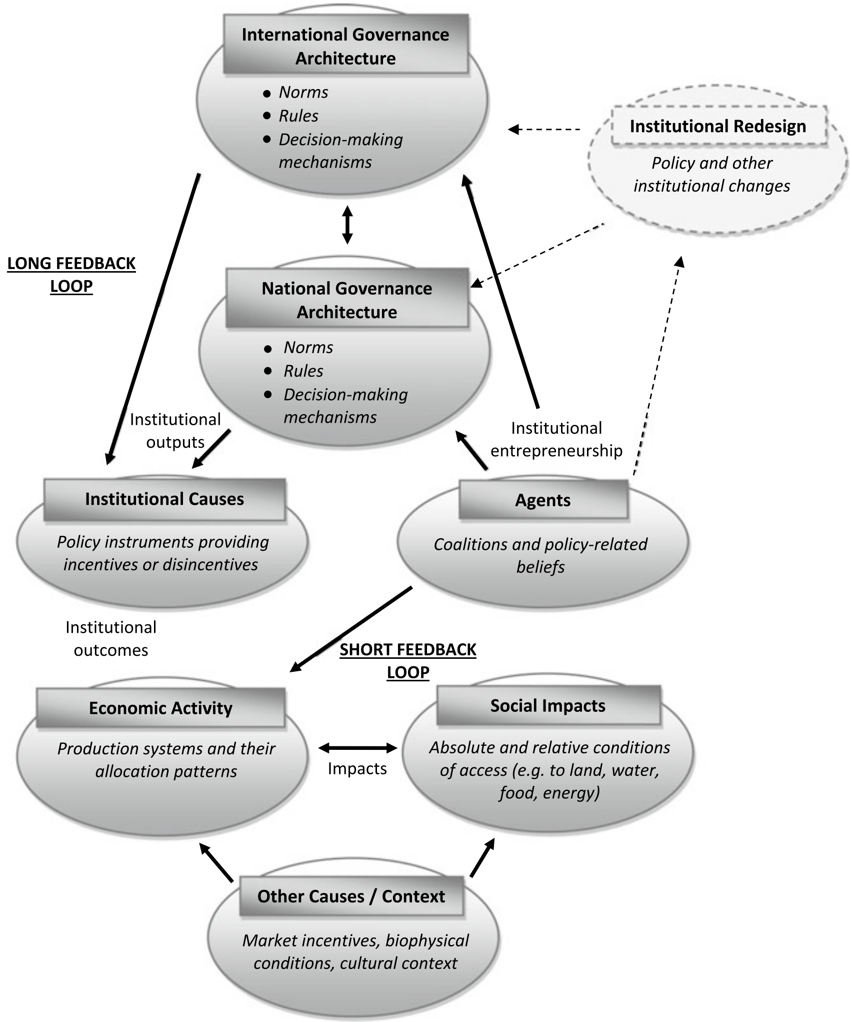

Fig. 3.1 Analyzing institutional, social, and political dimensions of governance

counterparts. This practice can be regarded as a tendency to promote institutional and material structures that create feedbacks to strengthen one's power and dominant position, thereby keeping a form of inequality lock-in. There are *short feedback loops* when agents directly promote activities that benefit themselves the most, without necessarily doing institutional entrepreneurship, i.e., without targeting the institutional milieu and the governance architecture. This route includes, for instance, the use of material capabilities to directly advance favorable pathways at the expense of others. Analytically speaking, there may also be *long feedback loops* stemming from agency in the form of institutional entrepreneurship, aimed at crafting governance architectures that promote the activities favored. This longer route can rely on various forms of policy advocacy and discursive strategies to sway public opinion and retain government support, leading to the commonplace observation that prevailing institutions generally reflect the dominant actors' views and beliefs.

Figure 3.1 presents this analytical framework to be applied in the subsequent chapters to assess biofuel governance cases as proxies for what the bioeconomy has looked like to date. The figure draws from previous work by Young et al. (1999/2005) on the role of institutions in addressing environmental change, though here the focus is shifted to the influence of governance on social equity. Following Soni (2007) and Gupta et al. (2013), there is also a sub-division between national and international governance architectures to identify which institutional incentives, causality links, and redesign needs belong to each level. More significantly, here this framework includes the element of agency, previously absent. It makes explicit that institutional redesign is not a given but rather something that *may* happen. Design thus is regarded not as something detached from agency but rather wholly dependent on it, since institutions do not change by themselves. Finally, it includes the new dimensions of feedback—first from social impacts back to agency, following political ecology's tenet that distributive outcomes and socio-economic inequalities are likely to have political implications, then the short and long feedback loops discussed above.

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Chapter 4
International Bioeconomy Governance: Unveiling the Initial Patterns

Abstract Bioeconomy governance builds on that of biofuels, its most prominent sector thus far. Biofuels' transnational drivers and impacts have received substantive international attention, raising the prospects of global policy action to address sustainability concerns. However, biofuel governance has been marked by the preeminence of national policies and the thinness of multilateral institutions. The international biofuel policy context has been characteristically non-intrusive and neoliberal. There is a shared view among major producer countries—led by the US and Brazil—that biofuels are a viable and desirable replacement for oil, to be fostered in international trade, but in a mostly unregulated global context where each country can pursue its agenda. There is a degree of purposive governance and collective issue-management led by major players in ad hoc venues—showing that biofuels should not be considered a case of non-governance. However, those fora have excluded a broader discussion that would have involved other actors and divergent interests. Moreover, this vacuum has given rise to attempts to govern biofuels unilaterally, as in EU sustainability criteria. This situation exposes the vulnerability of poorer producer countries, as they are compelled to adopt foreign rules that do not take their views and interests into account.

Keywords Biofuels · Agency · Equity · Governance architecture · Power · Sustainability

The bioeconomy has recently climbed up the global sustainable development agenda, yet there is no clear blueprint for its governance. International bioeconomy governance, in particular, remains very unclear and is seldom examined. Nevertheless, in an increasingly integrated world, there are obvious—and some not-so-obvious—global implications to the large-scale diversion of agricultural land and commodities to other purposes. Biofuels demonstrated how, in the space of only a few years, a burgeoning sector quickly moved from being an inconspicuous market in a few countries to become one of the most contentious sustainability issues, often making it to the highest political level.

Bioeconomy governance deserves far greater attention, and preferably before the *fait accompli*, i.e., while the bioeconomy still is in its formative stages. As the biofuels experience nevertheless offers a relevant precedent to go by, this chapter addresses

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the question of why biofuel production and consumption have expanded globally in the particular way they have. It first maps out the global setting and identifies the major biofuel producers and consumers. The chapter then analyzes the existing architecture created for international biofuel governance, examines what distributive outcomes and social impacts have emerged, and assesses the forms of agency already at play. The last section integrates these analyses to unveil the patterns being set in place for the emerging global bioeconomy governance.

4.1 The Global Setting of Biofuel Expansion

Biofuel policies, production and consumption have spread fast across the globe. By 2018, more than 70 countries—over one-third of the world—had biofuel consumption mandates in place, in addition to sub-national governments and countries without clear mandates but having policy incentives to production (REN21 2019). However, globally the ethanol and biodiesel sectors are very much dominated by a few major players. Together, the United States (US), Brazil, and the European Union (EU) account for more than 80% of the world's production of liquid biofuels and an even larger share of their consumption. The US and Brazil remain by far the largest producers, particularly of ethanol. The EU previously led in biodiesel production, pulled primarily by Germany and France, but it has gradually moved away from it. In contrast, outputs in emerging countries such as Indonesia and Argentina have become increasingly important (see Fig. 4.1). The following paragraphs look into the biofuel production contexts of those major players.

4.1.1 United States (US)

The US is by far the world's largest biofuel producer, most of it (89%) being corn-grain ethanol, and to a much smaller extent, soybean biodiesel (which has animal feed as a co-product) (REN21 2019). Ethanol has consistently utilized about 40% of the US corn, whose supply increase since 2010 has nearly all been used by the biofuel industry (OECD/FAO 2019; USDA 2020). Meanwhile, a growing share of its vegetable oil (from 11% in 2011 to 20% by 2018) has been converted into biodiesel (OECD/FAO 2013, 2019). Still, biofuels make up only 5% of the energy used for transportation in the US (EIA 2020).

The US has had a large-scale biofuel promotion policy since 2007, with consumption mandates in place and forecasts of an increase in production (OECD/FAO 2019), but much of the context has changed since that year of peak oil price. For one, the US has moved from a position of energy insecurity—concerned with its dependency on oil imports from Venezuela and the Middle East—to become the world's top producer of fossil fuels and a significant exporter, thanks to shale oil and gas. While this controversial "shale revolution" is widely advertised as a bridge to a low-carbon

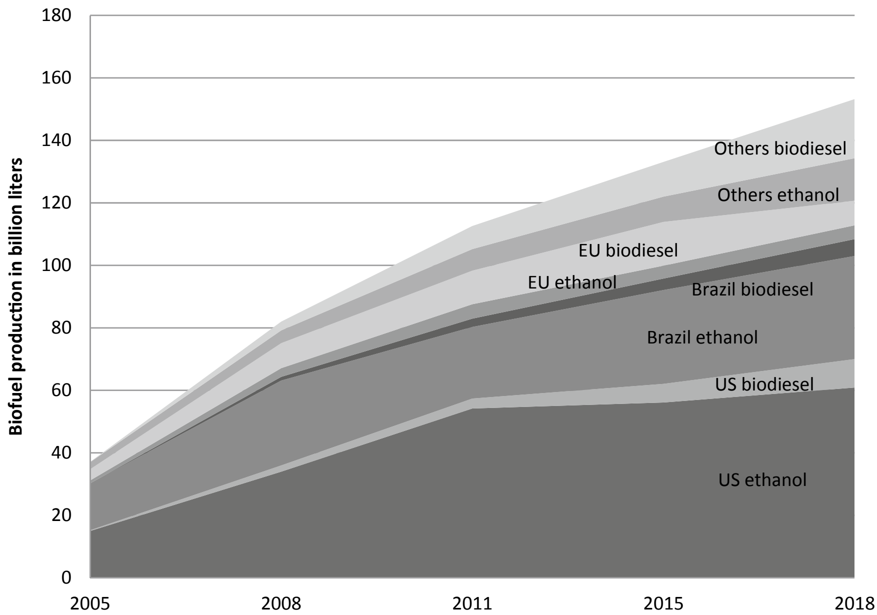

Fig. 4.1 Expansion of global ethanol and biodiesel production. *Data Sources* REN21 (2013, 2016, 2019)

future, some have argued it may have delayed the development and deployment of more advanced technologies (Jacoby et al. 2012). Second, Donald Trump's election was a game-changer, with the US more vigorously embracing energy nationalism, promoting domestic fossil fuel production, and pulling out of global climate mitigation efforts (Guliyev 2020). The extent to which the new Democrat administration will effectively change gear in practice, beyond the rhetoric, remains to be seen.

Whether in part as a result of those changes or not, US biofuel policy outcomes have been different than expected. In 2007, the government planned to more than double its biofuel production and reach 36 billion gallons (~136 billion liters) by 2022 (REN21 2013). Based on actual production capacity, the US Environmental Protection Agency (EPA) then every year sets mandatory biofuel blending targets (EPA 2010). In 2018, overall production stood at only 70 billion liters, not on track to meet the 2022 target; but more importantly, there was excessive optimism about cellulosic ethanol. The US Renewable Fuel Standards (RFS2) determines that biofuels, in their life cycle, must reduce greenhouse gas emissions by at least 20% compared to the fossil fuel replaced.[1] Besides, the mandated blending targets require an increasing share of so-called "advanced biofuels", defined by the EPA as those that achieve at least 50% emission reductions (EPA 2010). Within this, there are specific minimum amounts required that must consist of advanced biodiesel or cellulosic ethanol (which is required to reduce emissions by at least 60%). Out of the 136 billion liters mandated

[1] Average gasoline and diesel emissions are taken from an EPA benchmark from 2005 (EPA 2010).

for consumption by 2022, 79 billion liters should be of “advanced biofuels”, and within these, 60.5 billion liters would be cellulosic ethanol (EPA 2010). However, the reality is that cellulosic ethanol production has mostly stagnated and is yet to gain commercial relevance due to technical difficulties and high production costs (Padella et al. 2019). In practice, it is mostly corn-grain ethanol that continues to fill the gap.

Although it remains to be seen whether US policy will change due to the shortfall in cellulosic ethanol production, another approach has also materialized to help fulfill the US consumption mandate. As sugarcane-ethanol is the only “advanced biofuel” available on a large scale, a peculiar, policy-driven, two-way ethanol trade between Brazil and the US became established. While the North American country would export to Brazil corn-grain ethanol (which does not meet its own “advanced biofuel” qualifications), the South American country would export to the US sugarcane-ethanol (which does) (EPA 2010). This bilateral trade was a reality for some time, before Brazil’s domestic ethanol consumption outpaced its production (see Chapter 5).

As reality imposes itself on the early optimistic predictions made in the heat of the food vs. fuel controversy, it becomes increasingly clear that biofuels made from conventional crops will remain dominant for the near future. Meanwhile, the actual contribution of next-generation technologies remains to be seen.

4.1.2 Brazil

Brazil is the world’s second-largest biofuel producer, has the longest large-scale commercial experience, and has been one of the most active promoters of biofuels worldwide. Brazilian biofuel production consists primarily of sugarcane ethanol (85%) and soybean biodiesel (9%). In total, ethanol and biodiesel meet about 23% of the energy demand in the transport sector (EPE 2019, p. 82). Their production claims nearly 37% of Brazil’s vegetable oil (mainly soy) and usually between 50 and 65% of sugarcane (OECD/FAO 2019). This variation occurs because most Brazilian sugarcane mills can switch back and forth between sugar and ethanol production depending on market signals. Besides, electricity generation from sugarcane biomass has provided 11% of Brazil’s total energy needs. Altogether, these crop-based biofuels have met 19% of the country’s energy consumption (EPE 2019, p. 27).

Brazil has also promoted biofuels abroad as a rural development strategy. It has particularly attempted to replicate experiences (e.g., sugarcane-ethanol production) in Sub-Saharan Africa (Wilkinson and Herrera 2010). In Ghana, Brazil opened the first foreign office of its state-owned agricultural research corporation (EMBRAPA) in 2008 (Bastos Lima 2012). It was also established in 2010 a development cooperation agreement with the EU focused on Portuguese-speaking Africa. With support from Brazilian companies, the initiative led to a trilateral partnership with Mozambique to produce sugarcane-ethanol in this country, aiming at the European market

(Reuters 2010). Although such Brazilian entrepreneurship overseas may have lost steam since its heyday during the Lula presidency, in the long term such promotion of rural development through biofuels also serves Brazil's strategic interests. It understands that global biofuel markets will hardly become established without a larger number of exporting countries (EPE 2010, p. 225; Bastos Lima 2012).

4.1.3 European Union (EU)

The EU has the world's third-largest biofuel output, mostly produced in Germany (4.5 billion liters), France (3.1 billion liters), Spain (2.5 billion liters), Italy (1.4 billion liters), Poland (1.2 billion liters), and the Netherlands (1 billion liters) (REN21 2019). Unlike the US and Brazil, where ethanol dominates, EU biofuel production consists primarily of biodiesel, using rapeseed as its primary feedstock. Although waste cooking oil has been increasingly utilized, the biodiesel sector has consumed as much as 45% of the EU vegetable oil supply (OECD/FAO 2019), meeting 5.7% of the transport sector energy demand in 2019 (Flach et al. 2019).

EU biofuel production and consumption have been guided mainly by its Renewable Energy Directives (RED I and RED II). In 2009, RED I established that every member country must reduce greenhouse gas emissions by 20%, compared to 1990 levels, to increase the overall EU rate of renewable energy use to 20% by 2020 (European Parliament 2009). A specific transport sector target specified that renewables should account for at least 10% of its energy consumption in every member-state by 2020. However, substantive controversy arose when civil society organizations observed that such targets would be met mostly by importing crop-based biofuels from overseas, fueling additional land-use change and deforestation in tropical countries. Between 2007 and 2012, on average, 20% of the liquid biofuels consumed in the EU were imported from overseas (Flach et al. 2013). Despite increases in domestic biofuel production and some fluctuation over the years, a significant share of imports has been a constant (see Fig. 4.2) and stood at 18% in 2019 (Flach et al. 2019). Although most imports have come from South America or Southeast Asia, Europe has also pursued development cooperation with Africa—through the Africa-EU Energy Partnership—by promoting feedstock cultivation and export-oriented biofuel production in this continent (Charles et al. 2009).

To address environmental concerns linked to its import reliance, the EU adopted several sustainability criteria that biofuel production must meet to count towards the binding target. These criteria require:

i. Minimum reductions in greenhouse gas emissions compared to the fossil fuel being replaced (based on the EU's accounting for different biofuels);
ii. Restrictions on land-use changes for feedstock cultivation in order to avoid deforestation or peatland degradation; and

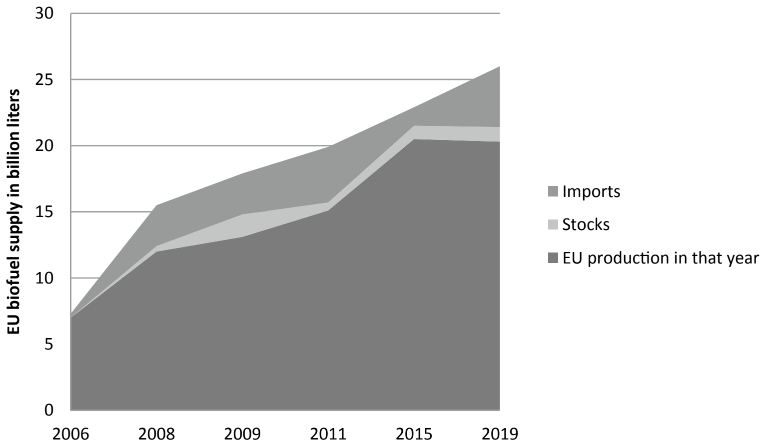

Fig. 4.2 EU aggregated supply of ethanol and biodiesel (FAME & HVO). *Data Source* Flach et al. (2012, 2019)

iii. Monitoring the social impacts of biofuel production, such as on food security and development, even if these were vaguely defined and lacked quantitative indicators (European Parliament 2009).

As in the US Renewable Fuel Standards case, these sustainability requirements apply to member countries and non-member countries exporting to the EU. They may be waived if the production is certified by another accredited system, such as a private certification mechanism.

However, the criteria still failed to address the critical issue of indirect land-use change. By placing additional demand on forest-risk crops such as soy and oil palm, the biofuel consumption mandate risks driving additional land-use change and deforestation even if biofuel supply chains did not directly cause these impacts. For instance, in 2017, more than half of the EU palm oil imports were used for biodiesel manufacturing (Buffet 2018). Sustainability standards applying to crops grown as feedstock but not to the same crops when cultivated for food may simply create a reshuffle of production (and, thus, a form leakage). For example, in 2010 and 2011, the whole of Germany's rapeseed production was used for biodiesel, while its vegetable oil needs were met by increasing rapeseed oil imports from other countries such as Ukraine (Flach et al. 2012). As that importation is not for biofuels, it is not scrutinized for sustainability.

A second Renewable Energy Directive (RED II), which has come into force for the 2021–2030 period, has sought to close some of those loopholes and move the EU away from food-based biofuels. It establishes that by 2030 member-states should reach 14% or more of renewables in the transport sector, but now with a 7% cap on food-based biofuels. "Advanced biofuels", here defined differently from the US Renewable Fuel Standard, are understood by the EU to be only those made of non-food feedstocks (e.g., agricultural by-products). They are to meet at least 3.5% of the demand and are double-counted regarding RED II obligations (European Parliament 2018). In a supplementary Delegated Act to address indirect land-use change, the EU then went a step further and set a gradual phase-out of palm oil-based biodiesel by 2030—against protests and retaliation threats from Malaysia and Indonesia. Member-states may still import it, but by then, it will no longer count towards the mandate (European Commission 2019).

4.2 The Architecture of International Biofuel Governance

4.2.1 International Biofuel Governance Initiatives

An emerging framework of international institutions has accompanied the expansion of biofuels worldwide. These institutions, and associated attempts at biofuel governance, can be clustered into three groups:

i. Initiatives from multilateral bodies whose mandates directly relate to biofuel issues;
ii. New multilateral bodies created specifically for biofuel governance; and
iii. International multi-stakeholder platforms generally focused on creating biofuel sustainability standards for voluntary market certification.

Within the UN system, at least two significant attempts at building an international environmental framework for biofuels took place: one by the Food and Agriculture Organization of the United Nations (FAO) and another at the 10th Conference of the Parties (COP) to the UN Convention on Biological Diversity (CBD). When international agricultural commodity prices peaked in 2008, the FAO called a "High-level Conference on World Food Security" to address "The Challenges of Climate Change and Bioenergy". However, it did not agree on international biofuel policies. The final declaration only called for more dialogue, further R&D investments, and agricultural trade liberalization (High-level Conference on World Food Security 2008). Later, at the 10th CBD COP in Nagoya, Japan, high-level discussions on biofuels' sustainability took place. However, its decision X/37 on "biofuels and biodiversity" was limited to "recognizing" the substantial risks of unfettered biofuel expansion and to "inviting" and "encouraging" the parties to undertake sustainability assessments and adopt policies to minimize negative impacts (CBD 2010).

Outside the UN system, an initiative to articulate efforts has come from the International Energy Agency (IEA), part of the Organisation for Economic Co-operation and Development (OECD). Its bioenergy branch (IEA Bioenergy) has the exceptional membership of Brazil and South Africa, non-OECD countries and thus non-IEA members. It initially set up two task forces on biofuels: Task 39 ("Commercialising Liquid Biofuels from Biomass") and Task 40 ("Sustainable International Biofuel Trade"). Their work has primarily involved production chain and market analysis, optimization of biofuel technologies, and sustainability criteria for voluntary market certification (Faaij et al. 2010). Subsequently, newer tasks—41 to 45, as of 2020—have focused on biorefining, biomass supply chain governance, and the role bioenergy can play "within the broader bioeconomy" and concerning the 2030 Agenda, notably to help address climate change (IEA Bioenergy 2019).

Meanwhile, new multilateral bodies have been set up to assist with biofuel governance. The main body has been the Global Bioenergy Partnership (GBEP), set up in 2005. Its membership has remained more or less stable over the years and, as of 2020, comprised 23 countries and 15 international organizations. Members are arranged in working groups to coordinate bioenergy R&D and harmonize sustainability standards, in particular accounting methodologies for greenhouse gas emissions. These are the same goals pursued at the International Biofuels Forum (IBF), launched in 2007 by Brazil in partnership with China, India, South Africa, the US, and the European Commission. All these are also GBEP members except for India and South Africa, which have observer status (Bastos Lima and Gupta 2013).

Finally, several multi-stakeholder roundtables have emerged to pursue sustainability certification within the private sector (see Oosterveer and Mol 2010). They include, most notably: The Roundtable on Sustainable Palm Oil (RSPO), Bonsucro (previously named Better Sugarcane Initiative), the Round Table on Responsible Soy (RTRS), and the Roundtable on Sustainable Biomaterials (RSB), which aims to be universally applicable (see Palmujoki 2009). These initiatives have primarily brought together large agroindustrial producers from the developing world, food or fuel processors and retailers in developed countries, and environmental NGOs—mostly North-based ones (Bastos Lima 2009). They have focused on creating standards for voluntary international market certification, but biofuel producers' uptake of those standards remains limited. In some cases, contestation over their requirements has led developing country producers to seek their own certification schemes. Most notably, Malaysia and Indonesia came to create national sustainability standards—Malaysian Sustainable Palm Oil (MSPO) and Indonesian Sustainable Palm Oil (ISPO)—although these have limited international recognition.

4.2.2 Analyzing the Architecture of International Biofuel Governance

Three underlying assumptions and norms seem to characterize the architecture of international biofuel governance. First, most initiatives have focused not on regulating but on *promoting* biofuels, assuming as a principle that biofuels are mostly beneficial to sustainable development and that they can replace fossil fuels on a large scale. This premise seems to work as an a priori belief that has not been open to revision despite indications that such a large-scale transition raises serious sustainability issues (see Chapter 2). Second, as an explicit norm, there has been a mission to turn biofuels into commodities for international trade—among many options that could be taken up, such as encouraging biofuel production for local consumption.

Third, as an implicit norm, international policy initiatives have been kept limited and non-intrusive, leaving maximum room for individual countries and non-state actors to pursue their agendas. This norm reveals itself in a clear preference for voluntary governance mechanisms at the international level, based on market certification, instead of binding regulations.

In terms of rules, there is a density of public policies at the national level and paucity at the international one. Many governments have steered domestic biofuel production using economic and regulatory incentives that create politically instituted markets (Pilgrim and Harvey 2010), but no international biofuel regulations exist. Existing institutional arrangements such as the GBEP and the IBF have worked as fora for like-minded countries to debate biofuel issues and where they may agree on certain strategies, but preserving their autonomy to follow their individual preferences at the end of the day. None of those platforms has worked—or even meant to work—as a place to make collective commitments, let alone *legally binding* commitments. Attempts to make such commitments at more representative and consensus-based decision-making venues, such as the FAO and the CBD, have all failed.

It would be hard to say that any of those ad hoc bodies govern biofuel expansion in any meaningful way. Even on non-political issues, such as biofuel technical standardization, limited progress has been achieved (Unglert et al. 2020), let alone on more sensitive issues such as trade barriers or sustainability. It could be argued that the existing biofuel governance architecture has a lean, neoliberal institutional framework where the players are not bound by regulations but just voluntarily cooperate out of their own interests. A more critical examination, however, can also reveal problems of scope, accountability, and legitimacy. There is an evident prevalence of institutional arrangements that promote biofuels only as a technical-economic challenge. There is an absence of mechanisms to jointly address, deliberate, or articulate international and multi-level policies on biofuel production's ecological and socio-economic impacts. Scientists and other experts may hold such discussions, but those fora are not policy-making venues.

Moreover, the actors working in those institutional arrangements are not held accountable for their decisions—or their non-decisions—to anyone. Their legitimacy is also limited since those bodies are made by selective groups of like-minded actors only (mostly large biofuel producer countries), and not by a diversity of voices and stakeholders (Bastos Lima 2009). Those fora and partnerships may work effectively as platforms for joint exploration and research. However, this agenda is not necessarily unbiased, either, and it differs fundamentally from governance processes where science systematically feeds into policy-making, such as at the UN Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC) (Gupta 2010).

Biofuels are a clear case of a "non-regime", as there are no collectively established rules to steer countries' behavior (Bastos Lima and Gupta 2013). This international institutional framework is hardly a relevant driver of biofuel expansion; it primarily involves countries that are already engaged with biofuels and provides no significant additional incentive to production. Perhaps the exception would be the few small producer countries where GBEP members have deployed biofuels under this partnership's auspices. Still, overseas promotion is something that large players—the US, Brazil, and the EU—already were doing, according to their views, and regardless of those international institutions.

4.3 Equity: Access and Allocation Patterns

More often than not, debates on biofuel or bioeconomy sustainability overlook equity issues. Impacts on people's access to land, water, and food have been vital concerns, but the treatment of these issues in international biofuel policy remains limited and ad hoc. Extensive lip service may be paid to access issues by discussing voluntary sustainability parameters in multiple fora. Still, in reality, these problems have been left essentially for the market or individual countries to resolve—however limited their capacity may be. At the international level, access issues have received only nominal attention, without any collective policy measures. Despite some consensus around the Sustainable Development Goals, the tone of international biofuel (or bioeconomy) governance on equity remains the same one set at the 2008 High-Level Conference on World Food Security: biofuel impacts on food and ecosystems are discussed, and challenges are acknowledged, yet no international policies or concrete actions are agreed upon (High-Level Conference on World Food Security 2008).

However, leaving access issues to be addressed only by individual countries may prove dangerous because it does not account for the extraterritorial effects of domestic biofuel policies (Bastos Lima and Gupta 2014). There is little that food-insecure countries can do if the bioeconomy policies of major agricultural producers affect international food prices (see Clapp 2009). If anything, the COVID-19 pandemic has revealed the significant risks that agricultural commodity market volatility poses to developing countries (Clapp and Moseley 2021). The same applies to other global changes that may be triggered by expanding bio-based production, such as impacts on the climate, global hydrology, or cumulative effects of land-use change (see Rockström et al. 2009).

In addition, the surge of large-scale land investments (notably in Africa), driven in part by biofuels, has disenfranchised many indigenous peoples and the rural poor, exploiting the insecure land tenure situation of most of those customary owners (Borras and Franco 2012; Cotula et al. 2011). This phenomenon can be understood as state and non-state actors with the financial capital, but without the arable land needed (at least not at the same costs) for growing food and biofuel feedstock, increasing their access to natural resources while reducing that of local populations (Cotula et al. 2008). This access transfer typically includes not only land but also freshwater, associated with the land and embodied in the agricultural products exported (Takahashi and Ortega 2010). Such dispossession is not a new phenomenon; it has been widely observed in other sectors, such as in tree plantations for the shipping industry during the colonial era or for the pulp and paper industry in post-colonial times. However, additional large-scale biomass demand for energy and novel bioproducts add pressure over resources and can aggravate access issues (Hall et al. 2011; German et al. 2011; Bastos Lima 2018).

Meanwhile, as seen, existing biofuel institutions represent only particular groupings of actors working for a limited agenda. Grassroots organizations and other critical actors have lacked venues to express their views and interests on the bioeconomy, lacking influence over the institutions being crafted. Even at existing multistakeholder roundtables, the presence of South-based NGOs is minimal (Bastos Lima 2009).

Allocation patterns are revealing of the inequities in international biofuel and bioeconomy governance thus far. First, biofuel research, development, and production have been mostly linked to consolidated agricultural sectors rather than small-scale agriculture or strategies that target the poor. Vulnerable groups and energy poverty are regularly evoked to justify bioenergy promotion (Von Braun and Pachauri 2006; Hunsberger et al. 2017), yet the growing volume of biofuels produced mostly go to higher-income consumers (automobile users) rather than to the hundreds of millions still lacking access to modern energy. Second, developing countries have usually been allocated only the natural resource-intensive stage (feedstock cultivation) of bio-based production chains, the one of least economic value. Value-added from biofuel processing and biorefining technologies remains primarily controlled by governments and companies of developed countries—or, exceptionally, of emerging countries such as Brazil or China. Thus, international governance does not yet address either the risks or the much-heralded but largely undelivered potentials for the bioeconomy to promote socio-economic and technological development in poorer countries, despite more than a decade of work on biofuels.

As such, the global bioeconomic order starts shaped to prioritize improved access to land, freshwater, and renewable energy for more affluent consumers in developed countries. Poorer actors, instead of benefiting, mostly have become exposed to additional risks of ecosystem degradation, food insecurity, and reduced access to land and water (Smith 2010). By broadly neglecting equity issues, international biofuel governance risks aggravating rather than addressing existing inequalities.

4.4 Agency in International Biofuel Governance

4.4.1 Agents, Coalitions and Policy-Related Beliefs

The main agents of international biofuel governance have arguably been states. Except for the multi-stakeholder roundtables, all discussed venues have nearly exclusive state-based membership (e.g., GBEP, IBF, IEA Bioenergy, CBD). Although non-state actors such as biofuel businesses and the scientific community have de facto participated in these fora, this is done mostly by appointment, frequently as part of country delegations and in many cases clearly under the leadership of government officials.

In this context, the most relevant international biofuel governance views have been those of larger market players: the US, Brazil, and the EU. Meanwhile, UN agencies, international peasant movements, and most environmental NGOs hold contrasting views, much less enthusiastic about biofuels when not outright critical. Industry and scientists, in turn, have not had a consensual stance: oil, automobile, and agricultural industries have tended to align themselves with the pro-biofuel views of the EU, or of Brazil and the US, and to support their governments in these agendas (e.g., Jank 2011; Urbanchuk 2013); scientists, however, are more divided and can be found subscribing to any of those positions. Table 4.1 summarizes these major views on biofuels as policy-related beliefs—essentially policy-*core* beliefs, since "secondary

Table 4.1 Key agents and their policy-related beliefs in international biofuel governance

<table>
<tr><th>Key agents</th><th colspan="2">Policy-core beliefs</th></tr>
<tr><td>Brazil[a]</td><td rowspan="3">• Biofuels produced from industrial monocultures can and should replace oil on a large scale, thus making meaningful contributions simultaneously to energy security, rural development, and climate change mitigation
• Ethanol and biodiesel should be produced by a large number of countries and become established as internationally traded commodities</td><td rowspan="2">• More advanced biofuel technologies based on non-food feedstocks should be sought, but food crops can be sustainably used for large-scale biofuel production without threatening food security
• International regulations on biofuels should be limited to technical standardization</td></tr>
<tr><td>United States[b]</td></tr>
<tr><td>European Union[c]</td><td rowspan="3">• Food crops should give place to more advanced, non-food feedstocks (e.g., perennial grasses for cellulosic ethanol)
• It is essential to have internationally applicable sustainability criteria on biofuels</td></tr>
<tr><td>Moderately critical international NGOs[d]</td><td rowspan="2">• Biofuel policies should contribute to greater economic participation and empowerment of the rural poor, helping them climb up to value-adding stages of production
• Governments should refrain from providing public policy support to large-scale biofuel production based on food crops</td></tr>
<tr><td>UN agencies[e]</td></tr>
<tr><td>International peasant movements and strongly critical NGOs[f]</td><td colspan="2">• Further stimulus to conventional industrial monocultures is unacceptable, much less by turning food into energy resources for wealthy nations' consumption. Agriculture should be, instead, based on agroecology and food sovereignty principles (i.e., avoiding patented seeds and artificial chemical inputs, increasing agrobiodiversity and local nutrient cycling, and ensuring local communities' right to decide how their resources will be used and to prioritize their own needs first, thus building resilience from external decisions and food price volatility)</td></tr>
</table>

[a]MAPA (2006), Bastos Lima (2012), Dauvergne and Farias 2013, [b]Wright (2008), Seelke and Meyer (2009), Lehrer (2010), [c]European Parliament (2009), [d]See Chapters 5–7, [e]UN-Energy (2007), FAO (2008), UNEP (2009), FAO et al. (2011), [f]Ernsting (2007), and FoE Europe (2011)

aspects" have been hardly elaborated on in international biofuel governance. (It should be noted that, in some cases, agents might share one policy-belief but disagree on others).

While the EU continues to pursue its own approach and other, more critical actors remain vocal but mostly ineffectual, the main coalition that can be identified in this context is between Brazil and the US. Not only have these countries held a similar view on the subject, but they have also worked together to enhance bilateral biofuel trade, knowledge exchange, and deployment of feedstock cultivation and biofuel technology in third countries, particularly in Africa and Central America. This alliance of sorts became institutionalized through a memorandum of understanding between the two countries signed in 2007, followed in 2011 by a presidential-level *Strategic Energy Dialogue* with biofuels as a priority area (Wright 2008; Seelke and Meyer 2009; The White House 2012). Despite tariffs that either country may put in place to control bilateral ethanol trade, globally they remain very much aligned on biofuels, and cooperation continues despite the changes of administration in both countries (Afionis and Stringer 2020).

4.4.2 Strategic Uses of Power

Agents have strategically used all three forms of power—instrumental, structural, and discursive—to pursue their policy beliefs in international biofuel governance.

The first form, instrumental power, has been exerted primarily through foreign investments and unilateral sustainability import criteria that aim at determining how, where, and for whom biofuels are produced. Most knowledge, technology, and institutional experience on feedstock cultivation and biofuel production and utilization are in the hands of government agencies and private companies from the EU, Brazil, or the US. These actors also have the financial capabilities that most developing countries lack. The moment these assets are used to induce a change in others' behavior, they by definition become power instruments (Bachrach and Baratz 1962; Lukes 1974/2005). For example, this is seen in the biofuel investments in Africa, mostly aimed at European markets—instead of, say, local decentralized energy consumption or import substitution in African countries that depend on foreign oil (Charles et al. 2009).

Such foreign steering of biofuel production also appears in the form of unilateral sustainability requirements. The policies of both the US and the EU are cases in point. Although allegedly aimed at the global common good, they have set minimum environmental requirements that have not incorporated views, preferences or concerns of any other countries to which they may be applied. Instead, those standards are unilaterally elaborated and embraced a priori, then imposed as a conditionality for development cooperation or import of feedstock and biofuels. Brazil has been a vocal opponent of such unilateral rule-making (see Afionis and Stringer 2020), while other emerging countries have generally critiqued the EU for often "talking at" rather than "talking with" its overseas partners in governance matters (Chaban et al. 2017).

Strictly speaking, such unilateral sustainability requirements are not a trade restriction: biofuels and feedstocks that do not meet the criteria can still be legally imported. However, they do not count towards the US government or the EU's mandatory targets. By doing this, these actors have deftly avoided incompatibility with rules of the World Trade Organization (WTO), which could lead to legal contestation of their policies (see Douma 2010). This example shows that the induced behaviors are not necessarily detrimental to those on whom power is exerted. Nevertheless, they give a clear demonstration of "who decides"—in this case, US and EU decisions for the pre-eminence of climate and biodiversity concerns over the socio-economic development needs that poorer countries tend to emphasize.

The second face of power—in the form of agenda-setting—has complemented that and played a significant role in international biofuel governance. Its relevance becomes clear when one observes the remarkable continuity of non-decisions on its several contentious points despite major controversies such as the "food vs. fuel" debate. This crafting exercise has taken place in two concurrent ways: first, by blocking unwanted decisions in more representative fora, such as in the UN system; second, by promoting institutions and organizations where representation is much more restricted and where the agendas are limited to comparatively innocuous issues.

Since most decisions at the UN level depend on consensus, it has not been hard for large biofuel producers to prevent any intrusive multilateral regulatory framework from emerging. The US achieved that at the 2008 FAO High-level Conference on World Food Security, as did Brazil at the 10th CBD COP in 2010 (Pomeroy and Doyle 2008; Borger 2008; IISD 2008; Petermann 2010; Scott et al. 2014). After the FAO conference, the UN Special Rapporteur on the Right to Food, Olivier de Schutter, noted that smaller countries were concerned about the impacts of global biofuel expansion but could do little against major biofuel countries, who accepted no intervention in their agendas (Pomeroy and Doyle 2008). While bypassing decisions at UN fora, those like-minded actors have structured their institutional framework to promote biofuels under a leaner and less inclusive agenda. It suffices to add that, quite unsurprisingly, it was Brazil who launched the International Biofuels Forum, while the G8 + 5 launched the Global Bioenergy Partnership.

Finally, major biofuel producers have utilized discursive power to obtain consent from other parties. Three major discourses have characterized biofuel promotion. The first one is a securitization discourse, usually more aimed at domestic constituencies, framing biofuels as an essential tool to reduce economic—and, eventually, "national"—vulnerability to political adversaries (see Boussena and Locatelli 2013). The second one, the environmental labeling of biofuels as "sustainable", "green" or "low-carbon", seems aimed at broader audiences such as the international community in order to obtain public approval, add legitimacy, and garner support for biofuel promotion. This discourse is widely present in biofuel policy texts and the grey and scientific literature, even if sometimes with small caveats about the risks to be avoided (e.g., Farrell et al. 2006; Goldemberg et al. 2008). Lastly, there is the discourse—aimed primarily at populations and countries eager to escape poverty—of "rural employment creation" and "pro-poor development", which most developing countries use (Bastos Lima 2012; see Chapters 5–8). Such an emphasis is often present in North-South and South-South cooperation on biofuels (Charles et al. 2009). This discourse also finds broad resonance in the international development community (see Von Braun and Pachauri 2006; UNEP 2009). Its capacity to captivate becomes very clear, for instance, when African countries request Brazil's support to expand biofuel production (see Maximo 2007). What is often not unpacked is a general understanding of rural development only as job creation in monocultures and smallholders' integration in contract-farming schemes with private companies (see Chapter 8). As subsequent chapters will discuss, this discourse plays a crucial role in that relationship with local actors.

4.5 Conclusions

There has long been a consensus that global biofuel expansion primarily owes to domestic policies (Sagar and Kartha 2007; FAO 2008; Koh and Ghazoul 2008; Pilgrim and Harvey 2010). However, this chapter has argued that institutional arrangements, decisions and non-decisions at the international level have played important roles, too. Biofuel governance has been marked by the pre-eminence of national—or, in the EU case, supranational—policies and thinness of international institutions. It is arguably the example of a "non-regime", as there are no collectively established rules and thus no rule-consistent behavior. Although the literature tends to regard such cases as "institutional failures" (Dimitrov et al. 2007), they can only be labeled as such by those who aspire for more robust governance. States or non-state actors who prefer a neoliberal environment, without significant restrictions or rules on behavior, are likely to see non-regimes as an institutional victory (see Chapter 9).

In the case of biofuels, however, this neoliberal approach cannot be considered an agreement implicitly made, because not everyone agrees to it. Instead, it is because the multilateral fora that could draft regulations, such as those within the UN system, all operate under some form of consensus-based decision-making where unwilling actors—notably Brazil and the US in this case—can easily block such attempts. Major producers have, instead, promoted their own "pro-biofuel" international institutions that treat it merely as an economic good, viewed automatically as sustainable and subject to no regulation. This analysis reveals that those countries have not only been leading biofuel producers but also key agents in international biofuel governance.

Figure 4.3 summarizes the nature of this governance and its interrelation with the nature of biofuel production. Of particular concern is that biofuel governance has had no place for critical voices, except for states in UN fora. As such, indigenous peoples, customary landowners, net food consumers such as the urban poor, and others who have been impacted by biofuel expansion do not participate in the policy- and decision-making processes. In a way, this explains why biofuels promotion continues unabated despite mounting criticism. Certain features of international biofuel governance also reflect such a lack of access, such as the prevailing view of biofuels as commodities for large-scale production and international trade, rather than as a tool for local development; the absence of binding sustainability rules and

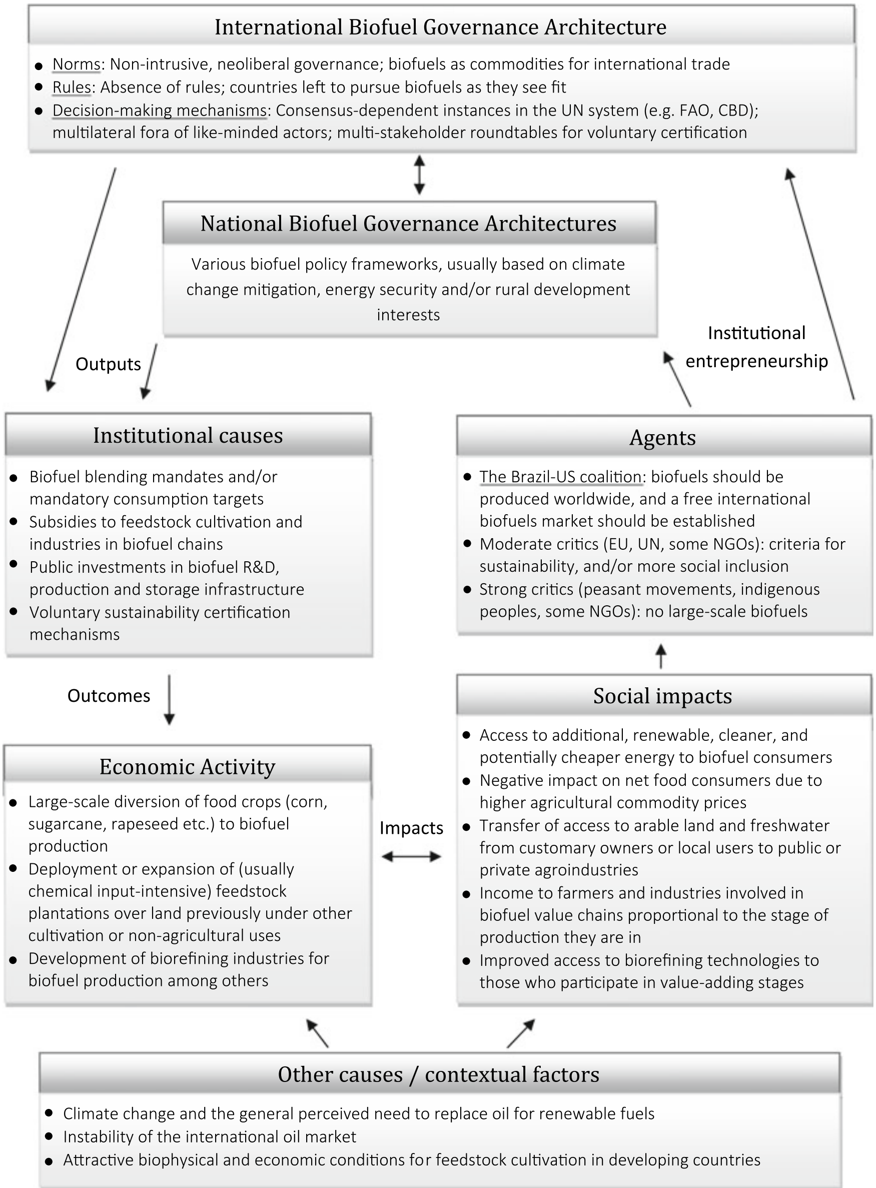

Fig. 4.3 Analyzing institutional, social, and political dimensions of global biofuel expansion

preference for business-friendly self-regulation mechanisms; and the exclusion of alternative views—such as food sovereignty[2]—from the debate. Given the lack of fora where such actors can influence the global biofuel agenda, their international influence becomes dependent on their capacity to sway their states. However, there they might have difficulty facing the larger and more powerful agro-industry lobbies.

This global experience in steering biofuels development since at least 2005 has shaped the initial governance patterns of the broader bioeconomy. As seen most explicitly in the cases of IEA Bioenergy (now addressing also bioproducts) and of the RSB (simply renamed from Roundtable of Sustainable Biofuels to Roundtable of Sustainable Biomaterials), international bioeconomy governance builds on the biofuels experience. The institutional framework set up for biofuels exerts some path dependency and has been merely broadened without any qualitative change, which becomes increasingly difficult. However, change may be needed if the bioeconomy is to address the vulnerabilities of weaker actors, issues of inclusiveness, and fulfill its potential to meet broader sustainable development goals.

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[2]In short, food sovereignty refers to the rights of local communities to define and control their agri-food system. It prioritizes local needs and actors, and strives for equity, sustainability, and healthy living. See Altieri and Toledo (2011) and Rossett and Martinez-Torres (2012).

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Part II
Bioeconomy Governance and Sustainability Politics in Emerging Countries

Chapter 5
Brazil Between Bioeconomy Barons and Grassroots Agroecology

Abstract Despite grand bioeconomy ambitions in this megadiverse country, sugarcane and soy dominate Brazil's agenda so far. National policies have driven particularly biofuel expansion, consumed essentially in the domestic market. Those policies have included regulatory and economic instruments such as blending mandates, fiscal incentives, and public credit to key agroindustries, in addition to public investments in biofuel R&D, production, and storage infrastructure. This agenda has economically benefited agribusiness, helped substitute fossil fuels, and supported Brazil's energy independence. However, by relying only on a few industrial monocultures, this expansion has also furthered socio-environmental impacts, such as on agrobiodiversity and freshwater resources. Sugarcane-ethanol production has helped increase large agribusiness' control over natural resources at the expense of smallholders and indigenous peoples. Biodiesel chains, in turn, have attempted but broadly failed to include smallholders, relying in the end mainly on soy. The prevalence of these production patterns reflects the dominance of an agribusiness coalition in governance. Some critics advocate for structural change towards agroecology, but private agroindustries and like-minded state actors have prevailed thanks to their more considerable material capabilities, better access to positions of legal authority, and a successful discourse that promotes large Brazilian agribusiness as working for the national interest.

Keywords Biofuels · Sugarcane ethanol · Biodiesel · Equity · Governance · Value chains

Brazil has long been a hub of biofuel and now bioeconomy promotion. With a large ethanol sector since the 1970s, an expanding biodiesel industry, and coordinated efforts to export its production model abroad (most notably in Africa), the South American country is a key player as well as a significant case study for how biofuels and the bioeconomy may develop. Brazil is the only nation where biofuels account for more than 10% of the energy used in the transport sector (REN21 2019). From economic and ecological standpoints, its sugarcane-ethanol is considered the most efficient biofuel commercially produced from standard crops (Pereira et al. 2019). The country also pioneered policies to include the rural poor in biodiesel production chains, and many have regarded it as an example that other developing countries in the

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tropics could or should follow (Mathews 2007; FAO 2008; Mitchell 2011). Indeed, despite various fluctuations through the 2010s, the biofuels and bioeconomy sector has remained prominent throughout—from the heyday of Lula da Silva's presidency to the Bolsonaro administration. The Amazon is occasionally flagged as a source of virtually inexhaustible resources for bioeconomy development, but a reality check may be in order.

This chapter looks deeper into the Brazilian case to understand why it has engaged so actively with the bioeconomy in the way it has. First, this chapter describes the context of biofuel production and consumption in Brazil, its national policy framework, and examines institutional causality. Then, it analyzes the distributional outcomes and social impacts of that production as the most substantive example of bioeconomy to date—and the axis around which the country is now developing other novel bioproducts. Finally, the chapter delves into politics and agency, identifying the key agents of bioeconomy governance in Brazil's domestic context, advocacy coalitions and their policy beliefs, and strategic uses of power. The chapter concludes with key insights on why certain biofuel production and bioeconomy patterns have prevailed in Brazil.

5.1 Biofuels in Brazil: How and Why

5.1.1 The Brazilian Setting: Energy and Agri-Food Contexts

5.1.1.1 Energy Context

A high rate of renewables characterizes Brazil's energy mix. They made up 45.2% of the country's energy supply in 2018, a high share it has more or less maintained since the early 2000s despite absolute increases in consumption (EPE 2019a). This rate contrasts with 19% in the European Union and merely 10.8% on average in OECD countries (IEA 2020). Biofuels alone represent 19% of the total energy use, including ethanol, biodiesel, and electricity produced from sugarcane biomass. Still, fossil fuel dependence remains significant, particularly in transport, which represents one-third of Brazil's total energy consumption and is expected to remain the fastest-growing energy consumer among all sectors in the 2020s (EPE 2020). While 83% of Brazil's electricity comes from renewable sources, the renewables rate is 23% in the transport sector. Fossil diesel (mainly used for heavy road vehicles) meets nearly half of this sector's demand. Gasoline and ethanol (for light-duty vehicles), in turn, have shares of 26 and 19%, respectively.[1]

Meanwhile, domestic oil production is on the rise. Since 2006, Brazil's oil production has exceeded its domestic consumption, and in 2018 the country was a net

[1]This refers to energy content, not volume. The same volume of ethanol has only two-thirds of gasoline's energy content, therefore volumetric comparisons that do not take this into account may be misleading (EPE 2019a).

energy exporter for the first time. However, a share of its crude oil supply (11% in 2018)—usually oil of lighter quality—as well as of gasoline (11%) and diesel (23%) consumed are still imported (EPE 2019a). Such imports mainly owe to Brazil's limited oil refining capacity, aggravated by stagnant ethanol production that has not kept pace with growing demand, which has forced gasoline imports and the importation of corn-based ethanol from the US. Petrobras, the country's state-controlled oil company and leading fuel distributor, until the 2010s owned three-quarters of Brazil's refineries (EPE 2013a). However, in 2019 the government decided to sell such assets to foreign investors—notably Chinese (EPE 2020). If Brazil's energy strategy during its economic heyday of the early 2010s was to double refining capacity by 2020 and eliminate diesel imports as early as 2015 (EPE 2013b), financial troubles and government changes have maintained its import dependence on refined fossil fuels. Domestic gasoline production is forecast to grow by a modicum of 3% between 2020 and 2029, while official projections expect oil refining into diesel to increase by only 23% in the decade (EPE 2020). These precisely are the fuels that ethanol and biodiesel replace, and it remains to be seen how such a persistent import dependence will affect biofuel expansion.

5.1.1.2 Agri-Food Context

Of Brazil's 350 million hectares (Mha) of arable land, approximately 200 Mha are used as pastures, 35 Mha for soybean cultivation, and 10 Mha for sugarcane—these two being the country's most valuable crops in economic terms (IBGE 2019; CONAB 2019, 2020). More than half of the sugarcane is used for making ethanol instead of sugar, though the exact rate varies every year as mills can switch between one and the other based on market conditions (CONAB 2019). Soybeans, in turn, are used mainly for animal feed, having vegetable oil as a co-product of secondary importance.

Since Brazil is a net exporter of both sugar and soybean oil, the diversion of those crops for fuel making has not posed a supply problem. Greater diversity of uses has, in fact, helped raise their international prices and earnings from exports. Brazil exports the majority of its sugar production, being by far the world's top exporter. As low oil prices and the COVID-19 pandemic hit fuel markets in 2020, sugar production and exports are expected to increase (Barros 2020). Soybean, meanwhile, is mostly exported uncrushed to China or—to a much lesser extent—as soy meal to Europe for animal feed. Soybean oil is but a by-product for which producers continually seek new downstream markets. Since biodiesel blending mandates came into force in 2008, soybean oil exports have significantly dropped. Exports currently take only 11% of Brazil's soybean oil supply, and half of what stays in the country is used for fuel, the other half as food (Ustinova 2020). Overall, if biodiesel manufacturing used 29% of Brazil's total vegetable oil consumption in 2012, this by 2018 had increased to 37%, a share that continues to rise as the domestic bioeconomy grows (OECD/FAO 2012, 2019).

5.1.2 Biofuel Production and Consumption Chains

5.1.2.1 Ethanol

Although Brazil has a nascent corn-ethanol industry, the bulk of the country's commercial ethanol production is based on sugarcane. The processing industry itself owns approximately half of the sugarcane cropland, showing some degree of vertical integration (Goldemberg et al. 2008; MAPA 2013). Historically it has also been characterized by the utilization of a large number of workers in manual cutting, a process associated with the burning of sugarcane fields before harvesting to reduce accidents.[2] However, concerns about air pollution and poor work conditions—leading to mounting health issues, cases of bonded labor,[3] and manual cutters' deaths due to overwork (Novaes 2007; Gomes et al. 2010a)—have led to the legal phase-out of crop burning. These issues have caused larger growers to seek mechanized harvesting, now widely used. While undoubtedly beneficial to the environment and human health, this has created a barrier to smaller producers who cannot afford expensive machinery.

Processing mills utilize sugarcane both from their cultivation and from suppliers. Prices are usually set based on the *total recoverable sugar* rate, i.e., the sugar content per ton of sugarcane. Most sugarcane mills in Brazil can choose how much sugar and ethanol to produce based on price signals, which gives them leverage but creates inevitable volatility in the ethanol and sugar markets. They can also strike a balance between the two types of fuel-ethanol commercialized in Brazil: *anhydrous* (to be mixed in gasoline at a fluctuating mandated rate, set since 2015 at 27%) and *hydrated* ethanol (to be used in "pure" form). In either case, mills must sell the ethanol to a distributor that then performs the fuel blending and sales. The main final consumers are automobile—and increasingly motorbike—drivers, which count on flex-fuel engine vehicles that can run on any combination of (hydrated) ethanol or gasoline. These engines allow drivers to choose between fuels based on price or other criteria (see Fig. 5.1).

The growing market for Brazil's sugarcane agroindustry and its high efficiency have attracted multinationals from the oil and agricultural technology sectors. This attractiveness has increased the number of acquisitions, mergers, and the industry's horizontal consolidation significantly, especially after the 2008/2009 financial crisis. For instance, British Petroleum, Bunge, and Louis Dreyfus Commodities acquired much of the Brazilian sugarcane-ethanol sector between 2008 and 2011. The country's largest sugarcane company, COSAN, became a joint venture with Shell called Raízen. Monsanto, now owned by Bayer, acquired some of the leading sugarcane research and development centers—with biotechnology that public funds had helped develop, to the chagrin of many Brazilian researchers and public complaints

[2] This refers to poisonous animals in the field, risks of workers cutting each other, and to the sugarcane leaves themselves, which can easily cut the skin (Ripoli et al. 2000).

[3] In 2009 more than 2000 rural workers were released by government inspection groups from bonded labor conditions, considered analogous to slavery, in the Brazilian sugarcane sector (Gomes et al. 2010a).

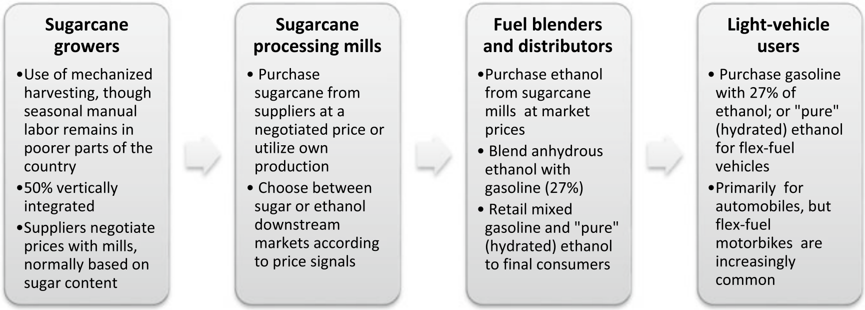

Fig. 5.1 Sugarcane-ethanol production and consumption chain in Brazil

by the minister of science and technology at the time.[4] Finally, Petrobras, too, started to make substantial investments in the sector and became a significant shareholder (see Gomes et al. 2010a), even though its participation would be forgone later in the decade due to political changes in Brazil.

Despite all the interest from large conglomerates, however, there is a clear perception that new investments in sugarcane-ethanol have fallen short of demand since 2010 (Jank 2011; REN21 2013; EPE 2019b). The 2010s saw a marked downturn in Brazilian ethanol production, with occasionally high international sugar prices also attracting producers to this other downstream market (EPE 2020). For instance, annual investments in sugarcane-ethanol decreased from 7.4 billion Brazilian reais (BRL) in 2011 (then about USD 4.5 billion) to one-quarter of it, BRL 1.8 billion in 2018 (USD 550 million at the time) (EPE 2019b). Since 2011, Brazil has had to import corn-ethanol from the US to meet its demand (Jank 2011). A once-thriving sector thus struggled under Brazil's economic hardship of the mid and late 2010s. Projections are of recovery of stability and gradual—if modest—growth through the 2020s (EPE 2020).

5.1.2.2 Biodiesel

Brazil's biodiesel production uses different feedstocks and often mixes them to achieve specific physicochemical parameters. Soybean oil (70% of the supply) and beef tallow (15%) are the leading feedstocks. The remainder of biodiesel uses other animal fats (e.g., pork fat) or plant sources such as cottonseed, castor bean and, increasingly, palm oil, which some expect to play a more significant role in the future (EPE 2019b, 2020). While the soy, cotton, and meat sectors are large industrial complexes, castor and palm oil chains tend to integrate smallholders, who biodiesel industries generally contract as feedstock suppliers.

[4]The minister of science and technology expressed his disappointment at the Brazilian private group, which had received large public funding over the years, for selling "those jewels so important to the country" to foreign groups (Escobar 2008).

Smallholder incorporation experienced a major initial crisis between 2006 and 2008 due to companies' inadequate technical assistance, low castor yields, and contract prices below market prices (Gomes et al. 2010b). Although castor was regarded as a "smallholder-friendly" crop capable of growing satisfactorily on poor soils and without water, fertilizer, or pesticide inputs, yields revealed to be small and mostly uneconomical under these conditions. As a result, companies broke many contracts and abandoned the smallholders, some of whom were later "rescued" by Petrobras Biofuels, a new state-controlled subsidiary. Petrobras started new agreements with the smallholders offering better seeds, improved technical assistance, and higher purchase prices adjustable to market conditions (Zapata et al. 2010). Rather than having farmers switch completely to feedstock cultivation (which proved harmful to local food security), Petrobras also started promoting mixed food-and-feedstock cropping, adding to the existing farming practices. Yet, despite purchasing castor beans for vegetable oil extraction, Petrobras did not use it to make biodiesel but instead sourced (cheaper) soybean oil for this purpose while selling castor oil more profitably to the oleochemical industry (Zapata et al. 2010; Bastos Lima 2012). Although later Brazilian administrations opted for a leaner state and largely dismantled Petrobras's biofuel operations, for some time it showed how different arrangements were possible—while also raising questions about who kept control of value-added.

Down the chain, all biodiesel manufacturers have to comply with rules from the National Agency of Petroleum, Natural Gas and Biofuels (ANP), which organizes auctions where fuel blenders and distributors purchase biodiesel. On average, about 25% of all biodiesel purchasing is done by Petrobras's distributor branch (down from 40% in the early 2010s), followed by Raízen (18%), and several other, smaller private distributors (ANP 2013, 2020). Distributors will then retail conventional diesel with a mandatory percentage of biodiesel mixed in it (12% in 2020, rising one-percent annually until 15% in 2023). All production is consumed domestically, primarily for heavy-duty vehicles or stationary engines in remote parts of the country (see Fig. 5.2).

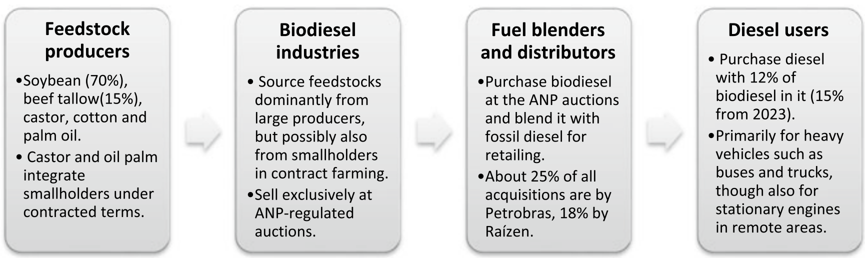

Fig. 5.2 Biodiesel production and consumption chain in Brazil

5.1.3 Brazil's Biofuel Policy Framework

Commercial biofuel policy in Brazil dates back to the 1930s, when the first ethanol blending mandates came to place. Sugar export was key for the country's colonial economy since the 16th century. Although by the first half of the twentieth century sugar was being used primarily for domestic consumption, this changed after the Cuban Revolution in 1959 left the large US market without a major supplier. Upon request from the private sector, there were significant public investments in the 1960s and early 1970s on sugarcane breeding, yield improvement, and industrial processing capacity, in addition to the subsidization of that sector (Moreira 2007; see Table 5.1).

By 1975, a crisis of overproduction led to record-low prices. Meanwhile, Brazil was spending large amounts of foreign exchange to import oil at soaring costs. These two factors led to a program of massive public financing for setting up ethanol distilleries (the "Pro-Alcohol" program). Besides, new regulations mandated the purchasing and blending of anhydrous ethanol at the rate of 22% in all gasoline (Szmrecsányi and Moreira 1991). In 1979, the government convinced—with fiscal incentives—the automobile industry to manufacture cars running on "pure" (hydrated) ethanol. This initiative diverted even more of the sugarcane overproduction and helped raise sugar prices. Brazil then lived its first ethanol boom, with record sales of ethanol-fueled cars in 1985.

By the late 1980s, however, oil prices had decreased, sugar prices increased, and many producers shifted away from ethanol, leading to supply shortages and massive consumer dissatisfaction. In addition, subsidies to (then more expensive) ethanol created a government budget deficit, which led to significant reform and the near dismantling of the program in a broad deregulation phase in tune with the neoliberal *zeitgeist* of the 1990s. Sugar and ethanol production and trade were liberalized, and sales of ethanol-fueled cars plummeted. Only the mandatory blending was maintained (Shikida et al. 2011; see Table 5.2).

The 2000s saw the resurgence of ethanol and new governmental engagement. The new approach (Law 10.453/2002) no longer relied on state-controlled prices and production but liberalization combined with economic incentives through tax breaks and public credit from Brazil's major development bank (BNDES). Fiscal incentives stimulated the introduction of flex-fuel cars in 2003, giving new traction to the commercialization of "pure" ethanol (Di Giulio 2006). Since its price is no longer set by the government but still should remain competitive with that of gasoline, the new policy became to tune the rate of ethanol blending (18–27%) as a market regulation tool. If "pure" ethanol prices are too high, the government can reduce the rate of anhydrous ethanol blended in gasoline to release supplies and lower them.[5] Since 2015 the blending rate has been fixed at 27%, but the government keeps that as a lever.

All these measures became part of the 2006 National Agroenergy Plan and were, for the first time, presented under a sustainable development rationale (see MAPA

[5]It was estimated that each percentage point down meant additional 250 million liters of ethanol that could be released in "pure" form in the market, bringing prices down (Reuters 2011).

Table 5.1 Import-substitution phase of biofuel promotion in Brazil

Year	Policy	Policy instrument type and target	Effect
1931	First mandatory ethanol blending	Blending mandate (*fuel distributors*)	Mandatory 5% blending (E5) to all imported gasoline to reduce dependence on foreign fuel[a]
1933	Creation of the Sugar and Alcohol Institute (IAA)	Economic regulation (*sugarcane processing industry*)	State to set sugar and ethanol prices and production quotas, and to mediate exports. Mills forced to source at least 40% of the sugarcane from suppliers to prevent too much sectoral consolidation[a]
1938	Ethanol blending expansion	Blending mandate (*fuel distributors*)	E5 extended to all gasoline, imported or domestic[a]
1961	Creation of an Exports Division within the IAA	Public credit (*sugarcane growers and industry*)	Subsidized loans to increase sugar production and exports, particularly to the US market[a]
1962	Investment package to enhance sugar production	Public credit and investments in production capacity (*sugarcane growers and industry*)	Expansion of production quotas, public investments, and financing for increasing sugarcane's agroindustrial capacity upon private sector requests to meet growing market demand[a]
1971	National Program of Sugarcane Improvement (*Planalsucar*)	Public investment (*sugarcane R&D*)	Public-funded R&D program on sugarcane breeding and agronomics to improve yields and adapt it to different soils and agro-climatic conditions[a,b]
	Rationalization Program to the Sugar Industry	Public credit (*sugarcane growers and industry*)	Subsidized loans to modernize the sector, prioritizing larger enterprises as a way to increase economies of scale[a,b]
1973	Support Program to the Sugar Industry	Public credit (*sugarcane growers and industry*)	Follows the Rationalization Program, nominally replacing it but maintaining the same agenda[a,b]
1975	Pro-Alcohol ethanol program	Public investment in ethanol processing infra-structure; Blending mandate (*fuel distributors*)	Public investment in sugarcane-ethanol distilleries; Petrobras to absorb that production and mix it in gasoline up to E22[a,b]
1979	Pro-Alcohol phase 2	Fiscal incentives and public credit (*automobile and sugarcane industries*)	The automobile industry to produce cars running on ethanol only, and the sugarcane industry to make hydrated ethanol (E100) directly from sugar juice[a,b,c]

[a]Szmrecsányi and Moreira (1991); [b]Moreira (2007); [c]Hall et al. (2009)

Table 5.2 Deregulation phase of biofuel promotion in Brazil

Year	Policy	Policy instrument type and target	Effect
1990	Extinction of the IAA	Economic (de)regulation (*sugarcane industry*)	Start of the deregulation phase, eliminating the IAA and Planalsucar[a,b]
1994	Liberalization of sugar exports	Economic (de)regulation (*sugarcane industry*)	Permission for the industry to export sugar directly, without government mediation (previously done by the IAA)[b]
1997	Deregulation of anhydrous ethanol prices	Economic (de)regulation (*sugarcane industry*)	Anhydrous ethanol prices no longer set by the government; they can fluctuate freely in the market[b]
1998	Deregulation of sugarcane prices	Economic (de)regulation (*sugarcane industry*)	Sugarcane prices no longer set by the government; mills and growers to negotiate[b]
1999	Deregulation of hydrated ethanol prices	Economic (de)regulation (*sugarcane industry*)	Hydrated ("pure") ethanol prices no longer set by the government but to fluctuate freely and compete with gasoline in the market[b]

[a]Szmrecsányi and Moreira (1991); [b]Shikida et al. (2011)

2006). This new emphasis was accompanied by key initiatives to address social and environmental concerns, such as a National Plan for the Eradication of Forced Labor (Brazil 2003)[6] and an "agroecological zoning" policy for sugarcane, to reduce deforestation risks. Through this mechanism, public credit became limited to producers who complied with the zoning, even if cultivation did not become strictly forbidden (Manzatto et al. 2009). (This zoning policy would remain in place for over a decade until the Bolsonaro administration abolished it in late 2019.)

In 2012, the government announced massive new public investments in sugarcane expansion and ethanol storage,[7] totaling about USD 38 billion by 2015. It also changed regulations to allow greater state control over ethanol markets, given a lack of private investments and shortfall in ethanol production after 2010 (MAPA 2012a). Such modifications included, for instance, legally changing ethanol from an "agricultural product" to a "fuel" and a "public utility," which allows the government to prevent price volatility and interfere in international trade in the name of national and public interest.[8]

[6]Although the policy targets forced labor in all sectors, there was a clear link with the sugarcane sector, which has been in the spotlight in this regard since at least the early 2000s.

[7]This is particularly key for periods in between harvests, when ethanol supplies tend to be lower.

[8]Law 12.490/2011; Law 12.666/2012.

An economic recession (2015–2016) significantly slowed Brazil's ethanol prospects, but policies would experience a come-back in 2017 with a National Biofuels Policy.[9] This time, the emphasis has been on systematically using biofuels to meet the country's international climate commitments. Brazil's increasingly neoliberal administrations—first the business-oriented Temer, followed by far-right Bolsonaro—consolidated a radical political U-turn, away from the Workers' Party governments (2003–2016). Yet, the country has maintained its commitment to the Paris Agreement. The *RenovaBio* program, instituted as a National Biofuels Policy, has adopted 2025 and 2030 fuel emissions reduction targets, has created a grading system to certify biofuel producers according to their emissions reductions, and set up a market for Certificates of Decarbonization by Biofuels (CBIO). The program should operate initially from 2020 through to 2030, with the expectation of renewal after that (MME 2018). Table 5.3 summarizes the key policies from this current, sustainability-oriented phase of ethanol promotion in Brazil.

In contrast to ethanol, biodiesel in Brazil is a far newer commercial sector, and it has a much leaner policy. Its framework was laid out in the National Program on Biodiesel Production and Use (*Programa Nacional de Produção e Uso do Biodiesel—PNPB*), launched in 2004. PNPB introduced a sequence of biodiesel blending mandates: 2% blending (B2) came into force in 2008; B3 was initially foreseen for 2010 but anticipated to July 2008 thanks to industry readiness; and the same happened to B5, pulled from 2013 to 2010 (Law 11.097/2005). These blending mandates continue to be the core of Brazil's biodiesel policy. Later increases have been steadily implemented, with B12 coming into force in 2020 and an expectation of B15 by 2023. Besides, the government has offered credit and fiscal incentives to biodiesel producers. Finally, PNPB established that biodiesel sales to distributors would take place exclusively through state-regulated auctions (Law 11.116/2005). By early 2020, more than 70 such auctions had taken place, trading a continuously growing amount of fuel.

A key element of PNPB has been its social orientation. The policy determines that biodiesel industries that source feedstock from smallholder "family agriculture" (which has a legal definition in Brazil[10]) receive a *social fuel seal*, which grants additional credit, fiscal advantages, and priority in 80% of the auctioned sales.[11] Due to the initially problematic integration of smallholders, the program was reformed in 2009 and subsequently amended in 2011 and 2012 to add further requirements and specifications. The policy started requiring that biodiesel industries provide smallholders with technical assistance and that supply contracts be validated by a representative labor union or social movement to safeguard smallholders' interests (MDA 2009). This change coincided with the creation of Petrobras Biofuels—then presided by the

[9]Law 13.576/2017.

[10]Law 11.326 of 24th July 2006 defines family farmers as those who run the farm with and use primarily labor from his/her own family, whose income derives mainly from farming, and who owns not more than four fiscal modules—an area measure which varies depending on the region of the country, from 20 ha in more developed to 400 ha in remote regions.

[11]The requirement is that at least 30% of the company's total expenditures on feedstock sourcing must be directed to smallholders (MDA 2009).

Table 5.3 Sustainable development phase of biofuel promotion in Brazil: ethanol

Year	Policy	Policy instrument type(s) and target(s)	Effect
2000	Creation of the Inter-ministerial Council on Sugar and Alcohol	Governance and overseeing	A deliberative body on sugarcane and ethanol policies, comprising the ministries of agriculture (coordinator); finance; mines and energy; and development, industry, and foreign trade[a]
2002	Law on ethanol subsidies	Governance and overseeing	Sets a new legal framework for ethanol subsidization to ensure stable supplies[b]
	(São Paulo state) Law phasing out sugarcane burning	Environmental regulation (*sugarcane growers*)	Phasing-out of sugarcane field burning, made illegal by 2021 on flat areas where mechanized harvesting is possible and by 2031 in all areas[c]
2003	Fiscal incentives for the production of flex-fuel cars	Fiscal incentives (*automobile industry*)	Reduced taxation on flex-fuel vehicles, able to run on any combination of hydrated ethanol and gasoline[d]
	National Plan for the Eradication of Forced Labor	Labor regulation (*sugarcane growers*)	Stricter laws against forced labor, linking it to rural public credit; farm inspection teams from the Ministry of Labor are set up[e]
2006	National Agroenergy Plan (2006–2011)	Public investment (*R&D on biofuel value-chains*)	Orchestrates the rationales, means, and goals for biofuel expansion in Brazil; announces funding for biofuel R&D[f]
2009	Sugarcane Agroecological Zoning	Zoning (*sugarcane growers*)	Agronomic classification of lands based on suitability to sugarcane cultivation, and recognition of environmentally sensitive, no-go areas where public credit is unavailable[g]
2011	State regulation of ethanol stockpiling and trade	Economic regulation (*sugarcane industry*)	Ethanol legally treated as a "fuel," not anymore as an "agricultural" product, to allow greater state regulation on ethanol stockpiling and foreign trade; blend range widened, E20–25 to E18–25[h]
2012	Subsidized credit for ethanol stockpiling	Public credit (*sugarcane industry*)	Subsidized credit to increase ethanol stockpiling capacity, to prevent supply shortages and ensure ethanol's price competitiveness face gasoline[h]
	BNDES *Pro-Renova* credit	Public credit (*sugarcane growers*)	New billion-dollar credit line at Brazil's Development Bank (BNDES) to renew and expand sugarcane cultivation[i]
	Strategic Plan for the Sugar-and-Ethanol Sector	Public investments (*sugarcane growers*)	BRL 29 billion (~USD 14 billion) to renew 6.4Mha of sugarcane cropland and BRL 23 billion (~USD 12 billion) for an additional 3.8 Mha[j]
2015	Increased blending mandate (E27)	Blending mandate (*fuel distributors*)	Ethanol blending mandate widened to E18–27 and set at 27% for the time being[k]
2017	*RenovaBio*—National Biofuels Policy	Emissions reduction targets and carbon market (*domestic ethanol industry*)	Annual carbon intensity reduction targets, producer certification, and trade of Decarbonization Credits[l]
2017	Ethanol import tariff	Tariff on imports (*domestic ethanol industry*)	A 20% tariff on imported ethanol beyond a 600 million liters quota (raised to 750 million in 2019) to protect domestic ethanol producers[k]
2019	Abolition of sugarcane zoning	Zoning (*sugarcane growers*)	Zoning restrictions to sugarcane growers (keeping the Amazon off-limits) lifted

[a]Decree 3.546/2000; [b]Law 10.453/2002; [c]São Paulo State Law 11.241/02; [d]Di Giulio (2006); [e]Brazil (2003); [f]MAPA (2006); [g]Manzatto et al. (2009); [h]Provisional Measure 532/2011; Law 12.666/2012; [i]BNDES (2012); [j]MAPA (2012a); [k]Barros (2020); [l]MME (2018)

former Minister of Agrarian Development—and its direct engagement with smallholders contracting in the country's most deprived areas where the private sector had given up (Gomes et al. 2010b). Petrobras then adopted as its policy the provision of improved seeds from the—also state-controlled—Brazilian Agricultural Research Corporation (EMBRAPA). It started promoting mixed food-and-feedstock cultivation to avoid food insecurity problems that smallholders experienced when converting exclusively to feedstock cultivation. Finally, Petrobras began to experiment with alternative feedstocks to castor, such as sunflower oil.

Those changes successfully reversed the earlier problems with smallholder integration. Yet, in time the only family farmers to effectively contribute to biodiesel making would be soy producers from the more well-off South of the country. Castor and other oils appeared too valuable (and expensive) to become biodiesel feedstocks—they played a more sensible role in other bioeconomy chains, such as in the oleochemical industry, to which Petrobras Biofuels started supplying. That notwithstanding, Brazil's neoliberal administrations since 2016 have all but dismantled the state-controlled subsidiary. Poor performance, insufficient investments, and later lack of buyers led the castor bean planted area to shrink from 219,300 ha in the 2010/2011 harvest to only 28,000 ha in 2016/2017 (growing back to 45,600 in 2019/2020, but still far below its apex) (CONAB 2020).

The biodiesel sector would become effectively sustained by feedstocks from large agro-industrial complexes (soy and beef), thus mainly losing its original social purpose of addressing rural poverty through biofuel value chains. In 2019, a new ordinance would then eliminate the need for an organization to ratify supply contracts. Moreover, it made not only family-agriculture cooperatives but any cooperative that includes family farmers eligible for the Social Fuel Seal and its benefits.[12] In practice, this has allowed commercial soy-farmer organizations to occupy a niche originally envisaged for poor smallholders—without formally dismantling but making a travesty of the sector's original social orientation.

By the start of 2020, the biodiesel industry met a 12% biodiesel blending mandate using mainly soybean oil and beef tallow. These are by-products in abundant supply in Brazil, and therefore a growing mandate has been steadily implemented. With the COVID-19 pandemic, however, for the first time, the government *reduced* the obligatory blending rate temporarily to 10%.[13] Much to the chagrin of biodiesel industries, that had to do with abundant soy supplies sold in bulk—primarily to China—leaving little to be domestically processed. A devalued Brazilian currency has made raw soy exports attractive to growers, but it reduced biodiesel feedstock supplies and increased the cost of (soy) cooking oil to Brazilian households.

While it remains to be seen what will prevail in terms of using Brazil's growing soy supplies, from 2023 a 15% blending rate is to be in place, at which stage technical limitations of current engines might stall further increases. The official forecast is that this rate will remain fixed throughout the 2020s, although representing ever-larger absolute amounts as total diesel consumption is expected to increase (EPE 2020).

[12]Ordinance N.144, of 22nd July 2019.

[13]See Resolution N. 824, of 13th August 2020.

Table 5.4 summarizes the principal policy instruments behind biodiesel promotion in Brazil.

The rationales for Brazil's biofuel policies have varied through the years, arguably expanding their range and significantly shifting depending on the federal administration. Table 5.5 synthesizes the five main foci identified.

5.1.4 Assessing Institutional Causality

The state has played a crucial role throughout the history of biofuel expansion in Brazil. Unlike other markets, which may emerge spontaneously out of consumer demand and private sector initiative, biofuels have been a governmental project in all the occasions they appeared: in the 1930s, 1970s, and most recently in the 2000s. Public institutions have always been critical for the debut, development, and acquired economic viability of the sector.

All along, the Brazilian government has used a powerful combination of regulatory and economic instruments to enable private agroindustries to produce biofuels and make this production economically attractive. From their earliest days, blending mandates have secured captive markets to absorb production regardless of biofuels' competitiveness vis-à-vis gasoline and diesel. There has been vast subsidization in the forms of tax breaks, public credit, and investments in production infrastructure and R&D (including vital public-funded research to improve soybean and sugarcane yields during the 1970s and 1980s). Notably, the government never engaged in feedstock cultivation. Instead, it has mandated consumption, creating additional markets for an agricultural sector that in Brazil has historically been in private hands, while oil refining and fuel distribution have been dominated by Petrobras, a state-controlled company. Every time, surges in biofuels production came as a direct consequence of public policies.

The pattern of how public institutions drive biofuel expansion has, however, changed over the years. While direct subsidization and government-set prices characterized the sector in the 1970s and 1980s, the 1990s saw a period of deregulation that was not reversed when biofuels resurged in the 2000s. Subsidies gave place to loans, primarily from Brazil's state-controlled development bank (BNDES). Moreover, although blending mandates have been maintained, sugarcane-ethanol production was already efficient enough to compete with gasoline in the free (non-captive) market, which was crucial for the extensive adoption of flex-fuel cars since 2003.

A few other differences have marked this more recent, post-deregulation phase. First, foreign bioproduct markets appeared in the 2000s for the first time and gained relevance. Brazil initiated the so-called "ethanol diplomacy" (Jank 2011) to increase exports and promote biofuels abroad to establish them as globally traded commodities (see Chap. 4). These foreign markets can be considered additional drivers of biofuel and bioeconomy expansion in Brazil, but their influence is arguably minor compared to that of the broad framework of Brazilian institutions promoting them. Moreover, most investments and the lion's share of biofuel consumption remain domestic.

Table 5.4 Sustainable development phase of biofuel promotion in Brazil: biodiesel

Year	Policy	Policy instrument type(s) and target(s)	Effect
2004	National Program of Biodiesel Production and Use (PNPB)	Blending mandate (*fuel distributors*); Conditional public credit, procurement, and fiscal incentives (*biodiesel industry*)	Biodiesel blending allowed and phased in, aiming initially at mandatory B5 by 2013. Creates the Social Fuel Seal, providing preferential procurement and additional fiscal and credit benefits to biodiesel industries which purchase feedstock from smallholders[a]
2006	National Agroenergy Plan (2006–2011)	Public investment (*R&D on biofuel value-chains*)	Orchestrates the rationales, means, and goals for biofuel expansion in Brazil; announces funding for biofuel R&D[b]
2008	B2 mandate	Blending mandate (*fuel distributors*)	Mandatory 2% biodiesel blending (B2) comes into force
2009	New rules for biodiesel's Social Fuel Seal	Conditional public credit, procurement, and fiscal incentives (*biodiesel industry*)	Biodiesel industries must provide contracted smallholders with specified technical assistance; a labor union or social movement representing smallholders' interests must validate the contracts[c]
	B3 mandate	Blending mandate (*fuel distributors*)	Mandatory B3 comes into force
2010	B5 mandate	Blending mandate (*fuel distributors*)	Mandatory B5 comes into force, anticipated from 2013
2014	A second round of blending mandates	Blending mandate (*fuel distributors*)	New blending targets: B7 (2014), B8 (2017), B10 (2018)[d]
2018	A third round of blending mandates	Blending mandate (*fuel distributors*)	B11 (2019), B12 (2020), B13 (2021), B14 (2022), and B15 (2023)
2019	New rules for the Social Fuel Seal	Conditional public credit, procurement, and fiscal incentives (*biodiesel industry*)	Eliminates the need for a representative organization to ratify supply contracts; makes larger commercial cooperatives eligible as "family farmer" suppliers[d]
2020	B12 mandate	Blending mandate (*fuel distributors*)	Mandatory B12 comes into force.

[a]Law 11.097/2005; [b]MAPA (2006); [c]MDA (2009); [d]Magossi (2012); [e]Ordinance N.144, of 22nd July 2019

Table 5.5 Rationales for biofuel policies in Brazil

Rationale	Specific interests	Period of relevance
National energy security[a]	Reduction in imports of oil and oil derivates Diversification of the energy mix[b]	From the 1930s to the present
Economic growth[c]	Expansion of domestic biofuel markets Foreign exchange earnings from biofuel exports	From the 1970s, though exports have become relevant only since the 2000s
Social inclusion[d]	Smallholder integration in biodiesel production chains	From 2004 to 2016; only residual afterward
Atmospheric benefits[e]	Climate change mitigation and reduction of urban air pollution by replacing fossil fuels, particularly in the transport sector	From the 2000s; more systematically since 2018 with *RenovaBio*
Geopolitical power[f]	Legitimacy from the international recognition of Brazil's expertise and experience with "clean" technology in the strategic area of energy Further authority in global governance (energy, environment, trade, agriculture) Greater relevance in global trade, taking over some of the influence of oil exporters Closer relations with like-minded countries Ultimately, a permanent seat at the UN Security Council	From the 2000s, mainly 2004–2010. Political entrepreneurship on the international stage has significantly reduced since then, but these geopolitical elements arguably continue to be strategic, long-term goals

[a]Szmrecsányi and Moreira (1991) and MAPA (2006); [b]Different energy sources are subject to different supply determinants, types of price volatility, and impacts that could compromise availability; [c]Szmrecsányi and Moreira (1991) and Hall et al. (2009); [d]MDA (2009); [e]MAPA (2006) and Goldemberg et al. (2008); [f]Dauvergne and Farias (2013); see Bastos Lima (2012)

Second, through the creation of Petrobras Biofuels, the government began to engage directly with biofuel production, a degree of government-controlled vertical integration that had not happened before in the sector. Third, the government started to increasingly shape the bioeconomy by determining *how* biofuels should be produced, through a growing number of social and ecological requirements. Clear examples have been the incorporation of smallholders to reduce social exclusion, the stricter prohibitions on forced labor, and the phasing out of sugarcane field burning—all these century-old problems which the private sector had never tackled voluntarily, and which previous governments had not bothered to sufficiently address until the emergence of an environmentally scrutinized bioeconomy. Finally, the state started taking increasing advantage of its position as the leading financier of biofuels to impose conditions for credit, as seen in the sugarcane zoning policy and the Social Fuel Seal.

Even if, in recent years, large agricultural interest groups have prevailed in loosening restrictions, on the whole the Brazilian bioeconomy—and particularly its biofuel sectors—provide a good illustration of a "return of the state" to the fore, after a period dominated by neoliberal policies of deregulation and privatization in the 1990s. Non-state actors surely lobby for biofuel production and other nascent bioeconomy sectors behind the scenes, but mainly through the medium of public policies. This practice in itself does not conflict with the observation that (domestic) public institutions have been the key *sine qua non* cause of biofuel expansion in Brazil.

5.2 Allocation and Access: Analyzing Institutional Performance

5.2.1 Allocation Patterns: Who Owns, Does, and Gets What

Brazil remains one of the most unequal countries in the world, and Latin America is the most unequal region of the globe (UNDP 2019). Despite reductions in economic inequality due to social inclusion policies in the 2000s, in Brazil the wealthiest 10% of the population still get as much as 55% of the country's total income (UNDP 2019, p. 107). Its Gini coefficient[14] on income remained as high as 0.53 on average between 2010 and 2017 (UNDP 2019).[15] The index on land ownership inequality reached 0.87 in 2018, worsening from 0.85 in 2009 (IBGE 2009; Oxfam 2019). The 2017 rural census showed that family farming constituted 77% of Brazil's approximately 5 million rural properties but occupied only 23% of the farmland. In turn, large-scale agribusiness held 77% of the farmland—a gradually decreasing number of

[14]For a comparison, the coefficient for income inequality in most African countries is below 0.50, and as low as 0.25–0.30 in Northern Europe (UNDP 2019).

[15]This was already a decrease from 0.59 in 1998 (Lustig et al. 2013).

ever-larger, consolidated farms (IBGE 2019). Yet, the latest data show that family farming provides for 70% of all the food consumed in Brazil and 74% of all rural jobs, employing on average 15 persons per hectare, against 1.7 persons per hectare in large agribusiness. Moreover, the former has created twice as much economic value per hectare than the latter (IBGE 2009).

Biofuels and other bioeconomy value chains have therefore entered a very skewed agricultural sector. Policy incentives have targeted and primarily benefited the agribusiness minority. Large-scale farms—often vertically integrated and owned by the industry itself—control 75% of all ethanol production in São Paulo state, the center of Brazil's sugarcane agroindustry (Goldemberg et al. 2008). This proportion is even more significant in Brazil's Northeast, where traditional structures of large landlord ownership are even more prevalent (Hall et al. 2009). As such, smallholder participation is considerably limited. Smallholders at sugarcane expansion frontiers usually sell their lands and move to a city, increasing land ownership concentration (see Novo et al. 2010 for the case of small dairy farmers in São Paulo state). Experiences are demonstrating the feasibility of small-scale distilleries and local ethanol utilization in some parts of the country. Still, these usually face financial, technological, infrastructural, and organizational limitations, and they have poor market access. Biofuels cannot be sold in Brazil without verification of technical standards, but meeting these standards incurs technology and transaction costs that small-scale producers have difficulties to afford (Moreno and Ortiz 2007). Consequently, small- or medium-size sugarcane growers are usually bound to sell their produce to processing mills controlled by large landowners or agribusiness companies who possess the necessary resources and capacities (see Hall et al. 2009; Gomes et al. 2010a). These private industries, therefore, capture all value-added stages of production.

Meanwhile, there is an increasing ownership concentration of crop genetic resources. Although much of the feedstock plant breeding and processing technology was developed with public funds since the 1960s, the recent spike in acquisitions from multinationals has shown an increasing transfer of control to international private capital. Consequently, profits are likely to become less "socialized," and access to those technologies becomes more restricted even though their base was built on taxpayers' money. This social equity issue applies to genetically modified soy and corn feedstocks widely used in Brazil as much as to sugarcane.

Advocates of the sugarcane-ethanol sector argue that there are substantial social benefits in employing hundreds of thousands of sugarcane cutters for manual harvesting every year (Goldemberg et al. 2008). However, mechanization is rapidly reducing that form of employment in some regions, and indeed an examination of the quality of those jobs quickly reveals their insecurity and health-degrading work conditions (Novaes 2007; Gomes et al. 2010a; Rocha et al. 2010). Cases of cheating on workers' payment per productivity are also common and a source of conflict

(Biondi et al. 2009). By employing primarily seasonal migrants, the sector exacerbates household disintegration, too.[16] The current transition towards mechanized harvesting has improved on these social impacts, but at the cost of consolidating the sugarcane sector's socially exclusive structure. Although many manual cutters have sometimes been trained for more skilled jobs (Jank 2011), it is clear that only a small minority is being absorbed. The larger unskilled and illiterate mass is simply being excluded from the sector.

Brazil has tried to fill these social gaps through its biodiesel policy by allocating additional economic benefits to industries that integrate smallholders. Engaging with smallholders incur further burdens and risks such as the provision of technical assistance, the need to source in smaller amounts from a larger number of suppliers, and dealing with partners who may not be used to business contracts. These were burdens the private sector seemed unwilling to take, triggering the creation of Petrobras Biofuels and its insertion in this market to save the government's agenda. Smallholder integration then quadrupled between 2008 and 2010 to more than 100.000 households (Gomes et al. 2010c).

Although this inclusion of smallholders would later erode due to Brazil's governmental changes, it is useful to analyze the experience and lessons therein. It was clear that, notwithstanding some poverty reduction benefits, allocation of control and of roles in those contracts remained skewed in favor of the industry. First, most arrangements have been made under monopsony conditions, i.e., with many potential sellers but only one buyer available, giving the latter disproportional leverage over price and negotiation terms. The disadvantageous terms smallholders initially got were crucial for the 2009 policy change requiring contract validation by a representative social movement. Second, while the industry benefits from value-added and can choose among different downstream markets (e.g., castor oil sold by Petrobras to the more profitable oleochemical market rather than for fuel), smallholders are limited to the condition of mere raw-material suppliers.[17] As a Brazilian professor describes the arrangement: "If everything works out, the farmer will live his whole life receiving a minimum salary for the crop he supplies, while Petrobras pockets the big money" (Personal interview). Finally, there has usually been an imposition of "improved" seeds that dismisses local varieties, even though the former's superiority has been questioned (Kilham et al. 2010; see also Altieri and Toledo 2011). Usually, those seeds come as a package together with fertilizer and pesticide inputs, to the dissatisfaction of many smallholders as it can easily create a form of dependence and undermine traditional knowledge, resources and local approaches sometimes based on organic agriculture (Wagenaar 2009; Kilham et al. 2010).

[16] Such seasonal migrants normally stay away for the largest part of the year. In Brazil, the wives left behind become known as "widows of living husbands" (Biondi et al. 2009). See also Hall et al. (2009) and Gomes et al. (2010a).

[17] In the particular case of Petrobras, it benefits twice from biodiesel production, not only from this market in itself, but also from reducing diesel imports. It has been estimated that the Brazil's 5% biodiesel blending saves Petrobras USD 1.4 billion per year in foreign exchange (Gomes et al. 2010c).

These biofuel production strategies thus reveal a profound imbalance in the allocation of power, roles, benefits, and burdens in the emerging bioeconomy. While control and value-added are retained mainly by private agribusiness—and previously also Petrobras, a company of mixed capital—the rural poor have been allocated at most with only the least valuable roles, with hardly any control, and minimal gains. In fact, their situation of need has often been exploited, as in the case of cheap degrading labor in sugarcane cutting. This shortage of societal benefit is even though most investments over the years in agriculture and much of the sector's financing have been public.[18] It is, however, the larger agroindustry that gets, in addition to those investments and credit, a whole new market of sizeable elastic demand, plus higher profits from increased sugar, corn, or vegetable oil prices.

5.2.2 Access to Resources: Land, Water, Food and Energy

Access to land, water, energy and food are all pressing issues that have often led to social conflict in Brazil. There are millions of landless rural workers in Brazil, while 1% of all rural properties amass as much as half of the vast country's farmland (IBGE 2019). More than four million Brazilians lack access to safe drinking water (WHO/UNICEF 2019), 400 thousand lack access to modern energy services (IEA 2019), and 13 million are undernourished (FAO 2019). Land and water, in particular, have been significant sources of conflict in rural areas. Annually there were on average over 1000 land conflicts in Brazil between 2003 and 2019, some persisting year on year. There was also a noticeable increase in water conflicts, from 87 recorded in 2010 to 489 in 2019. Overall, such conflicts resulted in 411 murders between 2010 and 2019, plus other adverse impacts on many thousands. Most cases have involved large landowners and private agribusiness, systematically at the expense of indigenous peoples and the rural poor (CPT 2020).

The surge of ethanol markets in the 2000s saw the doubling of the sugarcane area in Brazil. It expanded from 4.82 Mha in 2000 to 8.92 Mha in 2008, after being fairly stable since the late 1980s (MAPA 2013). That expansion had two significant implications on access to land. First, ownership and control over land became further consolidated, as small farms at the sugarcane frontiers were either bought out or turned into contracted sugarcane suppliers. This pressure increased, for instance, on small dairy farms in São Paulo state (Novo et al. 2010). Second, it raised opportunity costs and increased disputes between sugarcane farmers and indigenous peoples in frontier regions. Most notably, sugarcane expansion has inflamed conflicts with the Guarani-Kaiowá indigenous people in Mato Grosso do Sul State, hindering their legal access to land and aggravating violence (see CPT 2013). Due to limited investments, the sugarcane area remained more or less stable at 8.5–10 Mha between 2010 and

[18] For the 2012/2013 harvest, the government made available R$115.2 billion (about USD 57 billion) in public credit to private agribusiness. For a comparison, public credit available to all family farming is at R$18 billion (about USD 8.9 billion) (MAPA 2012b).

2020. Still, this period of stability might again find a new boon of expansion as more sugarcane uses for the bioeconomy become commercial.

Agribusiness has also been claiming growing amounts of freshwater. Even though most feedstock crops in Brazil are rain-fed, many producers have adopted irrigation to increase yields (Takahashi and Ortega 2010). Both sugarcane and soy crops have frequently enjoyed such supplemental irrigation (EPE 2008, p. 639). In soy's case, it includes river and groundwater withdrawals in water-insecure regions that experienced shortages and social unrest due to lost access (Bastos Lima and Persson 2020). Also, pesticide use and wastewater discharges have increased alongside the expansion in the cultivated area. Biondi et al. (2009) noted that pesticide use in sugarcane cultivation increased by nearly 70% between 2004 and 2008, the years of the ethanol boom. Moreover, for each liter of sugarcane-ethanol produced, there are on average 13 L of acidic *vinasse* wastewater to dispose of (da Cruz et al. 2008). Although sugarcane-ethanol advocates have marketed this as a closed-cycle natural fertilizer (see Goldemberg et al. 2008), there is evidence that irregular and excessive applications have become a source of groundwater contamination (da Cruz et al. 2008). Meanwhile, local populations have suffered immensely from pesticide contamination in areas where soy and corn (which are usually intercropped) expand (Russo Lopes et al. 2021).

Impacts on access to food have been ambivalent, and there is a distinction to be made between the macro and micro levels. At the macro level, there is already a consensus that biofuels help drive agricultural commodity prices up (see Chap. 2), though this effect seems comparatively small in the Brazilian case. Brazil does not significantly rely on staple crops for fuel, and the food resources it uses (mainly vegetable oil and sugar juice) have abundant supplies. In the case of biodiesel, current and foreseen blends in the short term (12–15%) do not seem to pose a food insecurity issue. Still, it is unclear whether that might change if the blending mandate increases 20% as some in the sector want, or if soybean oil finds further bioeconomy utilizations in the future.

Another food security concern is the gradual replacement of smallholder family farming with ever more consolidated industrial monocultures. Family farming in Brazil provides the largest quantity and variety of foods eaten in the country; therefore, a bioeconomy expansion based on a handful of industrial monocultures can impoverish national food security over time (see Bastos Lima 2008; IBGE 2009). At the local level, too, transitions from mixed farming to feedstock cash-cropping have created major food insecurity issues. Notably, when companies abandoned contracted smallholders, they left them with crops farmers could not eat and could hardly sell (see César and Batalha 2010; Gomes et al. 2010b). The policy changes of 2008/2009 and the insertion of Petrobras in the sector improved the outcomes significantly; in 2010, the industry spent BRL 1.2 billion (about USD 600 million at the time) on smallholders growing feedstock, generating an additional income that could enhance local food security (Gomes et al. 2010c). Such mixed results suggest that impacts on local access to food vary substantially depending on the institutions in place. Yet, some in Brazil have been critical of contract farming as a model. As an interviewed analyst puts it,

> For the small farmer, it is like becoming an employee of the industry, but without job security. Although the contract ensures him an income for some time, upon any economic downturn he is the first to be discarded. Then what will he do? He can't just go back to traditional farming that easily after having turned his land into a sugarcane monoculture. (Personal interview)

Finally, although biofuels have much potential to improve access to clean energy in rural and forest areas using local resources (Cunha et al. 2007; Kuik et al. 2011), the Brazilian policy all along has been to use them primarily in the mainstream fuel market, i.e., as an additional offer directed mostly at urban drivers. In other words, biofuels have been used mainly by those who already had access to modern energy. Motorists thus benefit from more fuel options, potentially allowing them to spend less on driving and reducing the costs of goods transported by road. This focus is, of course, advantageous to the automobile industry, too, as indicated by its record sales of flex-fuel cars in Brazil (Gomes et al. 2010a). Meanwhile, to improve rural electrification rates, Brazilian governments of all political hues have systematically preferred to expand centralized grids, such as through the national program *Luz para Todos* ("Light for All"), rather than investing in rural industrialization and local biofuel use.

5.3 Agency in Biofuel Governance in Brazil

5.3.1 Main Coalitions and Their Policy Beliefs

Two main coalitions can be identified in biofuel governance in Brazil: an *agribusiness* and an *agroecology* coalition. The former is dominant and comprises most of the government, in addition to fuel industries, sugarcane, soy and other private agribusinesses, and part of the scientific community. The agroecology coalition includes mainly civil society organizations (with stronger participation of smallholder and rural worker organizations than strictly environmental NGOs) and a more critical segment of the scientific community. Other actors such as urban dwellers and indigenous peoples are not particularly relevant agents in this governance context, even if they are affected by the biofuels and bioeconomy agenda.

Table 5.6 presents the two main coalitions' key policy-beliefs. It is useful to note that, in broad lines, the Brazilian government policy-beliefs regarding biofuels have not significantly changed despite changes of administration. They have maintained a clearly optimistic spirit, aligned with ecological modernization and dismissive of calls for structural change (Lima and Toni 2020). The table shows that there may be disagreements within a coalition, but usually at the (more superficial) level of secondary aspects. For example, the sugarcane agroindustry has long lobbied Brazilian governments to tax gasoline more heavily to make ethanol more competitive (Jank 2011), but generally without success. Similarly, more radical actors in the agroecology coalition have disagreed with those who believe that smallholders'

Table 5.6 Main agents, coalitions, and policy-related beliefs on biofuels in Brazil

Main agents and coalitions	Policy-core beliefs	Secondary aspects
Government	• Biofuels can and should replace fossil fuels on a large scale, but without structural changes in fuel distribution and consumption patterns • Brazil should promote biofuels in other developing countries to establish them as global commodities and become a major exporter. The unilateral imposition of sustainability requirements by importers is unjustified "green" protectionism • Brazilian biofuels cause no food vs. fuel conflict. Biofuel crops can expand over abundant pasturelands alongside cattle ranching intensification without aggravating deforestation • Biofuel production supports development and reduces poverty by creating jobs and income for smallholders and rural workers	• ~~Castor bean is capable of producing well without inputs.~~ (Revised: Provide chemical inputs and technical assistance) • ~~Integration in biodiesel chains will be good to smallholders by default~~ (Revised: Have representative social movements ensuring fair contracts) • ~~Smallholders should shift to castor bean monocultures~~ (Revised: Add castor to mixed farming)
Private agribusiness		• ~~Sugarcane-ethanol can compete easily with gasoline~~. (Revised: The government should tax gasoline more)
Fuel industry		• The biodiesel blending mandate should increase to 20% and beyond
Scientific community		• Large-scale production of sugarcane-ethanol and soybean-biodiesel reduces GHG emissions and is therefore sustainable. "Best practices" such as no-till farming can sufficiently minimize other environmental issues
Scientific community	• Agriculture should be based on agroecological and food sovereignty principles (i.e., avoiding patented seeds and chemical-input use, increasing agrobiodiversity and local nutrient cycling, and ensuring local communities' rights to decide how their resources will be used and to prioritize their own needs first, thus building resilience from external decisions, food price volatility, etc.) • Policies should ensure participation and empowerment of the rural poor, helping them climb up to value-added stages of production, with locally owned rural industrialization	• Conventional biofuel production may reduce GHG emissions but poses other ecological and social problems • Smallholder integration in biofuel chains is good but insufficient. Adopt agroecological principles, enhance local capacity, and gradually allocate better roles and more control to the rural poor
Minority within the government		
NGOs and rural social movements (moderate critics)		
NGOs and rural social movements (strong critics)		• A radical rural transformation towards agroecology and food sovereignty is needed. Smallholder integration has been a form of co-optation and of legitimizing unsustainable agribusiness • Biofuel production can be acceptable if done for local consumption

NB: Gray areas represent different coalitions; crossed-out text under *secondary aspects* indicates former beliefs replaced inclusion in industry-controlled value chains can be positive, even if insufficient. Policy-core beliefs, however, clearly set the two coalitions apart.

5.3.2 *Strategic Uses of Power*

Both coalitions have used various advocacy resources and forms of power to pursue their beliefs in biofuel governance. The agribusiness coalition has primarily relied on financial resources and members in positions of legal authority to influence policy-making—which is characteristic of dominant coalitions (see Sabatier and Weible 2007). This ability has allowed it to widely advance its development agenda while excluding non-member actors. In practice, the government promotes agribusiness through enabling policies and public financing, while the private sector uses its material capabilities such as technology and financial resources to produce biofuels. In turn, supportive scientists use information as an advocacy resource to further promote and legitimize the agribusiness approach, while they are favored with public and private funding. This collaboration works both domestically and internationally, as all three—agribusiness, scientists, and government actors—have actively helped promote Brazilian ethanol abroad and, consequently, the other two's competence. It reveals a degree of "symbiotic interdependence," i.e., a situation in which different actors depend on each other to fulfill their beliefs and therefore become inclined to cooperate (Fenger and Klok 2001). While the sugarcane sector has systematically relied on public policies, the government needs the private agroindustry to advance its ethanol agenda. Finally, scientists strengthen the coalition's technology resources (through biofuels R&D), add legitimacy, and increase public acceptance. Such a relationship of interdependency leads to strong coordination, where all these agents are better off with the pursuit of their shared beliefs (Fenger and Klok 2001).

Internal coordination is less strong in the agroecology coalition, and its financial resources and access to positions of legal authority are much more limited—which may help explain its subordinate position (Weible 2006; Sabatier and Weible 2007). Coordination arises much more out of a common view and belief system than of functional interdependence. That said, there has been cooperation around pilot projects of small-scale biofuel production following agroecology and food sovereignty principles, usually led by NGOs or rural social movements (see Moreno and Ortiz 2007; Biondi et al. 2009). The approach has counted on increasing scientific information on productivity and sustainability (see IAASTD 2009; Altieri and Toledo 2011; Horlings and Marsden 2011), but this is yet to seep through to public opinion or policy circles.[19] Tellingly, the government, too, has showed its divided nature by publishing on family

[19]See Clapp (2009) for a general analysis on how mainstream actors have largely ignored the IAASTD report, an assessment by more than 400 experts which concludes that a shift towards agroecology is necessary to improve the sustainability of agriculture.

farming's economic importance and funding smallholder biofuel projects—even if to a comparatively smaller extent.[20]

It is worth noting the government's ambivalent position in biofuel policy disputes and how such a politically instituted bioeconomy agenda increased its power. Although all along it has aligned mostly with large agroindustries, the government has had branches sharing the agroecology coalition's views, particularly on social inclusion. This ambivalence became most evident when Brazil had a Ministry of Agrarian Development distinct from the agribusiness-dominated Ministry of Agriculture during the Workers' Party administrations (2003–2016). It explains why the government pushed for the inclusion of smallholders in biodiesel production chains even though that was not in the agribusiness coalition's overall interest. It was, instead, a demand of the agroecology coalition members that filtered through the government.

The government's power grew as it became a major financier of the biofuels sector through the BNDES development bank. Similarly, it became an active player in setting a regulatory framework, best illustrated by private companies' near-obligation to obtain a Social Fuel Seal and other sustainability requirements such as the sugarcane zoning. Such a powerful position allowed the government to pose further demands and effectively lead the agribusiness coalition, according to its own policy-beliefs. That was particularly the case throughout the Workers' Party administrations (2003–2016), most notably during Lula da Silva's second term (2007–2010). However, it gradually waned afterward as economic and political crises engulfed the country from 2015 on. Eventually, the agroecology coalition's supportive minority within the government would be largely squeezed out as President Temer took power in 2016, with support to smallholders virtually disappearing later on under the Bolsonaro administration.

The agroecology coalition, in an increasingly subordinate position, historically has extensively relied on "mobilizable troops" (see Weible 2006). That refers to marches, protests, and land invasions by smallholders and (often landless) rural workers. It has been used both as policy advocacy[21] and as direct attempts to destabilize and gain ground from the agribusiness coalition.[22] The invasion and occupation of private farms is a legal imbroglio in Brazil because although the law safeguards individual property rights, it also establishes that land must fulfill a "social function" or be taken by the state for land reform (upon financial compensation). This social function has specific criteria, such as the absence of bonded labor and minimum

[20]Government data shows that family farming creates higher economic value per hectare than industrial monocultures in Brazil: on average BRL 677 (~USD 338) against BRL 368 (~USD 184) per hectare (IBGE 2009).

[21]Perhaps most notably, in 2011, the first year of Dilma Rousseff's administration (she being Brazil's first female head of state), female smallholders used a Women's Day march and encounter with the president as a window of opportunity to demand a national policy on agroecology as their number one request. The president acquiesced, and a National Policy of Agroecology and Organic Production was launched in August 2012.

[22]There were 200 land invasions in 2011, almost half of them in the so-called "Red April", which social movements organize every year (MDA 2011).

productivity levels, which governments have not revised since 1975 (Ferreira et al. 2008). The agroecology coalition, therefore, claims this law is not being implemented. The agribusiness coalition, in turn, benefits from the leniency and regular support of the judiciary—showing another instance of structural power (Gomes et al. 2010a; CPT 2013). Sometimes, this coalition resorts to instrumental power in the form of violence by murdering community leaders or environmental activists, as in the notorious case of Chico Mendes in 1988 or the hundreds assassinated in rural conflicts.

All these actions are underpinned by contrasting discourses from the two coalitions. The agribusiness coalition has portrayed industrial biofuels as sustainable and beneficial to national interests, emphasizing contributions to economic growth and to Brazil's competitiveness in the international market.[23] Agribusiness efforts on various social and political levels to attach its agenda to Brazil's national (self)image is nothing new; this tactic dates as far back as at least the 1930s, with the promotion of banana production and exports as a reason for national pride (see Rabelo 2018). The bioeconomy has been embraced under an old practice and being only the newest element or facet in a long-established advocacy repertoire.

In its latest incarnation, at least nominally embracing sustainability concerns, the agribusiness coalition also tactically focuses on CO_2 emissions instead of total greenhouse gas emissions or the environment as a whole. Agriculture and livestock farming emit more greenhouse gases than Brazil's entire energy sector—without even taking land-use change (i.e., deforestation) emissions into account (Angelo and Rittl 2019). That is also in addition to causing other environmental issues such as agrobiodiversity loss and widespread pesticide contamination. However, by focusing only on CO_2, transport emissions appear more relevant and thus more important to tackle.

Overall, the agribusiness coalition labels its adversaries as ideology-driven, out of tune with the market, and incapable of fulfilling Brazil's development needs. It has also framed land invasions as criminal actions against private property. In turn, the agroecology coalition also highlights national sovereignty interests, but from a bottom-up, grassroots perspective. This framing is captured, for instance, by peasant movements' coining of the term *Alimergia*—an abbreviation that combines food, environment, and energy—as a banner for locally controlled biofuels development within a smallholder agriculture framework (Patino et al. 2019). Such critics have contended that the dominant, mainstream biofuel production is unsustainable, primarily serves the vested interests of Brazilian elites and multinational corporations, and robs the poor of their access to resources (Mendonça 2009). Table 5.7

[23]On this, Marcos Jank, then president of the Sugarcane Industry Union (UNICA), argued that Brazil's forest code was an "anachronic piece of legislation" that could "compromise 3.7 million hectares of fertile land in São Paulo state and lead to R$5.6 million [USD 2.7 million] of annual revenues loss" (Gomes et al. 2010a, p. 24). The economicist perspective is clear, and so is the provocative nationalistic appeal used as a persuasion line. He continues: "[It is] sad to see an anachronic legislation with such a capacity to transfer income, revenues and jobs to other countries, who will certainly love this surprising modality of self-flagellation we are imposing on ourselves" (Gomes et al. 2010a, p. 24). See also Jank (2011).

Table 5.7 Features of the dispute between the agribusiness and agroecology coalitions

	Agribusiness coalition	Agroecology coalition
Key underlying interests	Economic growth; Domestic and international market shares	Agroecology; Social justice; Food sovereignty
Main advocacy resources used	Financial resources; Access to positions of legal authority; Information	Mobilizable troops; Information
Persuasion strategies	Appeals to national pride and a sense of international competition (e.g., Brazil to become a "green" global leader)	Appeals to ideas of social inclusion, conservation, and sovereignty from foreign capital and its volatility
Persuasion tools	Economic indexes (e.g., contribution of agriculture to a growing GDP, to exports); Biofuel production and consumption numbers; CO_2 emissions reduction from fossil fuel replacement in transportation	Equality indexes (e.g., Gini coefficient on wealth and land distribution); Comparisons between small- and large-scale farming in terms of employment creation, biodiversity, and contribution to food security
Strategies to undermine the opponent's arguments and actions	Focus of private property rights and criminalization of social movements	Land invasions, evoking the "social function" that by law lands must fulfill; Dissemination of information on the social and ecological impacts of large-scale agriculture
Framing of the opponent	Retrograde, anachronic, ideology-driven, incapable of fulfilling Brazil's development needs	Self-interested, socially unjust and environmentally degrading

synthesizes these discursive confrontations related to Brazil's biofuels—and broader bioeconomy—policy agenda.

5.4 Conclusions

5.4.1 Key Insights

Despite being a megadiverse country, Brazil's bioeconomy has, in reality, been highly tied to a few conventional agroindustrial complexes (e.g., sugarcane, soybean, beef). For only a period the agenda became linked to governmental support for small-scale family agriculture, and for the most part the country is yet to walk the talk on promoting novel, biodiversity-supporting value chains. Biofuels may have provided substantive economic benefits to agribusiness and increased renewable energy supplies that support Brazil's energy independence and position in international climate negotiations; however, this prevailing bioeconomy agenda has also intensified environmental impacts from unsustainable chemical-intensive monocultures. Moreover, except for some minor poverty reduction achieved through the biodiesel program, biofuel production in Brazil has been grossly inequitable, with a skewed distribution of benefits and burdens. There are four conclusions as to why this development path has been taken and to its particular features.

First, Brazil's biofuel production patterns and, thus, the shape of its bioeconomy to date owe primarily to public policies and the particular policy instruments in place. A combination of regulatory and economic tools (e.g., blending mandates, fiscal incentives and credit to key agroindustries, public investments in biofuel R&D, production and storage infrastructure) has provided essential support for the private sector—and to a lesser extent the public as well, through Petrobras—to produce biofuels. In this context, international market demands seem to have worked only as a supplementary driver, given that the bulk of Brazil's biofuel production is domestically consumed. Those instruments are essentially not transformational, i.e., they do not seek a transition from business as usual. Instead, they build on pre-existing agroindustrial sectors, with all their virtues (e.g., efficiency, scale) and vices (e.g., unsustainable agricultural practices, social exclusion), even though for a while the government succeeded in addressing the latter to a small extent through key policy instruments such as the sugarcane zoning to avoid deforestation and, perhaps most crucially, the social certification scheme to encourage smallholder integration in biodiesel chains. Such changes over the years illustrate what this chapter's assessment shows: that Brazil's public policy instruments have not only promoted but also steered the biofuel sector.

Second, behind these policy instruments, there are—sometimes synergistic, sometimes conflictive—fundamental guiding norms and interests that shape the emerging bioeconomy. On the one hand, there is a clear interest in using biofuels to boost economic growth, exports, and Brazil's international status as a rising power in global governance. On the other hand, there has been a normative underpinning—expressed in the biodiesel policy—requiring development to be socially inclusive and help reduce poverty in the country. However, the two imperatives are not that easily reconcilable. Brazil's most efficient biofuel production systems are highly inequitable, while the most inclusive ones are small in scale and could hardly meet the country's economic and geopolitical ambitions. The solution has usually been to have them in parallel, rather than trying to transform one or the other. Gradually, though, social concerns are being removed from the bioeconomy agenda as even the socially oriented policy instruments are modified to accommodate soy farmers. There is also an understanding that biofuels should be environmentally friendly, a normative underpinning that is mostly absent in other agriculture. It explains, for instance, why only feedstock crops received zoning policies even though they are not the main drivers of deforestation or land-use change in Brazil. Critically, however, this environmental norm has had a narrow focus limited mostly to climate change and rainforest protection only. Other ecological issues, such as agrobiodiversity loss and chemical-input use in agriculture, are systematically overlooked.

Third, the cause of those policies and dominant norms is to be found in agency. Although there is a coalition of contenders (smallholder movements, socio-environmental NGOs, and more critical scientists) advancing an approach based on agroecology, food sovereignty and social justice, an agribusiness coalition dominates Brazil's biofuels agenda. This dominant coalition has had a conveniently narrower view on sustainability, which coincidentally matches the key environmental concerns in export markets such as Europe (see Bastos Lima and Persson 2020). It is not interested in structural changes or power shifts—only at the international level. Using a combination of instrumental, structural, and discursive powers, this coalition has systematically succeeded in translating its policy-beliefs into the institutions that now guide Brazilian biofuel production and its bioeconomy agenda. Perhaps, the one exception is the Social Fuel Seal, which emerged due to pressure from the agroecology coalition. Now that this coalition's power waned, Brazil's biodiesel sector has been voided of its original poverty-reduction function.

Finally, a more systemic cause for the present shape of Brazil's bioeconomy agenda can be found in the distributive outcomes and social impacts of its production systems. By benefiting agribusiness disproportionately, dominant biomass production systems have increased their advocates' material capabilities, helped them reinforce their discursive power over civil society, and tightened their grip on public institutions. Meanwhile, critics and adversaries such as those in the agroecology coalition lose legitimacy, political space, and opportunities to advance their beliefs. As such, Brazil finds itself in a vicious cycle, like a power spiral where the prevailing systems of biofuel and other bio-based production reinforce the status quo, preventing any significant changes in the agenda (see Fig. 5.3). "Locked" as it is in this biofuel and bioeconomy development path, Brazil may well achieve its economic, geopolitical, and energy-related goals, but at the expense of the environment and of its society as a whole, who will continue experiencing the consequences of poverty and inequity.

5.4.2 Alternatives

More sustainable outcomes would require some key changes in Brazil's current biofuel policies and broader rural development strategy. Notably, ethanol production can be made far more equitable and socially inclusive. As a start, it could incorporate smallholders under similar requirements to those applied in biodiesel chains for social certification. However, for more significant results on poverty reduction and equitable rural development, smallholder integration in bio-based chains would need to foresee a second phase with feedstock-supplier cooperatives climbing up to value-added stages, such as ethanol distilling or vegetable oil extraction, and keeping co-products for sales or local use (e.g., as organic fertilizer or livestock feed). Smallholders could also be capacitated for local energy use or further vegetable oil processing into biodiesel, aviation biofuels or biomaterials, and to use co-products such as glycerin (e.g., in soap manufacturing).

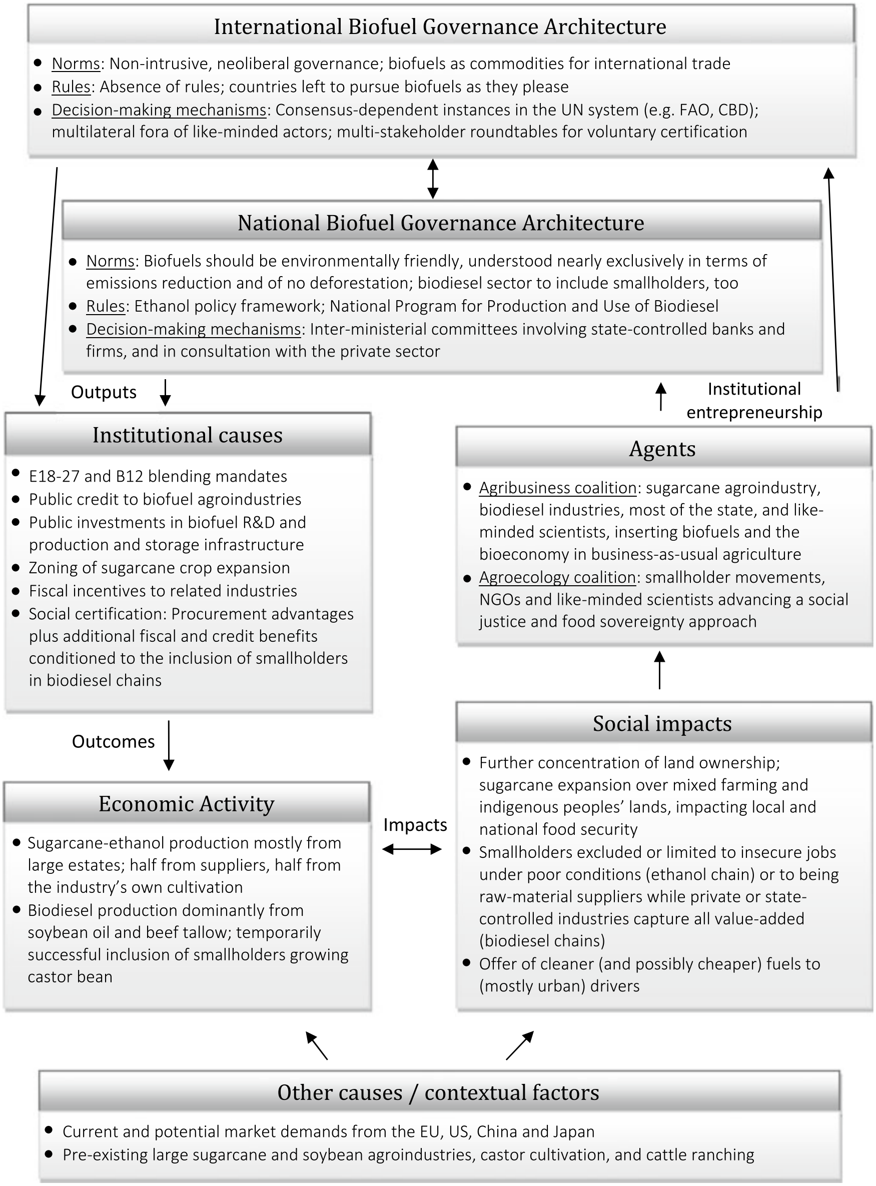

Fig. 5.3 Analyzing institutional, social and political dimensions of biofuels in Brazil

For that, the state could further its position as the leading financier of biofuels and put additional conditions on the incentives it gives. The same approach could also be used to make agricultural practices more sustainable (e.g., better water management practices, reduced chemical-input use), besides more stringent land-use and pesticide regulations. Furthermore, investment in agricultural R&D—which is mainly public through the EMBRAPA national company—would need to focus increasingly on value-adding technologies rather than primarily on crop productivity. Smallholders, in particular, would benefit from further investments in rural infrastructure, agricultural and biofuel-making technologies suitable to their contexts and scale. They would also greatly benefit from organizational capacity building (e.g., helping form cooperatives) and additional technical assistance—with proper monitoring and evaluation—to improve the use of those resources.

Finally, bioeconomy governance would be more equitable and likely facilitate the policy changes above if it included key stakeholders such as national smallholder and peasant organizations. That is not only locally at contract negotiation but also in decision-making and designing bio-based value chains—a space routinely granted to private agroindustries. However, any of these changes require either a change of beliefs within the dominant agribusiness coalition or more effective agency from the agroecology coalition. The former may realize that a better sustainability profile can effectively improve Brazil's position in global trade and environmental negotiations, as well as penetration in more demanding markets such as Europe. In turn, the contenders may need to show how agroecological development can help meet Brazil's economic and geopolitical ambitions, or it will just continue to be regarded as a niche or as a utopia.

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Chapter 6
India's Bioeconomy and the Ambition over "Wastelands"

Abstract While India aims for a broad bioeconomy, its experience in devising novel bio-based sectors has been mostly with biofuels. The country has had one of the world's most ambitious biofuel policies, yet reality checks have revealed numerous issues. Ethanol production based on sugarcane has increased but has little room for expansion. The main effort has been a large-scale biodiesel endeavor based on non-edible feedstocks to be cultivated on "wastelands." However, the deployment of *Jatropha curcas* through smallholder contracting or on public lands has left India's rural poor mostly worse off, and without any commercial production taking place. This analysis suggests that domestic public policies have been the leading cause, largely overlooking local resource uses and jatropha's input requirements. Lack of agreement with rural dwellers, in turn, resulted in local boycotts and sabotage of feedstock cultivation in parts of India. Such a top-down approach to rural development, without meaningful stakeholder consultation, has transferred legal or de facto control over land and freshwater from local communities to the private sector or the state. This biofuels experience sets a problematic precedent for India's broader bioeconomy, as already vulnerable actors have been disenfranchised instead of included in reaping benefits and in governance.

Keywords Biofuels · Jatropha · Marginal lands · Value chains · Equity · Governance

India has a fledgling bioeconomy, as elsewhere grounded first and foremost on biofuel sectors developed before the new umbrella-term gained currency. The country envisages a broader bioeconomy, and various biotechnology sectors have received growing attention and investments (BIRAC 2019). However, these plans remain mostly at an inception stage, and bioenergy represents most of the actual bioeconomy deployed.

India is one of the world's fastest-growing economies and a major consumer of energy, largely *imported* energy. It has therefore launched one of the most ambitious biofuel policy programs, which in turn paves the way for further bioeconomy development. For ethanol, India has relied on its large sugarcane agroindustry (the world's second, after Brazil), while targeting vast swathes of marginal lands—or, in the national policies' language, "wastelands"—for biodiesel. Among various non-food oil-bearing species such as neem (*Melia azedarach*) and pongamia (*Millettia*

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pinnata), the main crop of choice has been *Jatropha curcas*. This non-edible oil crop has received much praise and a surge of attention, partly for being allegedly a good "smallholder crop" suitable for "pro-poor development" (Brittaine and Lutaladio 2010).

Such an approach, while thriving on some grounds, is however ridden with contradictions. These contradictions and socio-environmental issues are often overlooked, yet they remain at the heart of India's increasingly ambitious bioeconomy plans (see BIRAC 2019). Therefore, analyzing why certain strategies have prevailed at the expense of others is critical. This chapter first describes the country's biofuel production and consumption. It examines the Indian policy context, assesses the distributional outcomes and social impacts of biofuel expansion, and analyzes agency and strategic uses of power in Indian biofuel governance. The chapter concludes by shedding light on why India has pursued its current biofuel development path and what alternatives may exist.

6.1 Biofuels in India: How and Why

6.1.1 The Indian Setting: Energy and Agri-Food Contexts

6.1.1.1 Energy Context

Rapidly growing demand and increasing dependence on oil imports characterize India's energy context. Economic growth has been accompanied by steady annual increases in both total and per capita energy consumption, with the latter experiencing an average annual growth of 4% during the 2010s (Central Statistics Office 2019). Most of this demand is met with coal-fired power (63%), followed by oil (31%). Traditional biomass—fuelwood and waste used for cooking and heating—remains an important energy source in rural India, but liquified petroleum gas (LPG) has been gradually replacing it. Between the 2008–2009 and 2017–2018, LPG consumption annually grew by as much as 6.7%, while the use of diesel oil (primarily in transport) increased on average 4.6% every year (Central Statistics Office 2019, p. 64).

Oil is particularly key to India's political economy because more than 86% of it is imported (Central Statistics Office 2019, p. 100). Besides leaving the country vulnerable to international political or economic volatility, this has long placed a heavy burden on the government's budget (Biswas et al. 2010). Although periods of low international oil prices have occasionally lightened that burden, this fluctuation is challenging—for instance, by 2019 India was spending 74% more on oil importation than in 2015 (Aradhey 2019a).

6.1.1.2 Agri-Food Context

India's agri-food context is marked by high population density in rural areas, limited availability of arable land and freshwater, and tight or insufficient domestic supplies of sugar and edible oil.

Around two-thirds of India's population—or more than 850 million people—live in rural areas (Directorate of Economics and Statistics 2019). Population density is very high, and most of the country's arable land is already under cultivation. There is, therefore, growing attention to combating desertification and to landscape restoration. Agriculture in India generally depends on seasonal monsoon rains, being thus vulnerable to climate change. Irrigation is increasing, but this in turn adds pressure on India's fragile water security (Mulder et al. 2010). Sugarcane cultivation, in particular, has 95% of its cropland irrigated, contrasting with an average of 49% for all crops in India (Directorate of Economics and Statistics 2019, p. 33). With the country's groundwater being rapidly depleted and polluted, severe problems of access to water have emerged, and there is a pressing need for careful water management (Kerr 2009; Mulder et al. 2010; Suhag 2016).

India's context is also limiting concerning its supply of key agricultural commodities used in the bioeconomy. In the case of edible oil, while domestic production has increased over the years, there is a widening gap between supply and demand. More than 60% of the country's edible oil consumption comes from imports, mostly palm oil from Southeast Asia (Aradhey 2019b). As the world's top edible oil importer, India has shied away from using it as biodiesel feedstock. Similarly, it for years avoided diverting sugarcane away from sugar production and towards ethanol. Although the country is the world's second-largest sugar producer, it has a large—and growing—domestic demand forecast to increase by 12% between 2020 and 2030 (NITI Aayog 2018). Moreover, India's sugarcane cultivation is marked by strong cyclicality, meaning that bumper harvest years are usually followed by years of low yields (Landes 2010). As such, its condition has shifted back and forth between that of net-importer and net-exporter of sugar, though usually trading only a small margin compared to what is produced and consumed domestically (Directorate of Economics and Statistics 2019).

6.1.2 Biofuel Production and Consumption Chains

6.1.2.1 Ethanol

Although other feedstocks (e.g., sweet sorghum) have been tested, commercial ethanol production in India still relies exclusively on sugarcane. The crop is native to South Asia, and its use has long been established for the production of sugar and non-fuel ethanol for human consumption, industrial or medical applications in the country. Unlike Brazil, India has over six million smallholders as part of the sugarcane sector, working as suppliers to the industry, particularly in the states of Uttar Pradesh, Maharashtra, and Karnataka. These farmers count on a government-set minimum price—termed the Fair and Remunerative Price—that is annually updated, and which sugar mills have to pay. The government set it at 2,750 Indian rupees (INR)—or about USD 36—per ton in the 2019/2020 season, increasing it both in nominal and real terms over time. For comparison, this remuneration was INR 1700 (about USD 30) per sugarcane ton in 2012/2013 (The Hindu 2012). Moreover, for each 0.1% in total recoverable sugar rate (i.e., the sugar content) above the Indian average of 10%, the grower receives a bonus (Landry 2019). State-level governments are free to indicate higher values, and sugar mills free to negotiate it with suppliers, but these cannot be below that legal minimum set by the Union. The fear that (neo)liberalization bills proposed by the Modi administration for India's agricultural sector would remove such legal support was at the center of the 2021 farmer protests in the country.

Sugarcane mills produce sugarcane juice and molasses, the former being used primarily for sugar production and the latter for various grades of ethanol and for animal feed. Therefore, unlike in Brazil, ethanol production has not significantly competed with sugar production in India. The utilization of sugarcane juice for fuel-ethanol manufacturing is allowed in years of surplus production, and after some initial years of stagnation it took off in the late 2010s. The Indian sugarcane industry has therefore been able to switch an amount of its production between downstream markets depending on sugar price fluctuations. Similarly, fuel-ethanol production from molasses has competed with other, non-fuel ethanol grades and the export of these sugarcane by-products as animal feed to Europe (Aradhey 2012).

The tasks of purchasing ethanol, blending it, and distributing it with gasoline are undertaken by India's three state-controlled oil marketing companies (OMCs): Hindustan Petroleum, Bharat Petroleum, and the Indian Oil Corporation. They make supply contracts with the (private) sugar mills but are dependent on the actual production of fuel-ethanol by the latter. OMCs, too, must pay a government-set Minimum Purchase Price (MPP). These fuel distributors then blend ethanol with gasoline and market it to end-consumers—primarily automobile drivers. As of 2019, the actual blending rate was at 5.8% and expected to reach 10% by 2022 (Aradhey 2019a). Figure 6.1 shows the main chain of ethanol production and consumption in India.

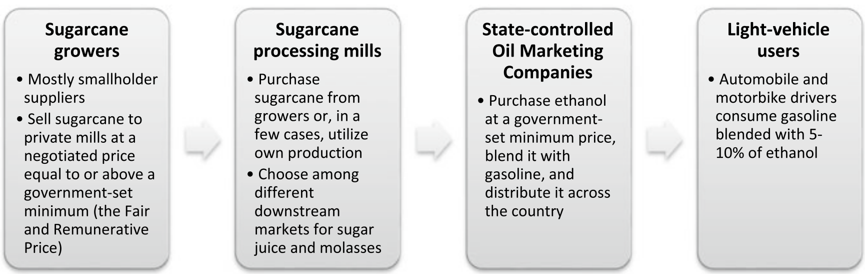

Fig. 6.1 Sugarcane-ethanol production and consumption chain in India

6.1.2.2 Biodiesel

Indians have long used oilseeds as fuel, including *Jatropha curcas* (e.g., in Rajasthan), particularly as lamp oil in rural areas. Farmers have used jatropha also as a fence crop since its toxicity helps keep herbivores away (Achten et al. 2008). These traditional uses differ from the way jatropha is promoted for large-scale biodiesel production. Although its commercial production remains insignificant, it is worth examining the government's attempts to promote non-food oil crops as biodiesel feedstocks throughout the country.

India's biodiesel production strategy has relied exclusively on non-edible perennial crops such as jatropha, grown on marginal lands under sub-optimal soil and water conditions, and not previously used for industrial agriculture. Although other crops such as pongamia, neem, and various other oil-bearing trees native to India have been tested, jatropha has received particular attention due to its shorter maturation cycle (3–4 years), drought tolerance, and alleged capacity to resist pests and produce high yields without inputs (Achten et al. 2008). For instance, jatropha has been deemed capable of bearing seeds with as much as 30–40% of oil content even in such sub-optimal conditions (Pohit et al. 2010).

Hence, government agencies and (particularly foreign) private biodiesel industries have sought to cultivate jatropha on India's marginal lands—labeled as "wastelands" (MNRE 2009; GOI 2018), a designation that dates back to the British colonial rule. As a foreign businessman promoting jatropha in India reported,

> Even though we cannot buy land here, we can have it through partnerships, as in our case. India offers better infrastructure and logistics than if you go to less developed places like Myanmar or Africa, and the costs of land and labor are still very cheap. (Personal interview)

Deployment has taken place with or without the participation of local smallholders. In the first case, companies—often with government support—have approached smallholders and persuaded them to grow jatropha under contract farming. These arrangements are also named "buy-back" or outgrower schemes, whereby farmers operate as contracted suppliers. Alternatively, national or state-level agencies have claimed public lands and have either cultivated jatropha or leased it to the private sector for that purpose, with or without local communities' prior consent.

This top-down agenda has led to social conflict or even sabotage by the locals hired as plantation workers. For instance, many locals reportedly cut off the roots of the jatropha saplings before planting them to ensure that it would not grow, or they simply returned to the field a few weeks later to uproot everything. Still, in many cases, jatropha plantations became installed, mainly where smallholders were contracted as suppliers. However, productivity expectations have proven vastly unfounded. Many saplings died without nursing or crushed by livestock, under the idea that jatropha, as a wild plant, would not require attention (Lahiri 2009). Pests plagued it when grown in plantation blocks, and the plants that survived have displayed low productivity under water stress and without fertilization. Jatropha's oil content in India has been lower than 25% on average, not the 30–40% foreseen (Personal interviews).

These low yields have compromised the economics of jatropha-biodiesel. Lower oil content means that the industry needs to purchase more seeds to obtain the same amount of oil, which means higher costs. Thus, although the government then set a Minimum Purchase Price for OMCs sourcing biodiesel, the industry soon found this price—set at INR 26.50/liter—unattractive (Confederation of Indian Industry 2010). The Confederation of Indian Industry (2010) suggested that the price be raised to INR 36.36/liter—and, even so, it assessed that subsidies would be required if international oil prices were below USD 95 a barrel.

Disappointing agronomic results have meant that most private companies who made buy-back contracts with smallholders pulled out and abandoned their deals, causing severe social impacts (see Ariza-Montobbio and Lele 2010). Interest in jatropha cultivation decreased for some time, remaining only in a few private endeavors to crush seeds locally and export jatropha oil for experimentation or biodiesel—and eventually jet fuel—manufacturing abroad.

After a hiatus of a few years, a new wave of jatropha—and other non-edible feedstocks—deployment returned to the agenda. This time, government and industry have agreed that jatropha breeding needs a green revolution to fit India's various agro-climates and produce high-yielding hybrids, and that water and fertilizer inputs are required after all. This retrofitted endeavor—nicknamed "Jatropha 2.0"—has garnered large foreign players in agriculture biotechnology and trading such as the US-based multinationals Bunge and Koch Industries, as well as domestic players such as Bharat Renewable Energy Ltd., an offshoot of the state-controlled oil giant Bharat Petroleum in association with private companies (Biofuels Digest 2010). Together in a consortium, these industries announced new contracts with 100,000 farmers to produce jatropha for making biodiesel, jet fuel, and petrochemical replacements (Biofuels Digest 2011a).

Figure 6.2 summarizes this envisaged but not yet operational production and consumption chain of biodiesel in India.

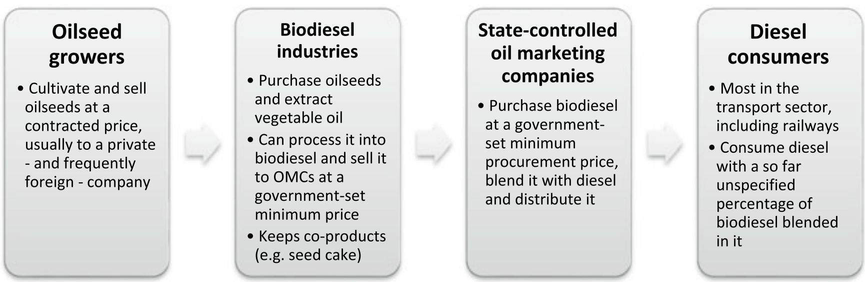

Fig. 6.2 (Envisaged) biodiesel production and consumption chain in India

6.1.3 India's Biofuel Policy Framework

India's first biofuel policies came about in 2003, by the erstwhile Planning Commission—which until its 2014 dissolution by the Modi administration prepared national five-year development plans. The Commission elaborated on the advantages of producing biofuels and launched an Ethanol Blending Programme and a National Biodiesel Mission (see Planning Commission 2003). The former included the phase-in of ethanol blending mandates and the minimum purchase price to be paid by OMCs to sugarcane mills. Ethanol was initially to be produced exclusively from sugarcane molasses, until the government allowed mills to manufacture it directly from sugar juice in years of surplus production. India's ethanol strategy, therefore, uses existing agroindustry and does not foresee new cultivation. The country's sugarcane cropland has remained mostly stable at 4–5 million hectares (Mha) since the year 2000 (Directorate of Economics and Statistics 2019).

In contrast, the National Biodiesel Mission promoted the deployment of jatropha on 11.1–13.4 Mha of uncultivated "wastelands." This strategy would "reclaim" these lands and put them to commercial use while avoiding a food vs. fuel conflict, which would emerge if biodiesel production utilized edible oil. First, the mission's *demonstration phase* (2003–2007) promoted the government-led development of jatropha nurseries, seed procurement, and pilot projects. A *self-sustaining execution phase* (2008–2012) allowed commercial private and government-run jatropha plantations and buy-back schemes with smallholders. The final target was to replace 20% of the country's diesel consumption with jatropha biodiesel by 2012 (Planning Commission 2003), something still far from being achieved even in the 2020s.

In 2009, the National Policy on Biofuels integrated economic and regulatory instruments under a single coherent framework (MNRE 2009). These instruments have included, in addition to the investment, blending and minimum price policies: (i) eligibility of jatropha cultivation under the National Rural Employment Guarantee Scheme (NREGS), which provides rural workers with 100 days of government-paid labor at a minimum wage each year; (ii) priority lending for biofuel projects at public banks; (iii) tax breaks and excise duty concessions on biofuels, plant materials, machinery and engines related to them; (iv) grants for R&D on biofuels; and (v) 100% foreign equity allowance on biofuel industry technology and products, to stimulate foreign direct investment—but only if production is for the domestic market (MNRE 2009). Foreigners are not allowed to own land or plantations, and the policy prohibits biofuel exports before meeting the domestic demand. Besides, only domestically produced ethanol can be used to meet the blending mandate. Ethanol may be imported (as it has been, from Brazil; Pohit et al. 2009), but only for non-fuel industrial purposes. Finally, the policy changed and postponed the consumption target. The new goal was to replace 20% of total diesel *and gasoline* consumption by 2017, allowing it to take the ethanol blending into account (MNRE 2009).

It is important to note that biofuels have created unprecedented changes in India's land-use regulations at both national and state levels. Since colonial times, lands have been divided into *forest land* (protected areas) and *revenue land* (usable for agricultural or other commercial activity). However, the biofuel policy creates an exception to label degraded forest lands managed by the Ministry of Environment & Forests as "wastelands" available for jatropha cultivation. Some have feared this creates a precedent for converting India's forest lands for commercial agricultural use. Also, state-level policies that regulate the leasing of public revenue lands have been altered in some cases to facilitate jatropha cultivation. For example, in 2007, Rajasthan passed a law allowing for the leasing of public "wastelands" for biofuel feedstock cultivation at very accessible, below-market prices (Government of Rajasthan 2007).

As of 2020, biodiesel blending remained negligible after reaching a meager 0.14% in 2018, and all of it produced from imported sources such as palm stearin (a by-product of palm oil imported for food) (Aradhey 2019a). However, a new National Biofuels Policy launched in 2018 has built new momentum, as it reiterates India's ambition to cultivate perennial feedstock crops on a large scale (GOI 2018). Although the policy itself does not spell out the area sought for that purpose, the Indian government currently identifies as much as 26 Mha of "wastelands" to be targeted for landscape restoration of different forms (GOI 2019). It emphasizes the importance of R&D to improve non-food oil crop yields and thus domestic feedstock availability, and it sets the indicative targets of having 5% biodiesel (B5) and 20% ethanol (E20) blends by 2030 (GOI 2018). For the first time, the government also explicitly links these goals to climate change concerns and India's nationally determined contributions under the 2015 Paris Agreement (GOI 2018; Aradhey 2019a).

Tables 6.1 and 6.2 present in detail the timeline of key biofuel policies in India and the country's prevailing policy rationales, respectively.

6.1.4 Assessing Institutional Causality

It is self-evident that public policies have driven biofuel production and consumption in India. First, the state controls the middle of both ethanol and biodiesel chains through its OMCs, namely the link between fuel demand and production. This arrangement has allowed it to set the ethanol blending mandate and ensure biodiesel procurement more easily. It has thereby created a demand for biofuels. Second, the government has provided economic incentives for biofuel production to private industries, including tax concessions, lending priority at state-owned banks, grants to biofuel R&D and pilot project implementation, and the leasing of public lands at below-market prices. Third, the government has changed regulations to enable and facilitate biofuel expansion, *inter alia*, by allowing feedstock cultivation on forest lands and eligibility under the National Rural Employment Guarantee Scheme. Fourth, the state has engaged directly in biodiesel production by establishing plantations and pilot projects during the National Biodiesel Mission's dissemination phase. More recently, it has engaged in the "Jatropha 2.0" initiatives, such as through Bharat Renewable Energy.

Table 6.1 Indian policies for biofuel production and consumption

Year	Policy	Policy instrument type(s) and target(s)	Effect
2003	Ethanol Blending Mandate	Blending mandate (*fuel distributors*)	Mandatory 5% blending (E5) in 9 States and 5 Union Territories. OMCs to purchase ethanol from sugar mills at the minimum price of INR 21.50 (~USD 0.40)/liter[a]
	National Biodiesel Mission, start of its "demonstration phase" (2003–2007)	National consumption target (*biodiesel industry*); Public investment (*jatropha cultivation*)	Jatropha deployment on 11.2–13.4Mha of "wastelands" to achieve a 20% biodiesel blend by 2012. Ministry of Rural Development to plant 400,000ha, develop nurseries, and create a jatropha-biodiesel value chain. The Ministry on Environment & Forests to carry it out on "forest wastelands," too[b]
2005	Biodiesel purchasing policy through OMCs	Blending mandate (*fuel distributors*)	OMCs to start purchasing biodiesel for blending at the minimum price of INR 26.50 (~USD 0.49)/liter[c]
2006	Expansion of ethanol blending	Blending mandate (*fuel distributors*)	E5 blending mandate extended to a total of 20 States and 9 Union Territories[c]
2007	Permission to make fuel-ethanol from sugar juice	Economic (de)regulation (*sugarcane industry*)	Industry allowed to divert cane juice from sugar to fuel-ethanol production, but only in years of sugar supply surplus[d]
	(State of Rajasthan) Leasing of public "wastelands" for jatropha cultivation	*Land (de)regulation*	*Allows the leasing of public "wastelands" to the private sector for jatropha cultivation*[e]
2008	National Biodiesel Mission enters its "self-sustaining execution phase" (2008-2012)	Public investment (*jatropha cultivation and biodiesel processing*); Public credit (*biodiesel industry*)	Large-scale deployment of ordinary jatropha cultivars on public lands and through buy-back contracts with smallholders; installation of processing capacity[b]
2009	National Policy on Biofuels	Consumption target; fiscal incentives and credit (*biofuel industries*); Governance and overseeing	Regulatory framework and economic incentives for a 20% replacement of diesel and gasoline by 2017. Set up of a National Biofuels Co-ordination Committee and of a Biofuels Steering Committee, both composed exclusively of governmental agencies[f]
2013	New rules and enforcement of the 5% ethanol blending	Blending mandate (*fuel distributors*)	OMCs to implement the E5 blending mandate nationally. Prices may be negotiated between OMCs and sugarcane mills based on gasoline prices[g]
2018	(new) National Policy on Biofuels	Overall institutional framework	Creation of a National Biofuel Coordination Committee of public agencies and a Working Group on Biofuels with experts and industry representatives. B5 and E20 targets for 2030. Investments in advanced biofuels and large-scale cultivation of non-food biodiesel feedstocks in "wastelands"[h]
2019	Financial support for ethanol supply	Credit and fiscal incentives (*sugarcane industry*)	INR 19 billion (~USD 262 million) in loans and incentives to expand ethanol production capacity[i]

[a]Ministry of Petroleum and Natural Gas (2002), [b]Planning Commission (2003), [c]Exceptions are island territories, Northeastern states, and Jammu & Kashmir; Aradhey (2012), [d]Bhardwaj (2007, Personal interviews), [e]Government of Rajasthan (2007), [f]MNRE (2009), [g]Press Information Bureau (2013), [h]GOI (2018), and [i]PIB Delhi (2019)

Table 6.2 Rationales for biofuel policies in India

Rationale	Specific interests
Sustainable economic growth	Meeting growing energy needs without compromising foreign exchange
National energy security	Reducing vulnerability to international oil price volatility
Rural development	Creating of "employment for the poor"[a] in biofuel production chains; Meeting "the energy needs of India's vast rural population"[b] with biofuels, seen as "an effective tool for rural development and generating employment"[c]
Climate change and landscape restoration	Climate change mitigation through fossil fuel substitution, as part of India's commitment to reduce emissions intensity[c]; and climate change adaptation through landscape restoration in 26 Mha of "wastelands"[d]

[a]Planning Commission (2003, p. ii), [b]MNRE (2009, p. 3), [c]GOI (2018, p. 14), and [d]GOI (2019)

Foreign private companies have, in turn, played a comparatively smaller but still important role in promoting biofuels and feedstock cultivation, particularly jatropha. There is, nonetheless, a conflict of interest. While many investors have wanted to sell (also) to foreign buyers, particularly in the EU and US markets (Biofuels Digest 2010, 2011a, b), the Indian policy forbids biofuel exports and limits incentives to production aimed at the domestic market. As a result, some foreign companies have been shipping off unprocessed seeds or unrefined, straight vegetable oil, and doing value-added abroad. "Otherwise, if we try to produce biodiesel here and ship it, we have problems at the border," a businessman reports (Personal interview). As such, domestic public policies have not only incentivized but also *shaped* biofuel production and markets in India to a large extent—including all such unanticipated effects.

6.2 Allocation and Access: Analyzing Institutional Performance

6.2.1 Allocation Patterns: Who Owns, Does, and Gets What

Although domestic income inequality in India is lower than in most other developing countries, it has been increasing steeply with the country's economic growth. By the 2010s, the gap between the top and bottom 10% had doubled compared to the early 1990s, pushing the country's income Gini index from 0.32 to 0.36 (UNDP 2019). By 2020, the richest 1% in India held four times as much wealth as the country's bottom-billion, or 70% of its population (Coffey et al. 2020). Substantive elite capture has characterized India's recent development, more so than in China and differently from some other emerging economies, such as Brazil, where inequality has mostly decreased in this century (UNDP 2019). This trend is particularly worrisome as India is already significantly divided in non-economic terms, such as gender or caste. To an extent, economic inequality has increased due to widening divides among more affluent and poorer states, and between rural and urban areas. As much as 21% of the population still lives on less than USD 1.90 a day in purchasing power parity terms, most of them in rural areas (UNDP 2019). There is a historical exclusion of the rural poor from most of India's development (Pal and Ghosh 2007).

Biofuel expansion has so far either maintained or aggravated these trends, despite its rural development rhetoric. For one, sugarcane-ethanol production makes no changes in the sector's highly skewed ownership and control structures, in which millions of smallholders remain poor. Private sugarcane mills keep hold of all value-added while enjoying access to tax breaks, regulatory incentives, and a new emerging market of high demand. Meanwhile, low-income sugarcane smallholders—often working under exhausting conditions—have remained marginalized. Working conditions of rural workers in India's sugarcane sector have been described as "arduous and inhuman" (Ashwani and Brahm 2011). The industry argues that further government benefits would trickle down to its sugarcane suppliers, but this argument is questionable (see Bisht 2012). Sugarcane growers' income seems to have improved more because of statutory Fair and Remunerative Prices (with states occasionally providing higher indicatory indexes than the Union) than because of the industry's supposed willingness to pass forward its increasing economic benefits and opportunities. Rather, the sugarcane industry has opposed that price policy and supported deregulation.[1] As various consulted Indian analysts have observed, such a move would allow mills to "squeeze" smallholder suppliers even further.

If sugarcane-ethanol policies have maintained smallholders' socioeconomic situation without necessarily making it worse, the same cannot be said about the biodiesel policy focused on cultivating "wastelands." What the government regards as 11 or 26 million hectares of wastelands land is hardly "unused" as the policy claims. These lands often are essential to smallholder subsistence, informal economies, and rural livelihoods. With such top-down initiatives, the government effectively reallocates the de facto control over those state- or community-owned lands from the rural poor to public agencies and private companies. In other cases, they are held privately but are shared by the community based on informal arrangements, with and local rules and institutions. The push of jatropha and other non-food feedstocks onto smallholders have resulted in further exclusion in rural India, particularly of weaker actors such as Dalits[2] and low castes (Lahiri 2009).

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[1]The Indian government, pushed by the industry, subsequently created a Sugar Deregulation Committee to assess the proposal (Bisht 2012).

[2]Dalits are out-caste, historically discriminated social groups in India. They include many of those once known as "untouchables", today termed Scheduled Castes.

Both feedstock cultivation strategies—on public-owned "wastelands" or under contract farming with smallholders—have allocated decision-making to government agencies and private industries. Cultivation plans have usually been developed without any consultation with local stakeholders, and agency or company interaction with rural communities is frequently limited to *convincing* them to grow feedstock (see also Biswas et al. 2010). Some smallholders (e.g., in Rajasthan) knew jatropha and were aware that it would not grow well without water and easily attract pests such as plant bugs and rats. This previous knowledge was a reason for local resistance to jatropha deployment. Furthermore, with biodiesel industries frequently positioned as the single buyers in a given region, it alone decides how much will be paid per kilo of seed, or the chemical inputs to be used, thus benefiting from a monopsony. These inputs usually are all purchased from the company using loans that small farmers can take from public banks, using the land as collateral and having the company as a guarantor. Such public loans often cannot be accessed without the company (Pal and Ghosh 2007). As such, the farmer often is virtually powerless in the whole process. Even though the rural poor are supposed to be significant beneficiaries, their involvement is only that of a workforce—they have had no say in what, where, or how feedstock is grown, let alone participation in value-added processes.

6.2.2 Access to Resources: Land, Water, Food and Energy

Despite its economic growth, India has high poverty levels and problems of access to basic resources. By 2019 it still ranked 129th in the human development index, fifty positions behind Brazil and eighteen behind Indonesia (UNDP 2019). Land tenure security is uncertain even though hundreds of millions of people depend on land and agriculture. More than 82 million Indians lack access to safe drinking water (WHO/UNICEF 2019), 194 million are food insecure (FAO 2019), and 74 million live without electricity (IEA 2019).

Biofuel policies have mostly aggravated these problems instead of helping to address them. As the sugarcane crop area has increased only slightly over the last 20 years (Directorate of Economics and Statistics 2019), ethanol production has not significantly impacted access. However, the targeting of "available" "wastelands" based on satellite imagery and remote sensing for biodiesel feedstock cultivation has been problematic as it overlooks local resource use. About 25% of India's rural population lives on resources from such lands, especially tribal communities (Agoramoorthy et al. 2009). This reliance includes, for instance, shifting agriculture, use as grazing areas for livestock, gathering of fuelwood, aromatic herbs and medicinal plants, or other uses linked to local food and income security (FIAN and HBF India 2008; Rajagopal 2008). In some cases, "wastelands" are part of complex traditional farming systems, such as when livestock grazing produces animal dung that is washed downhill and used as a fertilizer for cultivation—local land-use systems that are not captured by satellite imagery.

Water access, too, has been a usually overlooked problem in the face of large-scale feedstock cultivation, particularly in semi-arid regions like Rajasthan, where it has been promoted. Jatropha, in particular, requires five to ten times more water than most other feedstock crops per unit of energy yielded (Gerbens-Leenes et al. 2009). Therefore, its commercial production is suitable only where it can be rain-fed or irrigated from renewable water sources (Blesgraaf 2009). If not, feedstock cultivation may deplete subsurface or groundwater used for direct human consumption and agriculture (Gmunder et al. 2012). Furthermore, if fertilizers and pesticides are used for the new, high-yielding hybrids of “Jatropha 2.0”, soil and water pollution may also become an issue (see Achten et al. 2008).

From a food security standpoint, India’s government has all along been careful to avoid the utilization of edible oils for biodiesel. However, the dependence of many rural communities on such “wastelands” for local food consumption and traditional livelihoods has been consistently overlooked (Baka 2014). Moreover, suppose the cultivation of jatropha or other non-edible perennial crops is made attractive. In that case, smallholders may easily substitute their food crops and become vulnerable to private sector decisions, market price volatility, and food insecurity. For instance, in Tamil Nadu, many smallholders who had been traditionally growing groundnut substituted it for jatropha and suffered significant economic and social setbacks (Ariza-Montobbio and Lele 2010). As time shows that feedstock crops generally need inputs and good-quality soil to produce well, food vs. feedstock competition seems increasingly likely. Food security issues are not avoided by simply refraining from using food crops. Instead, reconciling food and fuel production requires careful consideration of local realities, crop diversity, and strong stakeholder involvement. Agroforestry systems with oil-bearing trees such as pongamia have shown promise in parts of India, notably in Karnataka, but on a country level such strategies remain the exception rather than the rule (Bohra et al. 2018; Dalemans et al. 2018).

Finally, many of India’s rural communities live without modern energy access, yet biofuel policies have hardly targeted them as beneficiaries. Although energy poverty always figures highly as a policy rationale for biofuel production in India, policies generally lack instruments to promote local utilization (see Planning Commission 2003). Instead, by strategic design, all biofuels are blended with oil products and used by those who already have access to energy. The biofuel policy thus perpetuates the existing inequalities in energy allocation and access, and falsely uses the energy poverty rationale. Sectors of the Indian Ministry of New and Renewable Energy have longed recognized biofuels’ potential for local renewable energy consumption. However, these efforts have experienced limited support both within the government and from the private sector. It remains an unfulfilled, long-held promise.

6.3 Agency in Biofuel Governance in India

6.3.1 Main Coalitions and Their Policy Beliefs

The state has dominated biofuel governance in India in cooperation with the private sector and like-minded scientists. Under government leadership, those mainstream agents have formed a dominant *agribusiness coalition* supporting the large-scale biofuels agenda. There have been internal conflicts on secondary policy aspects, but usually followed by successful negotiations. For instance, there have been continuous rounds of negotiations between the government and the sugarcane industry on the Minimum Purchase Prices paid for ethanol by the OMCs. The industry has repeatedly complained it is too low to make fuel-ethanol production attractive, and the government has accommodated its requests numerous times. The biodiesel industry has made similar requests, but so far without success. Clearly, the success of such negotiations is essential to make biofuel production chains operational.

In this context, the government and the industry cannot concretize their policy beliefs without agreement. As in Brazil, this need suggests a case of symbiotic interdependency between those two sets of actors (see Fenger and Klok 2001). Although the scientific community is not essential for the functioning of those production chains, it has become increasingly important as companies and the government decide to utilize improved feedstock varieties (e.g., of jatropha). Common policy beliefs and a need to cooperate have thus resulted in strong coordination within the coalition, with all those actors being better-off by the concretization of their beliefs (Fenger and Klok 2001). Furthermore, because this coalition has been dominant, it has had the chance to implement its beliefs experimentally. That has meant continuous revisions of secondary aspects, such as that jatropha could yield well without inputs or that a 20% replacement of diesel by jatropha-biodiesel by 2012 was attainable.

In contrast, critical voices have hardly displayed sufficient coordination to characterize them as an adversary coalition on the biofuels issue. Those voices include a minority within the government, scientists, as well as NGOs and social businesses. They all share a certain level of disagreement with the pursued policies, yet they do not all share the same policy-core beliefs (see also Kumar et al. 2009). For instance, some agree with the mainstream view that "wastelands" are available, but argue that biofuels should be used for local consumption rather than sold to oil companies. Others recognize the values in "wastelands" for the rural poor, but either argue that biofuels have no role whatsoever in rural development or that biofuels need to be promoted in a participatory way and focus on small farmers' needs. While one could downplay these disagreements as referring to secondary aspects, the actors do not coordinate their criticism of the mainstream agenda as a single coalition, let alone jointly propose an alternative approach. Even individually, it is questionable whether their participation in governance is sufficient to consider them agents (see Table 6.3).

Table 6.3 Actors, main coalition, and policy-related beliefs on biofuels in India

<table>
<tr><th>Main actors</th><th colspan="2">Policy core beliefs</th><th>Secondary aspects</th></tr>
<tr><td>Government</td><td colspan="2" rowspan="4">• Biofuels can and should replace fossil fuels on a large scale in India, without structural changes in fuel distribution and consumption patterns.

• A food vs. fuel conflict is avoidable by utilizing non-food feedstocks, such as sugarcane molasses, sugar juice in surplus years, and non-edible oilseeds cultivated on “wastelands” for biodiesel. This cultivation reclaims such lands for commercial use and benefits the rural poor.</td><td rowspan="4">• ~~Sugarcane-ethanol to be made only from molasses.~~ (Revised**:** Ethanol can be made from cane juice and thus compete with sugar in surplus years)
• ~~Jatropha is capable of producing well without inputs.~~ (Revised: agricultural R&D to increase productivity)
• ~~The incentives to the biodiesel industry are sufficient to create demand and make this chain operational.~~ (**Under revision:** biodiesel chain still nonoperational. Agreements on prices still to be reached)
• ~~It is feasible and desirable to replace 20% of diesel with biodiesel by 2012.~~ (Revised: Feasible and desirable to replace 20% of total diesel *and gasoline* by 2017)
(Revised again: E10 by 2022; E20 and B5 by 2030.)</td></tr>
<tr><td>Sugarcane agroindustry</td></tr>
<tr><td>Private biodiesel industry</td></tr>
<tr><td>Scientific community</td></tr>
<tr><td>Minority within the government</td><td>• Public and private “wastelands” are available to avoid a food vs. fuel conflict</td><td rowspan="4">• India needs innovative energy systems. Local bioenergy production in rural communities can reduce energy poverty and wasteful transportation of fuel from rural to urban and back to rural areas.</td><td rowspan="3">• Biofuels can play a role in sustainable development, provided the necessary policy instruments are there. (*Because this path has hardly been elaborated on yet, it is still unclear what the specific policy beliefs would be and where disagreements between these actors could emerge*)</td></tr>
<tr><td>Scientific community</td><td rowspan="3">• “Wastelands” typically are under some local use. Imposing non-edible oilseed plantations on them compromises customary community access to resources</td></tr>
<tr><td>NGOs and social businesses
(moderate critics)</td></tr>
<tr><td>NGOs and social businesses
(strong critics)</td><td>• Biofuel production is only acceptable if strictly for local consumption. Still, alternatives such as biogas are more suitable for that.</td></tr>
</table>

NB: The gray area represents the agribusiness coalition; crossed-out text under *secondary aspects* indicates former beliefs replaced

6.3.2 Strategic Uses of Power

If India's biofuel agenda has fallen short of its expected results, the *pursuit* of that agenda in terms of policy advocacy and agency has been a remarkable success. The dominant coalition has far outcompeted its opponents in using all three forms of power, facing very little meaningful opposition. It has displayed both instrumental and structural power at the national level, while discursive power has played a crucial role at the local level during implementation.

Three assets have favored the dominant coalition in biofuel governance in India: access to positions of legal authority, financial resources, and skillful leadership. For example, in India, private sugarcane business people have long held influential positions in government—the flagship example being Sharad Pawar, a sugarcane tycoon from Maharashtra who himself was Minister of Agriculture for a decade (2004–2014). Representatives from the sugarcane industry or research institutes supporting this mainstream agenda and consulted in this research agreed that they receive adequate support from the state. In contrast, NGOs and social businesses holding alternative views reported the opposite (Personal interviews).

Besides, the agribusiness coalition has counted on substantial financial resources. These are not only from private agroindustry but also in the form of public funds channeled as credit through the State Bank of India, subsidized labor (through the National Rural Employment Guarantee Scheme), and public funding for jatropha R&D in private institutes. Alternative biofuel production strategies, such as local use in rural areas, count only on minor public (or private) funding. As a senior government official puts it, "*It is unglamorous*; *industry does not participate in a big way*" (Personal interview).

Then, skillful leadership (or lack of it) has made a difference, too. Biofuel promotion in India—and, in particular, the seminal National Biodiesel Mission—received a significant kick-start thanks to the institutional entrepreneurship of D.N. Tewari, a jatropha enthusiast and then member of the Planning Commission (see Planning Commission 2003).[3] In turn, the opposition has lacked such skillful leaders who could articulate their commonalities, elaborate on a coherent alternative vision, and promote coalition behavior to strengthen their advocacy.[4]

Four discursive tactics have underpinned the approach of the agribusiness coalition in India. First, it has exaggerated the relevance of climate change as a policy rationale. As an Indian professor assesses it,

> The interest [on biofuels] is domestically generated, but the international debate on climate change has given us the space to scale up these initiatives. With that I mean not so much funds — the funds too, though they are very little — but particularly the discourse and the political space. We don't do things for the climate, but it then has "climate co-benefits."

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[3] D.N. Tewari later went on to write a book called "Jatropha and Bio-Diesel" (see Tewari 2007).

[4] Vandana Shiva is internationally regarded as a leader in the defense of smallholders and traditional agriculture in India, and she has been a vocal critic of the biofuel policy (see Shiva 2010), but without proposing any alternative that includes biofuels and thus distancing herself from those (more moderate) critics who seek that.

> Actions on this area [thus] become further legitimized. It also gives us one more reason to do it. In short, the international context creates the space for us to reframe the argument for things we want to do anyway. (Personal interview)

Second, dominant actors have maintained the colonial terminology of "wastelands" to downplay their existing uses and thus legitimize attempts to "put them to use" (Baka 2014). Third, it has tactically used the energy poverty argument even though the biofuel policy has no instruments targeting it (see Planning Commission 2003; MNRE 2009). Fourth, it has labeled jatropha as a "smallholder crop" suitable for "pro-poor development", even though those who have come up with this mainstream strategy, developed it, and carried it out are neither smallholders nor poor. Indian smallholders and rural poor have age-old agricultural traditions, with a vast amount of traditional knowledge and material resources. That includes social practices as well as locally bred seeds, adjusted to India's agro-climatic conditions and controlled by rural communities. Yet none of those were meaningfully explored as "smallholder crops for pro-poor development."

Scientists, in turn, have often helped buttress mainstream discourses—a role scientists frequently play in policy advocacy (Sabatier and Zafonte 2001). Researchers have supported the Indian biofuels agenda in various ways, such as by providing (over)estimations of jatropha productivity (e.g., Leduc et al. 2009), praising the advantages of biofuel utilization (e.g., Jain and Sharma 2010), or making overly optimistic assessments of large-scale feedstock cultivation without recognizing its drawbacks (e.g., Chauhan et al. 2007). Given that most government authorities and policy-makers already subscribe to this perspective, the target audience seems to be rather the broader scientific community and perhaps foreign or international actors, in an attempt to garner resources from abroad or simply as a way to portray India's potentials for success.

Finally, at the implementation level, the persuasion of smallholders and rural communities about the supposed advantages of growing jatropha has also been crucial. Tactics have included, for instance, pro-jatropha theatrical presentations in rural areas, its promotion through local teachers in schools, and co-optation of local leaders and authorities.[5] This discursive engagement has been complemented by using structural power to list jatropha for public credit with major lenders such as the State Bank of India, alongside instrumental power to provide the financial and material capabilities that small farmers generally lack.

India's large-scale biodiesel agenda has so far failed much more due to incorrect assumptions about jatropha and lack of price viability (sometimes compromising an understanding between government and industry) than to successful political opposition in the realm of agency or policy advocacy. Although NGOs have launched campaigns criticizing India's biofuel policy, this has hardly made a dent in the dominant agenda. Indicative of this is that none of the minor policy changes the biofuels agenda has experienced are related to the social and environmental issues raised

[5]These tactics were mentioned in an internal, unpublished report of a Delhi-based private research institute funded by the government promoting jatropha cultivation among smallholders in Andhra Pradesh. In its own terminology, the goal was to "rope in" as many smallholders as possible.

by its critics, but only to operational considerations among dominant actors or the revision of over-optimistic ambitions. It means the agribusiness coalition has free room to continue to try and experiment on the rural poor. It may potentially follow its Jatropha 2.0 with a Jatropha 3.0—or eventually change the crop but keep the same approach, until their power becomes seriously contested and a policy change occurs.

6.4 Conclusions

6.4.1 Key Insights

India has developed one of the world's most ambitious biofuel agendas, yet perhaps the one that has fallen the shortest of its goals. Sugarcane-ethanol production is on the rise, but it has little room for expansion due to India's growing sugar demand and lack of additional arable land available. Meanwhile, the large-scale jatropha-biodiesel endeavor has been disastrous both from a planning and social perspectives. Its widespread deployment on public lands and smallholder contracts has left India's rural poor mostly worse off while failing to generate commercial production.

Four interrelated reasons can explain the choices and outcomes of India's biofuel—and, broadly, bioeconomy—strategy so far. First, domestic public policies have been the main driving force. Although international demand (notably from the EU and the US) has helped attract foreign investment, its role is comparably minor. In the ethanol case, the policy primarily builds upon the pre-existing sugarcane sector. Policy instruments do not significantly attempt to alter production chains in that agroindustry. That is different in the biodiesel case, where there is a high level of policy steering. The biodiesel policy attempts to create a whole new production chain, attracting private biofuel and agricultural technology industries, deregulating access to land, and actively promoting large-scale feedstock cultivation on so-called "wastelands." In this context, although private investors and smallholders can benefit from this policy, they essentially are instruments to help fulfill a government strategy. However, unlike in the Brazilian case, there are no well-defined social inclusion requirements in place.

Second, there have been problematic assumptions underlying this government strategy. The scarcity of arable land and food resources to divert for biofuel production has limited the country's options. This shortage has led the Indian government's focus to marginal lands and a crop that could allegedly produce well under sub-optimal agroclimatic conditions. However, regarding such lands as unused and available proved shortsighted. It largely overlooked local resource uses, as well as jatropha's water requirements. Disagreements with rural dwellers, in turn, resulted in boycotts or even sabotage of jatropha cultivation, leading to a waste of public money. Furthermore, there was excessive optimism about feedstock productivity. Naive overestimations on jatropha yields resulted in overly high expectations, and a whole plan was envisaged based on those assumptions. When reality proved different, the production chain was revealed to be uneconomic and unviable. Clearly, despite the official discourse on climate change mitigation and rural development needs, the Indian strategy's main aim has been to quickly build (renewable) energy supplies. Nevertheless, this pursuit has been without sufficient consideration of the rural poor's needs and interests or even to the performance of the crop selected to be planted over more than 11 million hectares.

Third, these strategies stem from the dominance of a coalition of state and agribusiness actors that have concretized their policy beliefs without meaningful political opposition. Sugarcane was chosen as an ethanol feedstock not merely because it already had an established production infrastructure, sector-oriented policies and technologies (as in some apolitical path dependency), but also due to its powerful lobby to capture this new biofuel market. Meanwhile, the government has adopted a centralized, top-down approach to rural development—a form of administrative rationalism (see Dryzek 2005)—and drawn policies solely based on formal and recognized expertise, without meaningful stakeholder consultation. Critics, in turn, have failed to coordinate themselves as a coalition and to advocate effectively for an alternative agenda.

Finally, as in the Brazilian case, more systemic causes can be found in the distributive outcomes and social impacts these biofuel production patterns create. This (re)distribution refers, in particular, to the transfer of legal or de facto control over land and freshwater resources from local communities to the private sector or the state. Such a pathway not only meets the policy beliefs of the dominant coalition, but it also increases their material capabilities at the expense of already impoverished rural populations. These weaker actors thus become even weaker, and their capacity to influence governance is reduced even further. Moreover, with the expansion of production systems where smallholders are subordinate to private or state-controlled companies that keep all decision-making and value-added to themselves, not only are structural inequalities reproduced and maintained, but smallholders also lose autonomy. Their room or ability to pursue alternative production patterns based on their views becomes ever smaller. Figure 6.3 synthesizes these dynamics.

6.4.2 Alternatives

Equitable biofuel production strategies would require, first, respecting customary land rights and the local use of resources from the so-called "wastelands." If there is such tremendous pressure for land in India, it stands to reason that 11 million hectares can hardly be entirely unused and available. Such land conflicts could be avoided by complementing satellite mapping with assessments on the ground for adequate planning. Second, biofuel policies can require mixed food and feedstock cultivation for safeguarding local economic and food security.

Third, precise equity requirements would likely improve the quality of smallholder inclusion: collective representation at contract negotiation to increase farmers'

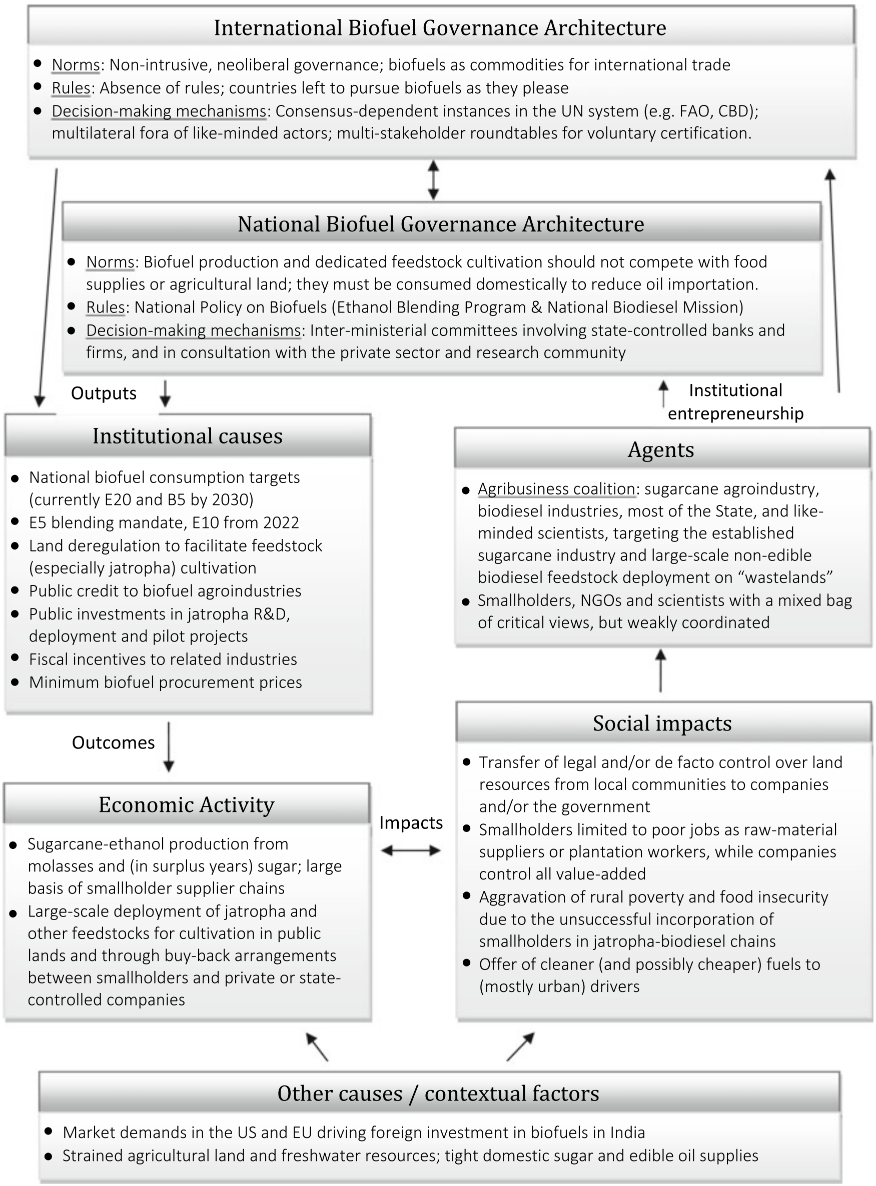

Fig. 6.3 Analyzing institutional, social and political dimensions of biofuels in India

bargaining power, technical assistance from the government or contracting companies to build local capacity, and eventually local value addition, such as vegetable oil extraction at the village level. The importance of climbing up to value-added production stages is well-understood in India as a whole, as seen in the flagship *Make in India* campaign to add value domestically. However, it remains broadly neglected when it comes to local communities and rural development strategies through biofuels or the bioeconomy.

Fourth, India's high rural energy poverty rate creates ample room for locally using biofuels, and its farmers often are keen to produce renewable energy (Winkler et al. 2018). Nonetheless, this requires direct investments in oilseed crushing, vegetable oil processing, and electrification infrastructure. Finally, given the freshwater scarcity and dependence on monsoon rainfall in much of the country, greater feedstock diversity and less water-demanding crops than sugarcane and jatropha would make environmental sense. Alternatives could include sweet sorghum for ethanol (Basavaraj et al. 2013) and native oil-bearing species such as neem or pongamia for biodiesel, trees which may have longer maturation periods but provide better results in the medium term (see Altenburg et al. 2009).

India's biofuel governance would also be more equitable by taking smallholder networks, cooperatives, and representative NGOs on board in biofuel (or other bio-based) value-chain planning and policy-making. It is legitimate that local communities decide what rural development strategies they prefer, which may or may not include biofuels. Yet any significant policy changes may require further agency from critics of India's dominant biofuel agenda. Such actors would need not only to deconstruct the "pro-poor" argument of the mainstream agenda but also to articulate a common advocacy position and complement their resources around a credible alternative strategy. Alternative strategies would need testing and clear prospects for how they can help meet the country's rural development and energy needs, so as to gain political support. For that, greater participation of socially oriented businesses may be particularly useful to fill financial gaps and demonstrate economic viability.

As the bioeconomy broadens, it is essential to learn the lessons from this ample biofuels experience rather than only do more of the same.

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Chapter 7
Bioeconomy in the Oil Palm Republic of Indonesia

Abstract Biofuels give but a prelude of broader bioeconomy development in the Southeast Asian nation. Although many biofuel production chains were initially envisaged in Indonesia, palm oil reigns supreme as the only feedstock commercially used on a large scale. Its production occurs primarily in industry-owned plantations or through farming contracts between private companies and rural households. These arrangements have provided rural workers or smallholders with a much-needed income that alleviates their poverty; however, the allocation of rights, roles, benefits and burdens is highly inequitable. Moreover, the environmental degradation from oil palm plantations further makes their expansion unsustainable, despite attempts to frame them as climate-friendly due to their role as carbon sinks. Foreign investments play a significant role, but domestic promotion policies arguably remain the only *sine qua non* cause for biofuel expansion in Indonesia. State and private-sector advocates of agribusiness have firmly pushed for plantations as a form of land use and development. Meanwhile, adversaries advocating for conservation have not yet offered a clear alternative development path. Most criticize the mainstream agenda without saying much about how to address Indonesia's development needs sustainably. Credible alternatives may be imperative for the country's land use and to develop its bioeconomy on a more sustainable footing.

Keywords Biofuels · Palm oil · Biodiesel · Tropical forests · Equity · Governance

Maybe nowhere else in the world is the bioeconomy so dependent on one single crop as it is in this still megadiverse country. Indonesia is the world's largest supplier of vegetable oil, whose demand has considerably increased in recent years—among other uses, for biofuels. Its crop of choice is oil palm, a high-yielding oil-bearing tree of West African origin. It has adapted very well to Southeast Asian climates and has given Indonesia its most lucrative export product after coal (Ministry of Trade 2020). However, while this agroindustry brings large sums of foreign exchange to the country, its sustainability has been contested. Growing biofuel production and broader bioeconomy ambitions have further inflamed the debate, raising many questions about land-use changes from oil palm expansion, the role of policies from importers such as the European Union (EU), and also how equitable this palm-centered development is.

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With an inevitable focus on the oil palm sector and to understand the foundations of Indonesia's bioeconomy, this chapter analyzes its now decade-long biofuel industry and why certain production patterns have prevailed. After briefly appraising its energy and agri-food contexts, it assesses Indonesia's biofuel production chains and the evolution of support policies. The chapter then analyzes the distributive outcomes and social impacts of biofuels, agency in Indonesia's biofuel governance, and it concludes with critical insights on the country's bioeconomy development so far.

7.1 Biofuels in Indonesia: How and Why

7.1.1 The Indonesian Setting: Energy and Agri-Food Contexts

7.1.1.1 Energy Context

Indonesia's energy context is characterized by growing consumption, substantive domestic supplies of natural gas and coal (the latter being mostly exported), but declining oil production due to depleting reserves and, thus, a sensitive liquid-fuel import dependence. In absolute terms, energy demand more than doubled between 1990 and 2020. Since 2000, the Indonesian economy has on average grown by 5–6% per year, with its per capita energy intensity also on the rise (IEA 2008; MEMR 2019).

Despite abundant coal supplies—and being, on the whole, a net energy exporter—as much as 40–45% of Indonesia's energy consumption takes place in the transport sector. Therefore, its overall energy demand is primarily met by oil (39%), on which Indonesia's import dependency stands at 35% (National Energy Council 2019). This foreign dependency is a curious twist for a founding member of the Organization of Petroleum Exporting Countries (OPEC). Most of Indonesia's domestic oil production comes from mature fields exploited since the 1950s, and since 2004 the country has been a net oil importer (IEA 2008; EIA 2011). Indonesia left OPEC in 2009, joined it again for a brief period in 2015, but was suspended a year later due to disagreements with the organization's policies—in what might be a structural sign that its strategic position has misaligned from that of actual oil exporters.

Indonesia's refining capacity, too, has stagnated. It lacks investments and has been outpaced by the demand for oil derivates such as gasoline and diesel. This stalled capacity has meant increasing foreign exchange expenditures and budget expenses on subsidies (IEA 2008, 2010). Fossil fuel subsidy reforms have been politically challenging in Indonesia, not unlike elsewhere. Here, such subsidies have consumed a large share of the country's economic resources—as much as 20% of the central government's budget in the 2008–2014 period (Chelminski 2018; MEMR and MF 2019). In 2020, it was estimated that biodiesel alone could save the country USD 4.5 billion from what would have otherwise been fossil fuel imports (Sapp 2020).

Biofuels have, therefore, appeared as a broadly beneficial initiative to Indonesia's energy situation. In a short period, they have grown significantly from meeting only 1% of the country's total energy consumption in 2008 to as much as 13% in 2018 (MEMR 2019 p. 27). Unlike elsewhere where the electrification of transportation is forecast to take hold, the forecast is that electric vehicles will continue to play a very marginal role by 2050 in Indonesia. By that year, in the best-case scenarios for renewables, biofuels are expected to fulfill as much as 62% of the country's transport energy needs (National Energy Council 2019, p. 25).

7.1.1.2 Agri-Food Context

Indonesia's agri-food context is marked by competition between agriculture and other land uses (not only forest conservation, but also urbanization and infrastructure growth), rapid oil palm expansion, and perennial food security concerns—particularly an unyielding import dependence on rice, Indonesia's main staple.

About 71% of Indonesia's territory is formally forestland (Bastos Lima et al. 2013). However, the official estimates are that, in reality, about half of the country's land is covered by forests, without necessarily matching the same areas on paper (Ministry of Forestry 2009; Tsujino et al. 2016). Deforestation has been the single largest environmental issue for Indonesian agriculture and the country's most significant source of greenhouse gas emissions (IPCC 2019). Oil palm cultivation, in particular, has rapidly expanded across the archipelago. It grew in area at a staggering annual rate of up to 10% in the 2000s and early 2010s (Indonesia Statistics 2019), and most often at the expense of forests (Koh and Wilcove 2008; Vijay et al. 2016). Official estimates are that oil palm already occupies more than 16 million hectares (Mha) in the country; however, illegal plantations are rampant, representing as much as one-fifth of the total according to one governmental investigation (Listiyorini and Rusmana 2019). Indonesian civil society assesses that 21 Mha is more likely the actual area (Suwastoyo 2018).

Indonesia's palm oil production has become the world's largest by far, having the country account for 35% of global vegetable oil exports (OECD/FAO 2019). This substantive role is even though domestic biodiesel manufacturing already captures 22% of the country's vegetable oil supply—a share forecast to increase to 28% by 2028 (OECD/FAO 2019). Although domestic consumption is increasing, two-thirds of Indonesia's production is exported, mostly as crude palm oil (CPO) (Rahmanulloh 2020). Thus, oil palm expansion is largely a response to international market demand, notably from India, the EU, China, and the United States. While part of that foreign demand is for biodiesel and oleochemical industries, it is used primarily in processed foods—leading some to provocatively ask whether the world is "junking its forests for junk food" (Huay Lee et al. 2016).

That said, the share of exports in Indonesia's palm oil production is gradually decreasing as the country turns its attention to a booming domestic market (Rahmanulloh 2020). Domestic CPO consumption is growing fast with the expansion of Indonesia's biodiesel sector, along with industry enthusiasm for new bioeconomy uses of oil palm products, such as palm-based bioplastics (GAPKI 2020a). Besides the biorefining of CPO, which produces refined palm oil alongside co-products such as olein, stearin and glycerol, production of palm kernel oil (extracted from the seeds rather than the fruit pulp) is also on the rise, with utilization in the cosmetics industry.

Meanwhile, the Indonesian government has attempted to overcome the country's persistent dependence on rice imports (primarily from Thailand and Vietnam). While demand is growing, domestic production is increasing just enough not to let the import dependency augment. Rice is grown mostly in Java and Bali, islands of high population density that have experienced a continuous land conversion to non-agricultural, urban uses (McDonald and Meylinah 2019). Agricultural expansion on Sumatra, Borneo, and other outer islands, in turn, has been mostly for cash-crops, such as cocoa and oil palm.

7.1.2 Biofuel Production and Consumption Chains

7.1.2.1 Ethanol

Sugarcane has been Indonesia's preferred feedstock for ethanol, but fuel production is yet to take off. Sugarcane is cultivated mostly in Java and in Sumatra's Lampung Province, though new frontiers have been pursued in the outer islands. By world standards, however, Indonesia has only a modest sugarcane industry, producing about 2.1 million tons of sugar—less than one-tenth of the Indian production. As Indonesia consumes twice as much sugar as it produces, imports (primarily from Thailand) meet more than half of its demand (Meylinah 2020a). Indonesia, therefore, has targeted only sugarcane molasses for ethanol production to avoid sugar vs. ethanol competition. At any rate, fuel-ethanol production remains economically unattractive to the industry and has not taken place since 2010 despite some policy incentives (Rahmanulloh 2019). Pertamina, Indonesia's state-controlled oil company, made an agreement in 2012 with the US-based Celanese Corporation to advance cellulosic ethanol production (Celanese 2013), while during the COVID-19 pandemic the oil palm industry advertised hand sanitizers made with alcohol from palm biomass (GAPKI 2020b). However, as far as fuel is concerned, as of 2020 neither first- nor second-generation ethanol production had taken place at a commercial scale.

7.1.2.2 Biodiesel

Palm oil has been Indonesia's only commercial biofuel feedstock, but others were tried and tested in the early days. Namely, Indonesia has—like India—promoted jatropha as a biodiesel feedstock in the belief it could grow well under marginal conditions, without irrigation or chemical inputs (see Silitonga et al. 2011). Government agencies widely encouraged smallholders to grow it, expecting private companies to purchase it. However, this plan never materialized due to jatropha's low yields and inability to compete with (cheaper) palm oil as a feedstock (see Dillon et al. 2008). By the early 2010s, jatropha seeds for making one liter of vegetable oil would cost on average IDR 8,000 (~US$ 0.90), in contrast to IDR 5,000 (~US$ 0.56) for palm oil (Slette and Wiyono 2011). As such, the many smallholders who had been approached were left without a buyer. Jatropha remains under R&D efforts to select high-yielding and more tolerant varieties, but it has not (yet) reached commercial viability.

Oil palm is considered the most efficient biodiesel feedstock crop, with yields at least three times higher than any other vegetable oil crop per hectare (Tan et al. 2009; see also Sheil et al. 2009). Its cultivation takes place mostly as cash-crop monocultures: 10% managed by the government, 55% by private companies, and 35% by smallholders (Suwastoyo 2018). However, independent smallholders can hardly afford the high start-up costs of oil palm cultivation and bear the four years of maturation period; therefore, most of them work under buy-back contracts called “nucleus-plasma schemes.” The government mandates that smallholders manage at least 20% of the land in oil palm plantations to reduce conflicts between companies and rural communities (Feintrenie et al. 2010a; McCarthy et al. 2012).[1] Usually, the company acquires 70% of the farmers’ land (to become the plantation “nucleus”) and contracts their work on the remaining 30% (the “plasma”), providing seedlings, inputs, and technical advice at a cost. A bank (usually public) provides credit to the farmers, with the company acting as a guarantor to cover their needs during the crop’s long maturation period. Once they start producing, farmers start to pay back the debt as a fixed percentage of what they earn selling fresh fruit bunches (FFB) to the company. The latter processes FFB into CPO and occasionally into more refined products, and market it downstream (Feintrenie et al. 2010a, b; Rist et al. 2010).

The biodiesel industry has come as an add-on to an already thriving palm oil sector. Therefore, this biofuel industry is not about new players coming in but existing ones extending their activities to meet the demands of a new market. Private investments to install capacity for processing palm oil into biodiesel began en masse in 2006–2007, when international petroleum prices increased and CPO prices were low (Dillon et al. 2008; Schoneveld 2010; Caroko et al. 2011). Market volatility, however, soon revealed to be an issue when CPO prices rose in late 2007, and many processing units downscaled or suspended their operations (Caroko et al. 2011, p. 17). Biofuel production only resumed after the government agreed to provide further incentives and procure biodiesel according to a formula that ties it to fluctuating CPO prices.

Indonesian biodiesel production and consumption would substantially increase through the 2010s. With a mandatory consumption of 30% biodiesel blends (B30) in 2020, production of this fuel was estimated at close to 10 billion liters (bl)—essentially making Indonesia the world’s largest biodiesel producer and consumer. Installed capacity for 2021 has reached 12.5–13bl, following growing domestic demand. As for exports, while historically they have played a significant role,

[1]See Ministry of Agriculture regulation No. 26/Permentan/OT.140/2/2007, superceded by regulation No. 98/Permentan/OT.140/9/2013, which maintained the requirement, so-called “plasma obligation”.

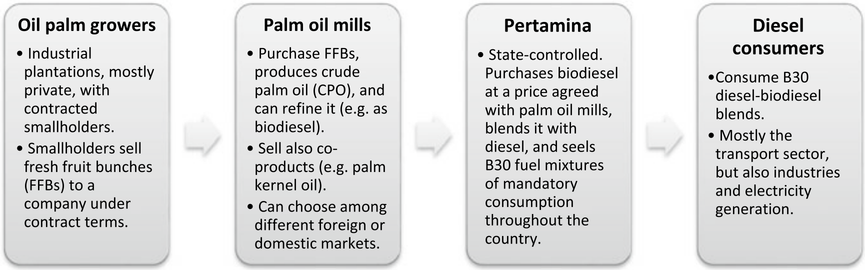

Fig. 7.1 Production and consumption chain of palm-based biodiesel in Indonesia

representing as much as 1.7bl or nearly half of Indonesia's biodiesel production in 2018, this is expected to decrease as key consumer markets (notably in the EU) reject palm-based fuel (Rahmanulloh 2019). The EU classification of palm-based biodiesel as "high risk" in terms of indirect land-use change, with a gradual phase-out through the 2020s until its complete elimination by 2030, has severely reduced Indonesian export prospects. Even if the European policy allows for exceptions depending on the specific production area, that can be a game-changer.

In the growing Indonesian domestic market, biodiesel procurement, blending and distribution are done primarily by the state-owned oil giant Pertamina (Dillon et al. 2008; Caroko et al. 2011). Blends with a share of biofuel receive various names depending on fuel specifications, such as *bio-premium* or *bio-pertamax* for the gasoline-ethanol blends[2] and *bio-solar* for the diesel-biodiesel blend. Initially, biodiesel blends were limited to public-sector transport, mostly heavy-duty vehicles (Sianipar 2012); however, this has expanded to include all diesel sold in the country. See Fig. 7.1.

Currently, CPO exports are the main competition for Indonesia's biodiesel production, as they are often favored when international prices become attractive. Domestic CPO availability—for biodiesel manufacturing as well as other purposes—therefore fluctuates. This fluctuation is despite an export tax the Indonesian government levies on CPO. As such, partly as an effort to increase the security of supply, Pertamina has started investing in having its own palm oil refining plants while seeking from the government a domestic supply obligation applicable to all CPO producers (Asmarini and Christina 2020). If this path is taken, it will increase vertical integration upward in the biodiesel value chain, with the state taking control of further steps upstream to secure its biofuel policy goals.

[2]Pertamina distributes various types of gasoline in Indonesia, the main ones being: subsidized 88-octane (branded "Premium"), and non-subsidized higher-performance, 92-octane gasoline (branded "Pertamax") (Rahmanulloh 2019).

7.1.3 Indonesia's Biofuel Policy Framework

Indonesia's policy of phasing-in biofuels began with the release of a blueprint for the country's energy planning in 2005, which became consolidated in the 2006 National Energy Policy (Government of Indonesia 2006; Legowo et al. 2007). A presidential decree created the National Team for Biofuel Development (TIMNAS BBN), a group of government and private sector representatives with the mission of drawing up a roadmap with milestones of biofuel consumption targets until 2025 (Legowo et al. 2007; Dillon et al. 2008; Caroko et al. 2011). The roadmap aimed at a 10% replacement of diesel by 2010 and 20% by 2020, accompanied respectively by 5% and 15% gasoline replacement with ethanol (Legowo et al. 2007).

To meet those targets, the government foresaw the expansion of feedstock plantations onto an additional 5.25 Mha of "unused land" by 2010, projected to increase to 10.25Mha by 2015 (Caroko et al. 2011). The government offered two new lines of subsidized credit through public banks as well as tax exemptions and other fiscal incentives to biofuel industries (Dillon et al. 2008; Caroko et al. 2011). It also revised regulations concerning private sector investments in plantations. In 2007, a new investment law (Law 25/2007) simplified the land-leasing bureaucracy for agribusiness investors and extended the duration of the required land-use permits (HGU, *hak guna usaha*, "right to cultivate"; and HGB, *hak guna bangunan*, the "right to build" agricultural processing infrastructure).[3] Concurrently, the Ministry of Agriculture set higher ceilings for the area sizes that can be leased for private plantations. These ceilings are crop-specific and, tellingly, are much higher for biofuel feedstocks. While traditional—but non-feedstock—Indonesian commodities such as cocoa and coffee are limited to 5,000 ha, jatropha's ceiling is ten times higher (50,000 ha), as are oil palm's (100,000 ha) and sugarcane's (150,000 ha). Only feedstock crops have ceilings above 25,000 ha.[4] All these caps are twice as high for Papua, perceived by the government as having abundant lands available.[5] Finally, the government sought international cooperation on biofuels and signed 67 agreements in 2007, including bilateral technological cooperation with Brazil (Dillon et al. 2008). These efforts underscored the beginning of Indonesia's biofuel strategy (see Table 7.1).

However, despite those incentives, biofuels remained uncompetitive due to fossil fuel subsidization (Krismantari 2007). Then, in 2008 the government introduced *mandatory* blending targets. Palm oil mills remained reluctant to produce biofuels, as CPO prices were more attractive on the international market (Sasisitiya and Liem 2009). The Indonesian Biofuel Producers Association requested a benchmarked biodiesel price based on that of CPO, a request to which the government acquiesced later in 2009 (Wulandari 2009). Still, with the continuous increases in CPO market prices, palm-oil biodiesel became too expensive to produce without further economic

[3]It increased the duration of HGU permits from 35 years (with the possibility of renewal for additional 25 years) to 60 years (renewal for 35 years), and HGB permits from 30 years (renewal for 20 years) to 50 years (renewal for 30 years) (Caroko et al. 2011).

[4]Ministry of Agriculture Decree No. 26/Permentan/Ot.140/2/2007, appendix 3.

[5]Ministry of Agriculture Decree No. 26/Permentan/Ot.140/2/2007, Art. 12, par. 3.

Table 7.1 Initial phase of Indonesian policies for biofuel promotion

Year	Policy	Policy instrument type(s) and target(s)	Effect
2005	National Energy Blueprint 2005–2025	National consumption targets	Phasing-in of biofuels in the energy mix: 2% by 2010, 3% by 2015, and 5% by 2025[a]
2006	National Energy Policy	National consumption targets	Adoption of blueprint projections with specific targets for biodiesel, ethanol, straight vegetable oil, and total biofuels. National agencies to devise policy instruments to stimulate production projects and facilitate land procurement for feedstock crops[b]
	Creation of the National Team for Biofuel Development (TIMNAS BBN)	Governance	Preparation of a biofuel development roadmap to create employment and alleviate poverty[c]
	Fuel specifications for ethanol and biodiesel	Economic regulation (*fuel distributors*)	Technical fuel specifications and permission to blend 10% of ethanol and 10% of biodiesel[d]
	Taxation on ethanol imports	Import tariff (*Foreign ethanol industries*)	Import tariff of IDR 10,000 per liter of ethanol plus 30% *ad valorem*[e]
	Subsidized credit to individual farmers growing feedstock	Public credit (*oil palm growers*)	National banks to provide farmers with subsidized credit for establishing feedstock plantations, particularly oil palm[f]
2007	Economic incentives for biofuels	Fiscal incentives (*biodiesel and ethanol industries*)	Income tax deductions, accelerated depreciation and amortization of costs, and government guarantee against operational losses[g]
	New Investment Law	Land (de)regulation (*sugarcane, jatropha or oil palm growers*)	More favorable land regulations to investors, including longer concession periods[h]
	New guidelines on plantation licenses	Land (de)regulation (*sugarcane, jatropha or oil palm growers*)	Higher area limits to plantation licenses, particularly on feedstock crops such as sugarcane, oil palm, and jatropha[i]
	Subsidized credit to farmer cooperatives growing feedstock	Public credit (*sugarcane, jatropha or oil palm growers*)	National banks to provide farmers and cooperatives with subsidized credit for development projects on food and energy crops[j]

[a]Legowo et al. (2007), [b]Presidential regulation No. 5/2006; [c]Presidential regulation No. 10/2006; [d]Director General of Oil and Gas Decrees No. 3674 and No. 3675; [e]Ministry of Finance Decree No. 89/PMK.04/2006; [f]Ministry of Finance Decree No. 117/PMK.06/2006; [g]Government regulation No. 1/2007; [h]Law No. 25/2007; [i]Ministry of Agriculture Decree No. 26/Permentan/Ot.140/2/2007; [j]Ministry of Finance Decree No. 79/PMK.05/2007

incentives (Sasisitiya 2010). The government response was to provide further fiscal incentives and double the direct subsidy paid to processors, from IDR 1,000/liter to IDR 2,000/liter for the year 2010 (Caroko et al. 2011). Biodiesel production then finally started to increase and gained scale.

A new National Energy Policy in 2014 consolidated public incentives for biofuels (Government Regulation 79/2014). It also set Indonesia's renewable energy targets at 23% by 2025 and 31% by 2050, respectively, requiring the consumption of 13.9bl and 52.3bl of biofuel in the country (Rahmanulloh 2019). The government introduced progressive export taxes on both CPO and biodiesel that apply whenever their international market prices go beyond an established threshold, to prioritize domestic use. As per the Ministry of Finance Regulation 23/2019, a USD 25/ton export tax applies to CPO when its prices stand between USD 570–619/ton, and USD 50/ton when CPO prices go above USD 619/ton. Levies are also collected from biodiesel exports when its prices are within the same range, but these levies are lower (respectively USD 10/ton and USD 20/ton) to encourage domestic processing (Rahmanulloh 2019). These taxes feed into an Estate Crop Fund for palm oil, also called the CPO Fund, used to subsidize biodiesel manufacturing in times of low petroleum prices as well as for broader investments in oil palm R&D, smallholder support, and crop replanting (Nurfatriani et al. 2019).

Meanwhile, the government has continued to incentivize private investment in oil palm plantations. In 2014, a new Law on Plantations dropped earlier limits on foreign ownership. Oil palm plantations, in particular, are increasingly framed as strategically contributing to both the nation's food and energy needs. Since a 2009 policy on special economic zones (with facilitated conditions for investment), such plantations have started to be regarded as "Food and Energy Estates" (Ginting and Pye 2011). The flagship example of this policy has been the Merauke Integrated Food and Energy Estate (MIFEE),[6] a program to set new plantations on up to 2 Mha in Merauke district, Papua (see Ginting and Pye 2011; Ito et al. 2014, Obidzinski et al. 2014). Initially launched by President Susilo Bambang Yudhoyono in 2011, it was relaunched in 2015 by President Joko Widodo, who has linked MIFEE to Indonesia's increasing self-sufficiency aspirations on energy and food despite negative impacts on local communities and natural forests (Suryiani 2016; Indrawan et al. 2017).

To dispel growing sustainability concerns from major importers, the government created the Indonesian Sustainable Palm Oil (ISPO) certification. This initiative came after industry complaints that certification from the Roundtable on Sustainable Palm Oil (RSPO) is too demanding, costly, and not sufficiently rewarding in providing either market penetration or premium price. This policy came in tandem with a similar initiative in Malaysia, which announced its Malaysian Sustainable Palm Oil (MSPO) certification. While some stakeholders argue that this is a greenwashing movement from the government to "certify" the domestic industry under laxer requirements, others contend that it is meant as a stepping-stone towards acquiring the stricter RSPO certification. After years of limbo, in 2020, ISPO became mandatory to all

[6]The project has been legally enshrined in the letter of the Governor of Papua Province No. 050/1879/SET, dated May 26, 2010, regarding MIFEE.

palm oil producers while coming to have more precise criteria and a governance structure to increase both its domestic uptake and foreign market acceptance.

For the future, it seems clear that Indonesia's biodiesel strategy increasingly has a domestic orientation. As key markets abroad limit palm-based biodiesel importation, both the Indonesian government and the country's Biodiesel Producers Association have started eyeing B40 blends and beyond (Suwastoyo 2020). Table 7.2 shows Indonesia's key policies related to biofuel production since 2008.

7.1.4 Assessing Institutional Causality

Four reasons make Indonesian public policies the primary driver of biofuel production in the country. First, they have provided the private biofuel sector with essential economic incentives, without which the sector essentially is not viable (see Dillon et al. 2008; Schoneveld 2010; Caroko et al. 2011). Second, they have made Pertamina procure, blend, and distribute biofuels. The only domestic buyer is essentially the state itself, in a monopsony. Third, public policies have granted needed permissions and necessary bureaucratic facilitation to private land-based investments, without which such investments would arguably be much fewer. Fourth, the government has directly engaged in garnering international support through agreements and technology exchange to improve biofuel production. Albeit less successfully, it has also engaged in a form of "palm oil diplomacy" through ISPO on behalf of its palm oil industry. As such, although biofuel policies have not *created* the feedstock production systems in place, there is a broad consensus that they have boosted private investors' interest in and government support to the expansion of plantations (Santosa 2008; McCarthy and Cramb 2009; Caroko et al. 2011). Table 7.3 summarizes the key rationales behind Indonesia's biofuel policy-making.

As a significant exporter, Indonesia's palm-based biodiesel industry seems more strongly influenced by foreign drivers than those of India and Brazil. The US and the EU are significant import markets and sources of much private investment (Pye 2010). Therefore, biofuel expansion—as the overall expansion of oil palm in the country—owes both to foreign market demand and to Indonesia's public policies, even if the latter have been the only essential, *sine qua non* cause.

7.2 Allocation and Access: Analyzing Institutional Performance

7.2.1 Allocation Patterns: Who Owns, Does, and Gets What

As in the rest of developing Asia, fast economic growth in Indonesia (at 5–6% a year) has been accompanied by a sharp rise in inequality. Its Gini index increased

Table 7.2 Evolution of Indonesia's policies for biofuel production since 2008

Year	Policy	Policy instrument type(s) and target(s)	Effect
2008	Ministry of Energy regulation on supply, utilization, and marketing of biofuels	Consumption targets (*fuel distributors*)	Milestones for mandatory biofuel consumption by different sectors from 2009 to 2025[a]
2009	Subsidies to biofuel processors	Direct subsidy (*biofuel industries*)	Subsidy of IDR 1,000 (USD 0.10)/liter to biofuel processing industries[b]
	Ministry of Finance decree on biofuels	Fiscal incentives (*biofuel industries*)	The government to absorb value-added tax levied on the biofuel sector[c]
	Special Economic Zones	Zoning (*plantation investors*)	Zones with facilitated conditions for investment in strategic sectors such as energy and agriculture[d]
	Procurement and distribution of biofuels	Economic regulation (*fuel distributors*)	Ministry of Energy and Mineral Resources (MEMR) to set a pricing formula for biofuel procurement[e]
	First of a series of increases in biofuel subsidies	Direct subsidy (*biofuel industries*)	Biofuel subsidies to processors are doubled, from IDR 1,000(~USD 0.10)/litre to IDR 2,000 (~USD 0.20)/litre[f]
2010	Directorate General (DG) of New and Renewable Energy	Governance	Creation of a New and Renewable Energy directorate-general in the MEMR to promote and steer biofuel production and consumption
	Foreign equity shares	Land (de)regulation (*plantation investors*)	Foreign investors allowed up to 95% of joint ventures on oil palm or jatropha plantations[g]
	Food and Energy Estates	Land (de)regulation	Creation of the "Food and Energy Estates" format within a special economic zones policy to facilitate investment in food and feedstock crops[h]
2011	The second increase in biofuel subsidies	Direct subsidy (*biofuel industries*)	Biofuel subsidies to processors raised from IDR 2,000(~USD 0.20)/litre to IDR 2,500–3,000(~USD 0.25–0.30)/litre for biodiesel and IDR 3,000–3,500 (USD 0.30–0.35)/litre for ethanol[i]
	ISPO sustainability certification	Certification	Creation of the government-run Indonesian Sustainable Palm Oil (ISPO) certification[j]
2014	National Energy Policy	Consumption targets (*Domestic industries*)	Renewable energy targets of 23% by 2025 and 31% by 2050, including biofuel consumption of 13.6 billion liters (bl) and 52.3 bl, respectively[k]
2018	Estate Crop Fund (CPO Fund)	Direct subsidy (*biodiesel industries*)	Established in 2015 and updated in 2018, a fund to subsidize biodiesel production and oil palm planting[l]
2019	CPO and biodiesel export levies	Export taxes (*Domestic industries*)	Export taxes on CPO or biodiesel exports if prices exceed USD 570/ton. Pooled into the CPO Fund[m]
2020	New ISPO rules	Certification	ISPO becomes mandatory to all palm oil producers, with more precise criteria and governance structure[n]
	B30	Blending mandate	30% biodiesel blending becomes mandatory

[a]Ministry of Energy and Mineral Resources regulation 32/2008; [b]State Budget—Fiscal Year 2009; [c]Ministry of Finance decree No. 156/PMK.011/2009; [d]Government regulation No. 39/2009; [e]Presidential regulation No. 45/2009; [f]State Budget—Fiscal Year 2010; [g]Presidential Regulation No. 36/2010; [h]Government Decree No. 18/2010; [i]State Budget—Fiscal Year 2012; [j]Ministry of Agriculture Decree No. 19/Permentan/OT.140/3/2011; [k]Government Regulation 79/2014; [l]Nurfatriani et al. (2019); [m]Ministry of Finance Regulation 23/2019. [n]President Regulation 44/2020

Table 7.3 Rationales for biofuel policies in Indonesia

Rationale	Specific interests
National energy security	Increasing domestic energy production to reduce reliance on foreign oil and expenditures on fossil fuel subsidies, eventually becoming a biofuel exporter[a]
Rural development	Rural employment in feedstock cultivation, particularly oil palm[b]
Climate change mitigation	Reduction of GHG emissions through fossil fuel substitution in transportation[c]

[a]Government of Indonesia (2006), Legowo et al. (2007), Hadiwidjoyo (2009), Caroko et al. (2011), [b]Legowo et al. (2007), Hadiwidjoyo (2009); [c]Legowo et al. (2007), and State Ministry of Environment (2007)

from 0.29 in the early 1990s to 0.39 by 2018 (Asian Development Bank 2012; World Bank 2020). The Asian Development Bank (2012) notes that market-oriented development policies and greater integration in the global economy have been the leading cause. The outcomes have been notably different from the more equitable growth experienced by Asia's newly industrialized economies (Japan, South Korea, Singapore, Taiwan) in the 1960s and 1970s. The Bank further argues that two factors are crucial: (i) large economic reliance on physical capital, including exhaustible natural resources, disproportionately benefitting those who own or control it, and (ii) regional disparities, such as the urban-rural divide. In Indonesia's case, there are also significant inequalities among the islands, with Java and Bali being the most urbanized, industrialized and densely populated ones, followed by Sumatra and Borneo, while Papua and the other eastern islands are on the other extreme (Asian Development Bank 2012).

Palm oil production systems have arguably contributed to such an inequitable development. First, they reallocate control over land and freshwater resources from rural communities to mostly private agroindustries, making the former utterly dependent on the latter for their income and food security. Second, even though such systems incorporate local communities as palm-fruit suppliers or plantation workers, the industry retains control of cultivation. Contracted smallholders must purchase expensive chemical inputs from the company; they are susceptible to its uneven bargaining power, as the company is frequently the only buyer in the area (monopsony). Moreover, according to some farmers, they occasionally are also subject to abuses from company staff, who allegedly are not always honest when determining the palm fruit quality and, thus, its price (Personal interviews).

Third, smallholders are limited to the role of raw-material suppliers without any prospects of climbing up in the value chain. In contrast, the industry benefits both from governmental subsidies and increasingly profitable markets—not only from palm oil and its derivates but also from co-products such as palm kernel oil. As such, in relative terms, the companies benefit much more. They keep the most advantageous roles, most income, control over technology and production, and simply use rural communities as hired labor. Still, this labor is ridden with health risks and exploitation cases (Gottwald 2018; Suwastoyo 2019). The incorporation of locals and, in particular, the "plasma obligation" is also a form of reducing land conflicts (Feintrenie et al. 2010a; McCarthy et al. 2012), a tactic that could easily be regarded as also a form of co-optation. A study by the Worldwatch Institute suggests that self-employment in traditional farming can provide livelihoods to 260 times more people per hectare than oil palm plantations do (Renner et al. 2008). However, these alternatives are simply not on the agenda.

The government's strategy has been to promote private oil palm agroindustries as "agents of change" to increase domestic (renewable) fuel supplies and improve rural socio-economic standards. Such an approach is clear from how regulatory and economic incentives are nearly all aimed at the private sector. Even instruments that target other actors, such as subsidized credit to farmers, seem ultimately linked to the industry—in this case, because farmers need a loan guarantor, who is usually a private company (McCarthy 2010). Therefore, this lending works as a tool to enable rural Indonesians to participate in such privately-run systems. Arguably, it indirectly targets the industry as much as it targets the smallholder.

Meanwhile, economic burdens are allocated to the state—and not only in the form of subsidies. Pertamina's role as Indonesia's sole fuel distributor means it has to absorb the higher costs of blending biofuels despite cheaper gasoline and diesel. As such, not only does the policy channel public funds to the private sector, but it also allocates the least economical step of the value chain to the state.

7.2.2 Access to Resources: Land, Water, Food and Energy

Access to land in Indonesia is conflictive both at the institutional level and on the ground (Colchester et al. 2006; Colchester 2011; Dhiaulhaq and McCarthy 2020). Most disputes refer to customary ownership *versus* land-use rights granted by the government to private companies for mining or plantation development (Colchester et al. 2006; Caroko et al. 2011). Regulations are fuzzy, and land tenure status is often unclear. Although the Basic Agrarian Law of 1960 recognizes customary ownership rights, it makes them subordinate to national interests as interpreted by the state (see Bastos Lima et al. 2013). As such, many conflicts have either emerged or been exacerbated by oil palm expansion and biofuel promotion (Marti 2008; McCarthy and Zen 2010; Colbran 2011, Colchester 2011; Abram et al. 2017). Throughout the 2010s, the Indonesian NGO Sawit Watch annually registered over 500 land conflicts involving local communities and palm oil companies in Indonesia (see Drost et al. 2019). Such conflicts have significantly affected indigenous peoples and other forest-dependent communities. Their lands rest mostly on agricultural frontiers (e.g., Kalimantan, Papua), and their customary rights are hardly recognized in practice (Colchester 2011; Abram et al. 2017).[7]

[7]Indigenous peoples seem also more sensitive to losses in terms of aesthetic values, sacred sites, and traditionally used plants (Colbran 2011).

In the case of smallholders incorporated into nucleus-plasma systems with private companies, most interviewed analysts regard the price paid for the 70% of land acquired as too low. Smallholders frequently agree it is, but they usually see it as a price to pay for the development opportunity that oil palm brings (McCarthy 2010; Feintrenie et al. 2010a). Nonetheless, they frequently misunderstand the contract terms. Once the leasing license expires (after 25 or 35 years), the land normally goes to the state, but farmers often believe that it comes back to them (Personal interviews). As such, further conflicts seem poised to erupt when current contracts end.

Oil palm expansion is also problematic from the perspective of access to water. Over 21 million Indonesians still lack improved access to safe drinking water (WHO/UNICEF 2019). Pesticide contamination of water bodies, aquatic biota and humans has been increasingly an issue (Sudaryanto et al. 2006; Koh et al. 2009; Nooteboom and De Jong 2010). Such environmental contamination also comes from palm oil mill effluents discharged without treatment (Marti 2008; McCarthy and Zen 2010; Stichnothe and Schuchardt 2011). Besides, there is increasing depletion due to extensive freshwater use for palm oil processing (McCarthy and Zen 2010) and peatland conversion into plantations (Sumarga et al. 2016). Such land-use change is highly problematic because peat absorbs water during rainy seasons and retains it during dry ones; therefore, peat conversion has led to increased flooding when it rains and reduced water availability during dry seasons (Koh et al. 2011; Yule 2010).

In terms of access to food, there have been mixed impacts. On the one hand, forest conversion has negatively impacted forest-dependent peoples losing traditional food sources (Colbran 2011; Colchester 2011; Abram et al. 2017). Fishing communities, too, have suffered disproportionately from water contamination (Nooteboom and De Jong 2010). On the other hand, many smallholders have welcomed the higher incomes obtained from oil palm cultivation, which have increased their purchasing power and access to food (Rist et al. 2010; Feintrenie et al. 2010a; b). However, they have become vulnerable to palm oil price fluctuations, over which they have no control.

There is a longstanding food security concern, shared both by parts of the Indonesian government and particularly female smallholders, about rice paddies' replacement by oil palm plantations (Personal interviews; see also Marti 2008). Indonesia remains an importer of rice, its key staple, though the level of import dependency has been decreasing (Slette and Meylinah 2013; Meylinah 2020b). As 8.3% of the Indonesian population (approximately 22 million people) is undernourished (FAO 2019), there is a fear that cash-crop and particularly oil palm expansion may aggravate the problem. Government officials at various levels seem divided, with some expressing concern while others deny that such a replacement takes place, and claiming they succeed in avoiding it. Many rural women, in turn, are categorical that it has happened and have resented the loss of local food self-reliance despite the income brought by oil palm (Personal interviews).

As for access to energy, Indonesia's rate of electrification improved substantially in the past decades. From only 59% in 2006—with significant regional disparities, such as 71% in Bali against only 28% in Papua—it reached over 98% before 2020 (IEA 2008, 2019). However, this near-total coverage does not mean that the quality, frequency, or reliability of access are comparable across the board. Rural areas and outer islands, in many cases, only have electricity access for a limited number of hours each day, besides still using traditional biomass for other needs such as cooking (Bhatia and Angelou 2015). Moreover, this has been achieved mostly by expanding the fossil fuel-based grid, as local and decentralized electricity production remains limited despite Indonesia's spread-out geography (IRENA 2017). As seen, biodiesel has been used primarily in transportation; thus, it has aimed mostly at motorists who already had access to energy. Those are either (mostly urban) drivers in Indonesia or export markets such as Europe. Plans to use jatropha oil in stationary engines for energy self-sufficient villages broadly failed due to low yields and lack of procurement for processing, except for a few NGO-supported cases (Caroko et al. 2011). Electricity production from palm oil-biodiesel has recently come to the agenda and would represent another market for this sector, but this is yet to gain scale. At any rate, it would still be the only structural change in Indonesia's energy access coming from biofuels.

In the end, there is no consensus on the extent to which oil palm expansion is positive or negative to rural communities—at least in the short run. Although such communities lose autonomy, control over the land, and at times access to other natural resources such as clean water, they earn a much-needed income (Rist et al. 2010; Feintrenie et al. 2010a, b). This trade-off might be seen as a "Faustian bargain," as rural communities have their environment degraded by chemical input-intensive oil palm monocultures—due to biodiversity loss (Fitzherbert et al. 2008; Koh and Wilcove 2008; Koh et al. 2011), soil depletion (Stichnothe and Schuchardt 2011; UNEP 2011), and freshwater contamination (Marti, 2008; McCarthy and Zen 2010; Stichnothe and Schuchardt 2011)—and become wholly dependent on that (one) industry. Still, smallholders contend that without oil palm their living standards would be much lower, with less financial resources and reduced access to transportation, infrastructure and education, among others (Feintrenie 2010a; Rist et al. 2010). The present situation has mostly been a take-it-or-leave-it deal for rural communities, who often find in oil palm plantations the only development opportunity available.

7.3 Agency in Biofuel Governance in Indonesia

7.3.1 Main Coalitions and Their Policy Beliefs

By affecting Indonesia's land-use policy, biofuels have entered a major ongoing conflict between conservation and plantation-expansion interests. There is a balance—in engagement if not in effectiveness—among state, business, and civil society agents, including foreign environmental NGOs. Such NGOs appear to play a more important agency role in Indonesia than in India or Brazil, possibly because agricultural issues here are closely linked to tropical deforestation, a topic of global concern. (Why international NGOs have been more influential in Indonesia than in

Brazil remains open for debate.) Indigenous peoples and farmers' unions also play relevant roles as agents.

The dominant coalition, which can be referred to as the *plantation coalition*, is formed by the state and the private sector, with minor participation from the scientific community. They believe biofuels can and should replace fossil fuels on a large scale in Indonesia, but without significant changes in fuel distribution or consumption patterns (Government of Indonesia 2006; Legowo et al. 2007; World Growth 2011). In their view, Indonesia should become a major producer and, to a degree, also an international supplier of palm-oil biodiesel, particularly to EU and US markets (World Growth 2011). These dominant agents see no food vs. fuel conflict in the country but food and cash-crop production going hand in hand. Moreover, some argue that as Indonesia still has significant forest cover (far above the world average), it is acceptable to convert land to agriculture for the sake of economic growth, food and energy security (World Growth 2011; Personal interviews). Biofuel production is thus seen as part of a poverty reduction and development agenda, where plantation expansion provides jobs and income to the rural poor and improves their access to infrastructure and services. In this view, the imposition of sustainability requirements by import markets such as the US or the EU is seen as an unjustified form of "green protectionism" or as a trade war—an attempt to benefit their biofuel producers at the expense of Indonesia's more competitive ones (World Growth 2011; Personal interviews).

Although such policy-core beliefs have remained mostly unchanged, this coalition has revised many of its secondary beliefs, related to more specific aspects and policy instruments. For one, the plantation coalition believed that high levels of biofuel blending could materialize quickly, but targets had to be lowered. Similarly, it had initially thought that biofuel production would be economical even without subsidies, benchmark procurement prices, or blending mandates — another belief that proved wrong and had to change. Finally, as in India and elsewhere, jatropha was believed to achieve high yields without water or other agricultural inputs, even in poor soils. The coalition later reconsidered that, and its members became focused on R&D investments to increase jatropha yields before largely abandoning it to favor palm-based biodiesel (see Slette and Wiyono 2011, 2013).

As the government and the private sector control different stages of the biofuel production chain, they are "symbiotically interdependent"—as in the Brazilian and Indian cases. It means they need one another to concretize their individual policy goals (Fenger and Klok 2001). Such interdependence is evident in the continuous negotiation on biofuel prices and policy incentives: success or failure of these negotiations has determined Indonesia's biodiesel and ethanol sectors' contrasting fates. An additional bonding factor is that they use complementary resources in agency (see Weible 2006; Sabatier and Weible 2007). While the private sector finances plantations and agro-industrial facilities, the government uses its legal authority to navigate investors through the bureaucracy and give them the necessary land-investment permits. This pattern is different from Brazil's case, for instance, where financing is largely public and investors can buy private lands relatively independently of the government. Such resource complementarity leads to even stronger interdependence and coalition coordination in Indonesia.

However, this mainstream agenda faces the opposition of what can be called the *conservation coalition*, which is composed of social and environmental NGOs (Indonesian and foreign), indigenous peoples, and part of the scientific community. These agents contend that plantation expansion degrades the environment and frequently leads to land grabbing and social conflict (Wakker 2005; Colchester et al. 2006; Colchester 2011). They have focused much more extensively on criticizing the plantation coalition than articulating an alternative view. A few have argued for development based on principles of self-determination and food sovereignty, emphasizing local communities' rights to decide how to use their resources and to prioritize their own needs, thus building resilience from external decisions and food price volatility (Wakker 2005; Colchester et al. 2006; Colchester 2011). Nevertheless, how such principles would translate into specific biofuel policy choices—if any—remains mostly unspecified. On a more general level, it is possible to divide such conservation coalition contenders into two sub-groups. On the one hand, those who believe that feedstock cultivation can play a role as a cash-crop or for local energy consumption. On the other hand, the ones who see no place for biofuels on an alternative development agenda and instead focus on food (Personal interviews).

Lastly, oil palm farmers (who are mostly smallholders) have argued for their views and beliefs without significant articulation with other actors. Their central policy belief is that biofuels production—and, more broadly, agriculture—should provide them with a decent income and improve access to services and modern infrastructure. Besides, they believe farmers' access to sufficient land and tenure security should be ensured (Personal interviews). Despite their participation in the large-scale palm-biodiesel chain, they do not necessarily share the plantation coalition's policy-core beliefs. There is also little evidence that their advocacy has any nontrivial coordination (see Sabatier and Weible 2007) with those other biofuel governance actors. They seem much more concerned about their own needs and have thus performed a form of isolated advocacy, apart from the two coalitions described above (see Table 7.4).

7.3.2 Strategic Uses of Power

The previous section explained how the plantation coalition strategically combines financial resources and access to legal authority positions to advance its agenda. Inside the coalition, it is interesting to observe how the government deftly uses its structural power to push biofuel policy goals ahead within the broader plantation-oriented vision of development. Not only does it set a captive market, siphoning off CPO and helping drive its prices up. It also compels palm oil producers to contribute to the biofuel agenda via a revolving door: the levies collected from CPO exports return primarily to the same palm oil companies as subsidies, so long as they comply with the biodiesel production agenda (see ICCT 2017). Still, the state shows its limited trust in private companies (which are largely of foreign capital) when public

Table 7.4 Main agents, coalitions, and policy-related beliefs on biofuels in Indonesia

Main agents	Policy-core beliefs	Secondary aspects
Majority within the government Oil palm agribusiness Sugarcane agribusiness Jatropha processing industry Scientific community	• Biofuels should replace fossil fuels on a large scale, but without structural changes in fuel distribution and consumption patterns • Indonesia should become a major producer and international supplier of biodiesel, particularly to the EU and the US. Sustainability requirements imposed by import markets are "green protectionism" • There is no food vs. fuel conflict in Indonesia; food and cash-crop production go hand in hand • Biofuel production promotes development. Feedstock plantations create jobs for the rural poor and improve access to infrastructure and services • Forests cover half of Indonesia, so it is acceptable to convert some of them for development, energy and food security	• ~~Production of palm-biodiesel and sugarcane-ethanol (from molasses) is economical without the need for blending mandates or subsidies.~~ (Revised: Subsidies to the industry are needed, as are blending mandates and benchmarked biofuel procurement prices to make it rewarding to the industry) • ~~Jatropha is capable of producing well without inputs.~~ (Revised: agricultural R&D to increase productivity) • ~~Feedstock and biofuel production do not need sustainability certification.~~ (Revised: ISPO certification is useful to minimize adverse environmental impacts)
Oil palm farmers	• Policies should provide smallholder farmers with a fair price, raise incomes, and improve access to services and modern infrastructure • Ensure to farmers access to sufficient land and tenure security	• Increase (>30%) smallholders' land share in nucleus-plasma schemes • After nucleus-plasma schemes, all land should return to the rural community instead of going to the government
Scientific community Environmental NGOs (moderate critics)	• Indonesia's land-use governance needs far greater attention to conservation. Plantation expansion is the primary driver of deforestation, greenhouse gas emissions, biodiversity loss, land grabbing, and social conflict in Indonesia. Policies should, therefore, focus on forest protection and ensure that agriculture meets sustainability standards	• Biofuel production can be sustainable if it helps secure farmers' access to land and tenure, without such tight corporate control
Environmental NGOs (strong critics) Indigenous peoples		• No role for liquid biofuels in sustainable development. Other forms of bioenergy, such as biogas or electricity generation from biomass, are more attractive

NB: Gray areas represent different coalitions; crossed-out text under *secondary aspects* indicates former beliefs replaced

companies such as Pertamina asserts itself. It is illustrative that the state-controlled oil company now seeks to directly produce palm-biodiesel, fearing that private mills may fail to deliver sufficient supplies given the frequently higher attractiveness of international CPO markets. It reveals tensions within the plantation coalition, which nevertheless have been managed to advance the common policy beliefs and interests of its members.

On the other camp, the conservation coalition has relied mainly on information as an advocacy resource.[8] Environmental NGOs (particularly Europe-based ones) and like-minded scientists have published extensively on the negative impacts of oil palm expansion in Indonesia, trying to expose the government and private agribusiness (e.g., Wakker 2005; Marti 2008; Colchester et al. 2006; Colchester 2011; Koh et al. 2011). Their target audience is not so much the Indonesian public opinion but the international community (mainly in palm oil-importing countries) to influence foreign policy-making (Personal interviews). Scientists have supplied evidence and detailed analyses of environmental degradation caused by oil palm plantations (e.g., Koh et al. 2011; Fitzherbert et al. 2008). In turn, NGOs have utilized “name and shame” tactics and engaged in strong consumer-oriented campaigns against palm oil, particularly targeting large food-processing companies in Europe (e.g., Unilever; see The Economist 2010). As such, the agency of NGOs and that of scientists have been complementary and mutually reinforcing. NGOs have been key in consumer-led certification schemes such as RSPO, holding both structural power (as board members that help craft the agenda) and discursive power (over companies and consumers who adopted the certification).

Indigenous peoples, too, have targeted international audiences by denouncing human rights violations from plantation expansion. Together with foreign and Indonesian NGOs, indigenous peoples sent a request to the UN Human Rights Council to internationally condemn the MIFEE project in Papua, which in their view should be suspended (Sawit Watch et al. 2011). The Council responded by formally requesting the Indonesian government to disclose information on the Merauke project and accept inspection visits in Papua of the UN Special Rapporteurs on human rights, indigenous peoples’ rights, and the right to food (UN Human Rights Council 2012). Although the Indonesian government initially refused such requests (UPR Info 2012), the UN Special Rapporteurs eventually visited and issued several critiques about plantation expansion in Papua (see UN General Assembly 2018).

These strategies of weaker agents recognize the plantation coalition’s vulnerability to foreign consumers’ and investors’ decisions. Such actors seem more easily swayed by environmental and human rights issues than dominant Indonesian ones. Foreign support may strengthen the conservation coalition (e.g., by adding members and resources). It may also impose resource constraints on the plantation coalition, whose agenda depends on international trade and financing. For instance, oil palm agribusiness resources suffered a setback between 2009 and 2011, when the World Bank suspended its financing of the sector after substantive criticism from civil society (see Van Gelder and Kouwenhoven 2011). Even if it did not significantly alter Indonesia’s development course, it temporarily reduced the plantation coalition’s material capabilities. A more lasting achievement has been conservationists’ success in changing the initial assumption that biofuels were automatically sustainable, helping push sustainability standards in the EU and the US. The imposition of standards—which broadly reject palm-oil biodiesel—has dealt a blow to Indonesia’s

[8] See Weible 2006 on the use of information as an advocacy resource.

oil palm sector, which has continuously questioned them. Such civil society advocacy in importing countries also led industry boards in Belgium, the Netherlands, and the United Kingdom to limit non-certified palm oil (Balch 2013). These moves may not have changed the policy-core beliefs of the plantation coalition (as it regards these restrictions as unjustifiable). However, they affect its material capabilities by limiting access to export markets. The reorientation of Indonesia's palm oil producers increasingly towards the domestic market, especially pulled by ever more ambitious biodiesel consumption targets, is in a way a response to the closing of some markets abroad.

The plantation coalition has responded with information and discourse, too. Supportive scientists have played key roles in publishing studies that buttress the coalition's policy beliefs. For instance, analyses that refute criticism on oil palm plantations' environmental profile,[9] or reassert the potentials and worth of large-scale fossil fuel replacement by biofuels, and overall give tacit or explicit support to Indonesia's biofuel policy (see, e.g., Silitonga et al. 2011; Gunawan et al. 2011; Jayed et al. 2011). For instance, a common argument has been to emphasize oil palm's climate benefits as a carbon sink—while ignoring or downplaying its other environmental problems.[10] Similar scientific backing was pivotal for the jatropha hype in Indonesia, primarily based on published overestimations (Afiff 2014). The private sector, too, has tried to gain discursive leverage, mostly by highlighting the importance of oil palm for the country's economy, but on occasion also blaming deforestation on smallholder agriculture instead (see Bahroeny 2009; World Growth 2011).

The creation of Indonesia's own palm oil certification scheme (ISPO), in turn, can be seen as a response to the perceived NGO-influenced consumer-orientation of RSPO. ISPO, in contrast, has a government-set agenda, granting the plantation coalition more structural power than it has in RSPO. Even if Europe and the US reject it, Indonesia can still rely on large emerging markets such as India and China, which impose no sustainability standards and where the discursive power of this conservation coalition is far weaker.

This agency context shows that Indonesia's more substantial reliance on global markets makes foreign affairs related to biofuels far more relevant here than in India or Brazil. Perhaps strangely, most of the discursive battle about Indonesia's development arguably takes place abroad. From a theoretical perspective, this case provides a good illustration of the importance of "forum shopping" and multilevel policy entrepreneurship. In practice, it means that Indonesia's biofuel governance—or land-use governance in general—is highly vulnerable to factors out of its domestic actors' control. Such a vulnerability is not only to international price volatility but also to foreign policy-makers (as seen in the case of the US and EU sustainability criteria), foreign investors, and multilateral financing organizations (see Caldecott et al. 2013;

[9]See Tan et al. 2009 for a pro-plantation piece that treats and rejects various claims of environmental degradation from oil palm expansion.

[10]This same argument has been used in Indonesia (and elsewhere) to advocate for timber plantations, too (see Bastos Lima et al. 2013).

Bastos Lima and Gupta 2014). However, such Western leverage is gradually eclipsing as Indonesia's oil palm sector turns increasingly inwards and to other Asian markets.

Amid this conflict between plantation advocates and conservationists, it remains unclear to what extent smallholder interests are represented. Oil palm farmers' advocacy relies only on their own capabilities—primarily through GAPPERINDO, the national plantation farmers union, and APKASINDO, the national oil palm farmers union. Others in rural communities do not have even that; they have no direct participation in the agenda-setting and no discursive power to speak of. Their primary agency is through demonstrations and protests—that is, by using *themselves* as "mobilizable troops," a typical resource of poor actors (Sabatier and Weible 2007). That has been done particularly as resistance to land evictions and in conflicts with plantation companies (Saragih 2012). However, this sometimes results in murder and torture, as companies rely on government military protection or private security (Asian Human Rights Commission 2011).

The advocacy of conservationists, too, has threatened rural and forest-based communities, such as through various cases of "green grabbing" (i.e., private leases of forest areas for conservation without taking into account populations who depend on local resources uses; Fairhead et al. 2012). These practices have increased in Indonesia as international funds start to flow for conservation activities, such as under the REDD+ framework (Reducing Emissions from Deforestation and Forest Degradation). Governments at various levels in Indonesia have started to seek revenue to keep forests standing (Astuti and McGregor 2017). Meanwhile, policies that reconcile conservation with traditional rural livelihoods such as *hutan desa* ("village forests"), which has received much praise from local NGOs and smallholders, appear to have been blocked on the agenda. Issuance of new village forest licenses by the central government has been scarce, and local governments have shown little interest as they have not received many economic benefits from such ventures. Instead, local governments often prefer to advance revenue-generating plantations or privately funded conservation (Bastos Lima et al. 2013). As such, smallholders find themselves squashed between the strides of the two coalitions, having the least power and yet the highest stakes (see Table 7.5).

7.4 Conclusions

7.4.1 Key Insights

Although many biofuel production chains were initially envisaged, palm oil reigns solely and supremely as the only feedstock commercially used at scale in Indonesia. While jatropha-biodiesel and sugarcane-ethanol have proved uneconomical and failed to take off, oil palm cultivation expands faster than any other crop in the country, and biodiesel production from palm oil grows substantially. Production occurs either in large-scale plantations or through farming contracts between private

Table 7.5 Features of the dispute between the plantation and conservation coalitions

	Plantation coalition	Smallholders	Conservation coalition
Key underlying interests	Economic growth; Development; Carbon stocks	Employment; Access	Biodiversity conservation
Main resources used	Financial; Information; Access to positions of legal authority (mainly within Indonesia);	Mobilizable troops	Financial; Information; Access to positions of legal authority in developed countries and international organizations
Persuasion strategies	To highlight oil palm's role as carbon sinks and the sector's contribution to Indonesia's economic development; To appeal to a sense of international market competition;	–	To frame plantation businesses as unsustainable and conservation as beneficial to all; To show that conservation also sustains indigenous livelihoods
Persuasion tools	Economic indexes (e.g., palm oil exports, contribution to GDP); Oil palm's high productivity and hence Indonesia's comparative advantage; Indonesia's forest-cover rate above the world average; Positive environmental indicators on plantations (e.g., carbon storage)	–	Negative environmental indicators on plantations (e.g., biodiversity); Opportunities to channel international funds for conservation (e.g., REDD+)
Strategies to undermine the opponent's arguments and actions	To picture the conservation agenda as being foreign-driven	–	Dissemination of information on the negative social and ecological impacts of plantations
Framing of the opponent	Protectionist; Self-interested; Uncommitted to Indonesia's socio-economic development	–	Profit-driven; Self-interested; Socially unjust; Unsustainable

companies and smallholders. The sector provides rural communities with a much-needed income that reduces their poverty, but the allocation of rights, roles, benefits and burdens is highly inequitable. Moreover, the environmental degradation caused by oil palm plantations further makes their continuous expansion unsustainable, despite attempts to frame them as climate-friendly due to their role as carbon sinks.

This chapter's analysis indicates the following reasons for the prevalence of such a development strategy to date. On a more immediate level, this biofuel production pattern is due to a combination of foreign investments and supportive domestic policies, causes that appear to be interdependent. Such investments play a more significant role in Indonesia than in Brazil or India (see Chapters 5 and 6). However, domestic policies arguably remain the only *sine qua non* cause both for biofuel expansion and for the particular shape it has taken. Those policies have included: consumption targets and blending mandates to create an artificial demand for biofuels, regulatory changes to encourage investments in feedstock crop cultivation, and generous subsidies to private palm oil industries. Finally, the Government of Indonesia has also created a national certification scheme (ISPO) to increase market penetration abroad.

Underpinning these policy instruments is a strategy to enhance food and energy production while creating jobs on plantations. To increase legitimacy, this is framed as Indonesia's contribution to national and global food and energy security. In the oil palm case, there is also a norm—reflected in the "plasma obligation"—to integrate smallholders, create jobs, and reduce rural poverty. The biggest challenge, however, has been to harmonize oil palm plantations and international norms on sustainability, which have become increasingly important for foreign market acceptance. Indonesia's answer has been the ISPO certification, which arguably owes much more to international normative pressures than to genuine domestic concerns.

These priorities and approaches, in turn, stem from the policy beliefs of state and private-sector advocates of agribusiness. These agents have firmly pushed for plantations as a form of land use and development, sometimes going as far as to frame them as environmentally friendly due to their function as carbon sinks. However, this coalition's dominance does not owe so much to its discourse but to the instrumental and structural power it exerts. These forms of power mainly rely on the private financial resources the coalition commands and on the positions of legal authority held in the government. In the latter, bureaucracy has been manipulated to either facilitate or block courses of action—as it has happened to the Village Forest program. Another critical factor is that the adversary, conservation coalition has not yet offered an alternative development path. Instead, it mostly criticizes the mainstream agenda and defends conservation interests without saying much about addressing the country's development needs sustainably. Arguably, this gap is the origin of much of the criticism received by the conservationists in Indonesia. It is perhaps the main reason for the lack of alignment with farmers and for the coalition's limited effectiveness so far.

Finally, this oil palm expansion strategy's distributive outcomes and social impacts are arguably the ultimate reason it has prevailed. As in India, there is a systematic transfer of legal or de facto control over land and freshwater resources from local communities to private companies and the government. Moreover, short-term financial gains and otherwise limited access to modern services have helped obtain the local communities' support. Such communities have generally been supportive even though most benefits accrue to state and private industry actors, local food security becomes more vulnerable to external shocks, and their access to land and clean water decreases. In a way, their inclusion co-opts such rural communities who otherwise are known to enter conflicts against private companies, and who could attempt to coordinate agency and confront the dominant coalition with the support of conservationists. The oil palm plantation strategy pre-empts such moves and tames potential opposition while increasing dominant agents' material capabilities and control over vital natural resources. As in the other cases, this is a cyclical process of self-serving power accumulation by plantation businesses and Indonesia's central government (see Fig. 7.2).

This context is particularly worrisome for Indonesia because of the environmental unsustainability of this development path. Even its short-term development benefits are limited, as investors are primarily cashing-in at the cost of the country's biodiversity, water, and soil while keeping most benefits to themselves. Indonesia could learn from the erstwhile "banana republics" of twentieth-century Latin America, which based their economies on foreign investments in single-crop plantations, environmental degradation, cheap labor, and inequitable development (see Bucheli 2008). However, as this analysis demonstrates, shifting the course of development is not an easy task. It requires not only institutional reform but also a counterweight to the agency that keeps the current structures in place.

7.4.2 Alternatives

First, to increase economic benefits and spur technological development, the government could incentivize further domestic value-added through palm oil refining. The increasing production of palm-based biodiesel is a step in this direction, but the bioeconomy is likely to make such downstream industry options much vaster. Oil palm cultivation could also become much more sustainable by conditioning to socio-environmental requirements the policy incentives given to plantation companies. In particular, more equitable outcomes could be achieved by increasing the land that smallholders retain in nucleus-plasma schemes (beyond 20–30%) and by returning it to them at the end of leasing contracts.

Second, an additional safeguard would be to mix oil palm plantations with food crops to reduce smallholder vulnerability. Moreover, integrated agroforestry systems could break with the land-sparing paradigm that so ravages Indonesia—squeezing smallholders between "green grabbing" on one side and corporate-controlled plantations on the other—and help local communities. The utilization of oil palm within agroforestry systems, instead of monoculture plantations, could significantly improve local economic benefits while conserving Indonesia's biodiversity (Bhagwat et al. 2008). In time, such systems could potentially develop a plethora of new bioeconomy

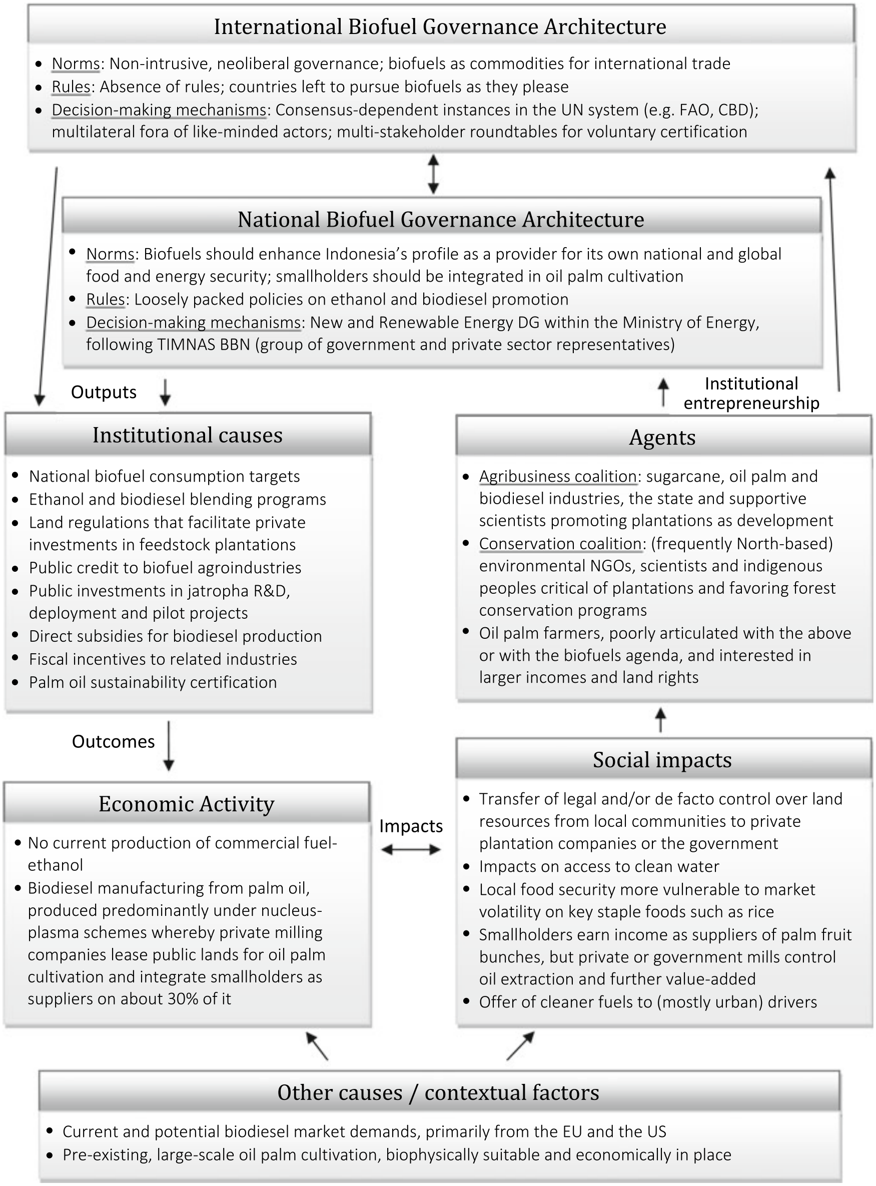

Fig. 7.2 Analyzing institutional, social and political dimensions of biofuels in Indonesia

value chains, too, based not solely on oil palm but also on other crops and products from Indonesia's native biodiversity.

Third, a way to make supply contracts more equitable would be to require the participation of grassroots organizations in the negotiation process to validate land deals and contract terms. Such more equitable arrangements, perceived as fairer, would likely reduce land conflicts between industries and rural communities, too. Still, local development benefits are limited unless smallholders climb to the value-added stages of production (i.e., palm fruit processing and oil extraction; and, eventually, also in other conjugated bioeconomy value chains). Value-added, however, requires additional material and institutional capacity.

To push for these policy changes, the conservation coalition could seek an alliance with smallholders to help with political, technological, and economic resources. In the end, the best conservation strategy for Indonesia may be sustainable rural development. Diverse agroforestry systems with a more considerable measure of locally owned technology, in particular, hold great promise (Dewi et al. 2005; Bastos Lima et al. 2013; Pratiwi and Suzuki 2019). However, the pursuit of these and other sustainable development arrangements require far more effective advocacy and creative strategizing from the ones preocuppied with the country's current course.

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Chapter 8
Bioeconomy Lessons from Biofuel Policies in Emerging Countries

Abstract Brazil, India and Indonesia show key similarities in their bioeconomy strategies. First, they all have stressed poverty reduction goals and adopted a common approach to rural development, though with strategies that have generally disregarded structural inequalities and uneven allocation patterns. The rural poor have systematically lost control over land, water and other natural resources while being allocated only with the least rewarding stage of bio-based value chains—that of raw material provision. Cases of "adverse incorporation," i.e., inclusion under unfavorable terms that ends up worsening poverty, have been commonplace. Second, the state has assumed a broad set of roles in these emerging economies, including as an important market actor through state-controlled fuel companies and development banks. Third, biofuel policies have characteristically sought to redress international inequalities but at the expense of domestic ones. In all three countries, rural development policy is crafted by agribusiness elites who do not suffer from the poverty that still pervades large segments of their populations. Those elites indeed often benefit from domestic inequalities and therefore have little incentive to address them. As such, current bioeconomy policies may help these emerging countries catch up with the developed world, but not without high social and environmental costs.

Keywords Rural development · Inclusiveness · North-South equity · Agency · Access and allocation · State-market relations

8.1 Introduction: An Emerging Country Take on the Bioeconomy?

The shape of the bioeconomy varies from place to place, following not only different resource constraints but, at times, also place-specific preferences and visions. In other words, the approach to biofuels or broader bioeconomy development vary according to context and to the policy-related beliefs of its guiding actors (see Scordato et al. 2017). Understanding this positionality and diversity is valuable to analyze the distinct governance pathways that different countries can take on the bioeconomy. Moreover, as emerging countries gain more relevance in an increasingly multipolar world, they also change global bioeconomy policy patterns.

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The emergence of large developing countries such as China, Brazil, India and Indonesia on the global stage is bringing about economic and political changes as well as distinct technological and policy innovations (Berkhout et al. 2011; UNDP 2013). Due to their different cultures, political standpoints and historical memories, these countries may not share the same views or preferred approaches of the highly industrialized countries of the Organisation for Economic Co-operation and Development (OECD) (Hurrell and Sengupta 2012; Roberts 2011). Yet, collective characterization of those countries in terms of governance and approaches to sustainable development—let alone to the bioeconomy—remains limited. There is, therefore, much value in using in-depth cross-country assessments to identify patterns and understand whether emerging economies do favor a similar approach to development and, if so, how to characterize that approach.

Based on the assessments of Brazil, India, and Indonesia as case studies of pluralist emerging democracies, this chapter conducts a comparative analysis of how such countries have pursued biofuel policies. This assessment serves the double purpose of drawing lessons from and for development patterns of those countries *and* specifically for bioeconomy sectors based on agriculture. The analysis has three foci: (i) understanding the links between particular bioeconomy policy strategies and social outcomes; (ii) analyzing how agency is taking place within emerging economy contexts and, in particular, the roles of the state as a prominent actor in all three case study countries; and (iii) examining whether and how large-scale biofuel production, as the most prominent bioeconomy sector to date, has increased or reduced North-South inequalities. This examination can answer both the critics who argue that biofuels are a form of neocolonialism and those who advocate for biofuels as a way to help the Global South catch up with the Global North. Finally, the concluding section discusses the similarities of approach to biomass-based production in emerging economies and the extent to which a typical pattern exists.

8.2 Linking Bioeconomy Policy Strategies to Social Impacts

While much has been said—positively and negatively—about the social impacts of bio-based production, be they rural development opportunities or resource dispossession, seldom are those impacts linked to particular policy designs in an *ex-post* examination. Therefore, this in-depth assessment of policies in Brazil, India, and Indonesia offers a valuable opportunity to do so. Their biofuel experiences, in turn, offer a glimpse of what might happen on a yet larger scale if bioeconomy strategies gain traction. Before comparing their policy strategies, however, it is useful to contrast the case study countries' energy and agri-food contexts, as any comparative considerations must consider them.

8.2.1 Comparing Energy and Agri-Food Contexts

Brazil, India and Indonesia have experienced rapid growth in energy consumption, particularly liquid fuels used in transportation. All three have met this demand partly through oil product imports. However, the degrees of energy self-sufficiency—and, therefore, vulnerability to external political and economic instability—vary significantly. India and Indonesia have a much higher dependence on oil imports (86% and 35%, respectively, against 11% in Brazil), which has increased due to stagnant domestic oil production from dwindling reserves in those countries (EPE 2019; Central Statistics Office 2019; National Energy Council 2019). Brazil, in contrast, has vast untapped oil reserves and is an importer only due to limited refining infrastructure. This difference has also meant more substantial budget expenditures of the Asian countries on imports and subsidies. India and Indonesia have, therefore, felt a much more pressing need to promote oil replacements. Haste may thus be part of the reason why their biofuel consumption targets initially were overly ambitious and had to be revised down (see Table 8.1).

Despite their energy needs, the Asian countries have had comparably less room to develop biofuels due to a more constrained agri-food context. Brazil is the world's largest sugar exporter, even though the ethanol industry absorbs more than half its sugarcane production. Contrastingly, India and Indonesia have comparably tight sugar supplies and, therefore, limited ability to produce ethanol from cane juice on a large scale regularly. This sensitivity of supplies explains why the focus has been on sugarcane molasses (a co-product). Otherwise, the reduction of oil imports could come at the cost of increased sugar imports. A similar situation is observed for biodiesel feedstocks and edible oil supplies, though Indonesia is comfortable in

Table 8.1 Biofuel consumption and targets in Brazil, India and Indonesia

	Policy timeframes for biofuel consumption in 2006	Target revisions by 2013	Consumption and targets as of 2020
Brazil	Fluctuating 18–25% ethanol (E18-25) blending in place, plus E100 available; 2% biodiesel (B2) by 2008 and B5 by 2013	B5 anticipated to 2010. B10 foreseen for 2020	E27 blending in place, plus E100 available; B12 in place, B15 by 2023
India	E10 and B20 by 2012	E5 to be enforced by June 2013 20% overall biofuels by 2017	Ethanol 5.8% blending in place; no biodiesel use. E10 by 2022, E20 and B5 by 2030
Indonesia	E5 and B10 by 2010; E15 and B20 by 2025	E10 and B10 by 2020 E15 and B20 by 2025 remains	No ethanol use, though the aspirational targets remain in place; B30 in place, B50 envisaged

this regard. Indonesia and Brazil are abundant producers and exporters of vegetable oil (palm and soy, respectively). Therefore, it is in their interest to find new markets to increase demand and raise these commodities' prices. In contrast, India is a net importer of edible oil and cannot divert its production for biofuels without deepening its import dependence.

Another critical factor has been the availability of land where to expand feedstock cultivation. Brazil has counted on large tracts of arable land used as pastures to convert into soy or sugarcane plantations—even if that has often meant pushing cattle ranching further into forest frontiers, i.e., indirect land-use change (Arima et al. 2011). Similarly, soy expansion has often come at the expense of the highly biodiverse Cerrado savannas (Rausch et al. 2019). Although this expansion would be more accurately credited to soybean's use as animal feed than its (comparatively unimportant) economic use as a biodiesel feedstock, the latter is nevertheless a new market. In contrast to Brazil, the situation is somewhat more delicate in Indonesia, which has a much higher population density, less availability of non-forest areas, and where oil palm expansion over peatland and rainforest has been very controversial. India, in turn, is severely constrained both in terms of arable land and freshwater for expanding cultivation, making it rely mainly on marginal lands.

Although these energy and agri-food contexts have not necessarily determined the policy choices of each country around biofuels and bioeconomy development, they certainly have limited the range of options and made some pathways more likely than others. As far as their agricultural sectors go, path dependency clearly is a significant factor at play.

8.2.2 "Development" as Livelihood Losses and the Proletarianization of the Rural Poor

"Rural development" has been commonly sought after as a major goal and justification of bioeconomy policies in the Global South. Its exact meaning, however, is most often—perhaps purposively—left unspecified, although references to job creation and income generation tend to be made (see Chaps. 5–7). In this regard, the cases of Brazil, India, and Indonesia, despite the contrasts in their energy and agri-food contexts, reveal somewhat similar strategies. Crops and specific policy targets have differed, but the types of policy instruments, production structures, value-chain organization, and business models have been more or less the same. This similar approach, in turn, has created a relatively common pattern of socio-political outcomes with similar limitations, falling into the same pitfalls, and ultimately, creating nearly identical allocation patterns.

All three countries have adopted a two-tiered strategy of biofuels production. On the one hand, they have relied on established agroindustrial sectors endowed with the capacity to offer sufficient feedstock supplies within a short time. On the other hand, they have attempted to promote non-food feedstock crop cultivation on marginal lands, trying to incorporate those lands and the rural poor thereon into an integrated formal economy. For that, governments have used regulatory and economic instruments to assign a protagonist role to the private sector. Conventional regulatory instruments have included: (i) technical standardization and licensing to commercialize biofuels in the country (frequently with standards that match those in the US or the EU, to allow for exports); (ii) blending mandates, obliging consumption and creating a captive market that shields producers from the competition with (often subsidized) oil products; and (iii) in the cases of India and Indonesia, where land is more often leased than purchased, facilitated conditions for private land investments and feedstock plantations. These instruments have been complemented by economic incentives such as tax cuts and offers of subsidized credit. In tandem, economic burdens have been systematically allocated to state actors, particularly to public banks and state-controlled oil companies.

Policies in all three countries have increased private agroindustries' access to land and water for feedstock cultivation while usually reducing that of customary land users, indigenous peoples, and local rural communities. This access reduction is either due to a clear transfer of control or to collateral impacts from agroindustrial activity in the area, such as soil and water pollution from chemical inputs or wastes (e.g., sugarcane wastewater, palm oil mill effluents). Meanwhile, despite contexts of energy poverty and its occasional use as an argument to help legitimize biofuel policies, these policies have been aimed primarily at urban consumers who already had access to fuel. Thus, rural development has mostly meant job and income creation as a co-benefit of increasing domestic (renewable) energy supplies. In this process, traditional food sources may disappear, but such incomes would improve access to food. The issues with this strategy, however, are many.

An apparent problem is trying to promote rural development by simply expanding corporate-controlled industrial plantations and the jobs they create. While employment is essential, one must look at: (i) the quality and in particular the work conditions in those jobs; (ii) the livelihoods, self-employment, and traditional forms of subsistence that plantation expansion may eliminate; and (iii) the inherent limitations of this dominant approach when it comes to creating structural change and reducing inequality. Labor conditions for the rural poor in sugarcane plantations are harsh (when not outright exploitative) in all three countries. The main difference is that in Brazil they tend to be wage laborers, while in India they are mostly smallholders or workers employed on an informal contractual basis. If Asian smallholders have retained some autonomy and benefit from government-set minimum prices, in Brazil migrant workers are squeezed through the agroindustry's efficiency optimization policies, which have made them work three times harder (in terms of sugarcane tons harvested per individual) than plantation slaves did in the past (Novaes 2007). In all three countries, feedstock plantations have also expanded over mixed farming and other rural livelihoods, even though these generally employ a much larger number of people per area (see IAASTD 2009; HLPE 2013). The promotion of feedstock cultivation has exploited a situation of poverty where there are hardly any alternatives for local economic development or support to improve traditional livelihoods' economic viability. Rural dwellers have most often found themselves having to choose between remaining marginalized or embracing the industrial plantation model that governments and private industry promote. While such plantation jobs might alleviate poverty, inequality structures remain, not only in terms of income but also of land ownership, power, decisions, and production control.

Similar structural limitations are present in the contract farming schemes promoted with alternative feedstock crops such as castor and jatropha. Although such schemes may provide smallholders with an income, they do not address equity issues. The contracting industries systematically retain most or all value-added processes and leave smallholders perpetually as mere raw material suppliers. Moreover, these are often monopsony conditions (i.e., only one buyer available in an area). Smallholders thus find themselves with minimal bargaining power and usually have to bend to the conditions, prices, and terms determined by the company.

In practice, that has meant the proletarianization of the rural poor. In other words, people have been forced or persuaded out of their livelihoods to either migrate or become agroindustry employees (see Kay 2006; Ariza-Montobbio et al. 2010). This process is problematic for at least three reasons. First, inequality structures persist or even expand. Despite its framing as "participation" and "social inclusion," it is clear that actual participation is quite limited and rarely includes participation in decision-making, as some more comprehensive definitions of the term would have it (see Cornwall and Brock 2005). The strategy promotes some economic empowerment by providing income to the rural poor, but at the cost of aggravating their political disempowerment, i.e., their ability to self-organize, advocate for their views of development policy, and to have such views represented in upper levels of governance. Indeed, such effects are in tune with the dominant coalitions' interest in undermining or co-opting potential competition.

Second, despite some income creation, such contracted jobs are generally insecure. They do away with fundamental labor rights acquired over time, such as the right to collective organization. Companies can easily lay off contracted farmers after a period—or even unilaterally terminate contracts, as seen. However, returning to mixed farming after such a material and livelihood transition may prove challenging, if not impossible. Third, there are heightened pitfalls and risks associated with contract farming on non-edible feedstock crops often used for the bioeconomy. Such risks are especially relevant when crops take years to mature and have limited market absorption, as in the cases of jatropha and castor.

The fact that, in all three countries, smallholders contracted to plant those crops were abandoned and left to bear the consequences should not be overlooked. Those have arguably been cases of "adverse incorporation," i.e., instances of inclusion under disadvantageous conditions (Hickey and Du Toit 2007; McCarthy and Zen 2010). Such early bioeconomy experiences reinforce the point that rural development policies, when misconceived, may easily leave the rural poor worse off. Contracts were established with little knowledge or transparency about those crops' actual performance under suboptimal growing conditions. Government agencies and private companies persuaded smallholders to participate in something primarily based on hype. Moreover, the strategies' design left smallholders even more vulnerable from the beginning—to market fluctuations on a single cash-crop without food or fodder uses, and to a single buyer that could respond negatively to such market volatility and either become bankrupt or move away. In other words, by design such contract-farming strategies undermined smallholders' resilience instead of strengthening it. As some have argued, such patterns are often promoted under the guise of "development" but, when failing to adequately pursue inclusiveness, may rather characterize instances of maldevelopment (see Russo Lopes et al. 2021)

Table 8.2 compares biofuel strategies' social outcomes in the three countries, showing their differences and similarities.

8.2.3 Inferences: Bioeconomy Promotion as Botanical Colonization for Attaining Control over Natural Resources?

This analysis clarifies that the distributive outcomes and social impacts of bioeconomy projects depend on the specific strategies and policy frameworks adopted. In Brazil, India, and Indonesia, despite the rural development rhetoric, biofuel policies have, in reality, focused on quickly building domestic (renewable) energy supplies. In the Brazilian and Indonesian cases, those policies have also aimed at creating additional markets for their large vegetable oil production (soy and palm, respectively), thus helping raise their prices and profitability. As these supplies flow into existing energy distribution and consumption structures, those biofuel policies have left the inequality of access to energy in those countries mostly untouched. India and Indonesia have pursued such bioenergy production with particular haste. Not only did these countries adopt unrealistic targets, but they also promoted strategies based on hype (jatropha's "wonder crop" myth), without carefully devising production chains or sufficiently experimenting with it beforehand. Upon failure of these non-edible feedstock crop experiments in all three countries, Brazil and Indonesia have been able to fall back on their abundant supplies of edible oil. In contrast, India, constrained in this regard, has remained without its much-wanted biodiesel production.

These outcomes represent not only social sustainability issues—they are also relevant to understanding the politics of biofuels and bioeconomy development. By impacting actors unequally, outcomes have affected both their material capabilities and their capacity to influence policy. In this sense, private agroindustries have been the main winners in all three cases, together with the state. In India and Indonesia, as shown by their missed targets, the state had hoped to gain much more in terms of fossil fuel replacement and thus a more favorable energy situation. Still, it has gained further de facto control over land resources from local communities—through what Scott (2009, p. 10) refers to as the "botanical colonization" of landscapes, transforming peripheral areas into "fully governed, fiscally fertile zone[s]." In Brazil, where there are hardly any public agricultural lands, the state's gains have been primarily in the form of (limited) taxation on a booming agribusiness sector and geopolitical

Table 8.2 Allocation and access patterns of biofuel production strategies in Brazil, India, and Indonesia

	Brazil	India	Indonesia
Allocation of ownership and control over production	Transfer of control over land, water, and plant genetic resources from smallholders and indigenous people to state-controlled or private companies	Transfer of control over land and water from customary users to the state and then to private companies	
Allocation of roles	Rural workers in manual wage labor (often under poor labor conditions); smallholders as perpetual raw material suppliers; private or state-owned industries control value-added, use co-products, and choose among different downstream markets		
Allocation of policy benefits	Regulatory and economic incentives primarily to private companies		
Allocation of policy burdens	To public banks: to finance industrial plantations and provide loans to contracted smallholders who otherwise fail to access credit To state-controlled oil companies: mandates to blend biofuels despite fossil fuel subsidization, with occasional economic losses		
	The task to engage with smallholders after unsuccessful attempts from the private sector; higher transaction costs, fewer economies of scale, risk from dealing with suppliers not used to formal contracts		
Access to land	Large-scale sugarcane and soybean growers ↑ Traditional rural communities and indigenous peoples ↓	The state and private investors leasing land ↑ Customary users of public lands and indigenous peoples ↓	
Access to water	Large-scale sugarcane and soybean growers ↑ Smallholders and indigenous peoples ↓	Public and private companies growing jatropha ↑ Local communities in semi-arid regions where jatropha is being deployed (e.g., Rajasthan) ↓	Oil palm growers (55% private plantations; 35% smallholders; 10% state-owned plantations) ↑ Local communities[a] and indigenous peoples ↓
Access to food	Smallholders contracted under advantageous terms ↑ Net food consumers of food crops replaced by sugarcane, castor bean, or soy cultivation, including smallholders contracted under disadvantageous terms ↓	Net consumers of food crops replaced by jatropha, including smallholders contracted under disadvantageous terms↓	Smallholders growing oil palm ↑ Indigenous peoples, fishermen communities, and net food consumers not benefited by incomes from oil palm ↓
Access to energy	Light vehicle drivers & heavy-duty vehicle owners ↑		

NB The arrows in the access rows indicate gains or losses by those particular stakeholders
[a]This includes communities of smallholders growing oil palm, as they use freshwater for cultivation but at the same time suffer from eventual scarcity and local contamination

influence. Therefore, it should be no surprise that the outcomes have benefited exactly the primary agents behind biofuel policy-making. This inference reinforces the point that different strategy designs and outcomes are unlikely to come without a significant shift within the state or more effective agency from those who are losing out.

8.3 Agency Patterns: State Reemergence Amid Transnational Actors

8.3.1 Recovered Protagonism: Six Roles of a Prominent State

Although recent scholarship on governance for sustainable development—and particularly on agency—has focused extensively on non-state actors (see Biermann and Pattberg 2012), this research shows that states have been central in bioeconomy governance. State protagonism has happened both in the international and domestic contexts, where they have played many roles. Public policies have been the main driver of biofuel expansion. Governments have been vital agents seeking coordination with other actors, leading dominant coalitions, and pushing the agenda in all three case studies. On the one hand, such a state-centered approach to development—instead of more extensive reliance on an already well-established private sector—may be a characteristic of emerging economies (Schmalz and Ebenau 2012). On the other hand, it is useful to examine what issue-specific reasons may have induced that to happen.

The state has played at least six crucial roles in the biofuel sectors of the examined cases, which might gain even further prominence in emerging bioeconomy development. While some of those seem to be more usual government functions (e.g., setting legal frameworks and regulations), others appear to be either new or reemerging functions that demonstrate a (re)conquest of governance space by the state after decades of strong neoliberalization.

First, the state has performed an *enabling* role, i.e., in changing regulatory frameworks to allow for biofuel utilization, setting standard quality specifications, creating blending mandates, and securing subsidies that at times have made biofuel industries viable. The bioeconomy has continuously been a politically instituted market (Pilgrim and Harvey 2010); thus, the state's prime role has been to set up the institutions that frame it.

Second, states have often gone beyond that and also taken a vital role in *financing* biofuels development, such as through R&D funding and generous credit offer from public banks. While the first function has been quite clear in all three case study countries, the second function is most evident in Brazil and India. Indonesia, in contrast, seems more dependent on foreign financing from private actors and international organizations (e.g., the World Bank).

Third, the state has also adopted a *market* role in those countries, engaging directly in biofuel production chains through state-controlled fuel companies. Unlike most highly industrialized countries (Norway being the chief exception), emerging economies characteristically have such companies, usually energy giants with the largest shares of the domestic fuel production and distribution markets.[1] This pattern owes to twentieth-century history when developing country governments were the only entities in those countries able to undertake fossil fuel exploration and production, while capital-rich developed countries already counted on several large private fossil fuel companies.

This path dependency now influences bioeconomy development in emerging economies. By holding the link between biofuel producers and final consumers, these governments have been able to not only oversee and regulate biofuel agendas, but also to implement them directly. More recently, governments have gone even further and expanded their "implementation arms" to biofuel production itself, as seen in the creation of Petrobras Biofuels in Brazil and Bharat Renewable Energy in India. Likewise, Indonesia's Pertamina has shown interest in itself processing palm oil to produce biodiesel. These moves have mainly been a reaction to disappointments with private industries, which at not finding profits in jatropha- or castor-based biodiesel, abandoned smallholders and threatened the government agendas. In Indonesia's recent case, private producers sometimes opt to export crude palm oil instead of contributing to the country's biodiesel supplies if doing the former is more profitable. By taking over this step of the chain and achieving further vertical integration, states have obtained more significant control over biofuel production and further adherence to their political or social goals. For instance, these goals may include ensuring that production suits national interests (e.g., domestic consumption rather than exportation). They may alternatively relate to smallholder incorporation, despite the less attractive economic conditions that private companies usually avoid (e.g., due to higher transaction costs, smaller economies of scale, or risk from dealing with suppliers not used to market contracts). In other words, the state has shown to be more ready to place national or social goals above profit-seeking and pure economic reasoning, and it has therefore advanced to fill perceived gaps left by the private sector.

Fourth, building upon these three roles above, the state has also sought to perform a clear *steering* role that differs from their free-market approach on the international level (see Chap. 4). Tight controls have accompanied bioeconomy promotion through public policies. They are present not only in general legal requirements but also in rules (e.g., environmental and labor standards, social inclusion requirements) from public banks that finance biofuel expansion and through state-controlled oil companies. The larger the state participation in the bioeconomy, the higher has been its leverage to impose such requirements. Such steering has been highest in Brazil, mainly due to the state's role in strongly financing bioenergy. It was particularly conspicuous during the heyday of Petrobras Biofuels and the left-leaning Workers' Party administrations (see Chap. 5). In turn, this steering role has been

[1]These state-controlled oil giants include Petrobras in Brazil, Pertamina in Indonesia, the Indian Oil Corporation, Hindustan Oil and Bharat Petroleum in India, and similar companies in other emerging economies such as Russia, China, South Africa and others. See De Graaff (2012).

historically low in Indonesia, where most financing is foreign. Indeed, social and environmental standards have been pushed mostly by foreign buyers and investors. However, Indonesia started to assert itself in the 2010s by creating its sustainability certification scheme (ISPO) and dismantling collective action attempts from the private sector to govern oil palm expansion (Dermawan and Hospes 2018). Such a dependence on the state or foreign partners to elevate social, environmental, and labor standards reveals inadequate levels of corporate social and environmental responsibility in those countries—and, therefore, how unreliable voluntary self-regulation is in those contexts.

Fifth, the state has also performed a key *advocacy* role. Whereas most studies on policy advocacy tend to focus on non-state actors, the biofuels case seems quite exceptional in that the state itself is the leading policy proponent. Although non-state actors have also done lobbying and advocacy, there has been perhaps a more forceful movement in the opposite direction. That is, governments have operated to buy private and civil society actors into their bioeconomy agendas with subsidies, discourses, and regulations. In a way, this suggests that biofuels have received the same treatment as other strategic sectors such as oil—though crucially, unlike the latter in emerging economies, the bioeconomy requires additional actors such as farmers and private agroindustries to operate. Hence, the need to get such other actors on board.

Finally, the state has also played an active *diplomacy* role seeking international support on their bioeconomies and biofuels, as discussed in Chap. 4. Such a role has been particularly notable from Brazil, especially during its "ethanol diplomacy" years under president Lula da Silva, with biofuel partnerships being actively established in Africa, Central America, and elsewhere (Bastos Lima 2012). This role has been less relevant in the Indian case, which has a more domestic-oriented sector. Indonesia, in turn, has also engaged in so-called "palm oil diplomacy," albeit with limited success. If key Western markets such as the EU indeed phase out Indonesian palm oil, this diplomacy role might either fade or turn more forcefully to other parts of Asia that continue to import it.

All these roles amount to an unusual prominence of state actors related to biofuels' strategic nature—closely associated with national economic and political interests—and a state-centered approach to development that emerging economies frequently favor. In this sense, the private sector's reluctance and poor performance in adhering to the government biofuel agendas—particularly regarding smallholder inclusion—has led to further state control. This state prominence appears to go beyond that of highly industrialized countries, where private companies tend to play the market roles of biofuel production, blending, and distribution.

Perhaps more notably, biofuel promotion in emerging economies has also been different from that of least developed countries. In the latter, without much of a domestic institutional framework, investments are mostly foreign-led (even if with the approval of national or local authorities) and oriented towards exporting raw feedstocks or unprocessed vegetable oil for value addition abroad (see Vermeulen and Cotula 2010; German et al. 2011; Schoneveld et al. 2011). Table 8.3 provides an

Table 8.3 Roles performed by the state in biofuel sectors worldwide

	Enabling	Financing	Market	Steering	Advocacy	Diplomacy
Brazil	●	●	●	●	●	●
India	●	●	●	●	●	•
Indonesia	●	•	●	●	●	●
United States[a]	●	●	•	●	●	●
European Union[b]	●	●	•	●	●	●
Other emerging economies (Argentina,[c] China,[d] Thailand[e])	●	●	●	●	●	●
Other emerging economies (Malaysia,[f] Philippines[g])[h]	●	•	●	•	●	●
Least developed countries (mainly Sub-Saharan Africa)[i]	•	•	•	•	•	•

NB A large circle indicates that the role is significant
[a]Lehrer (2010) and OECD/FAO (2012); [b]European Parliament (2009); [c]Joseph (2012); [d]Scott and Junyang (2012); [e]Preechajarn and Prasertsri (2012); [f]Wahab (2012); [g]Corpuz (2012); [h]Other emerging economies such as Mexico, Russia, and South Africa have not had significant biofuel production, for country-specific reasons; [i]Vermeulen and Cotula (2010), German et al. (2011), and Schoneveld et al. (2011)

overview of these differences and patterns, comparing the case study countries and others.

8.3.2 Bioeconomy Governance as a Struggle of Transnational Classes?

Besides the prominence of the state in all three cases, another issue is to what extent are there similarities in the agent types present in dominant and subordinate coalitions, the policy beliefs they herald, and the resources and strategies used. In the current context of globalization, many authors have started speaking of *transnational* classes trying to influence policy, such as a transnational capitalist class (van der Pijl 1998; Robinson and Harris 2000), international peasant and smallholder movements (van der Ploeg 2008; Altieri and Toledo 2011; Rosset and Martinez-Torres 2012), and epistemic communities such as scientist networks (Haas 1989). These are in addition to powerful individual actors that by themselves can operate transnationally, such as large NGOs or multinational corporations. The question, then, is to what extent this transnationality of agency has applied to biofuels and how it is interplaying with emerging state prominence in governance.

In all three investigated cases, private agribusiness—in a combination of domestic, foreign, and mixed-capital companies—has been part of dominant coalitions, typically allied with the state and providing essential support in the form of finance, technology, and bio-based production capacity. Its view has been consistently productivist in nature, minimizing criticism against biofuels, focusing on outputs and market expansion, and usually limiting social issues to job creation and environmental ones to climate change mitigation only. Their mobilization of material resources is characteristically a mix of domestic and international capital, as seen through the financing from foreign (usually North-based) and multilateral entities and the utilization of agricultural technology from multinationals, as in plant material and chemical inputs. Contrastingly, however, discourses have usually been nationally oriented, evoking a spirit of international market competition and struggle for national energy and food security.

Smallholders, social movements, and environmental NGOs, in contrast, have been consistently outside of dominant coalitions. Their exact positions, however, have varied. In Brazil, grassroots rural movements and environmental NGOs have largely joined forces to pursue an agroecology and food sovereignty-oriented approach to biofuels and the bioeconomy. To an extent, they succeeded in being recognized by the government and participating in decision-making, before government changes towards the far-right curtailed such civil society participation. Such a subordinate-actor articulation has been much more limited and without significant coalition behavior in India's biofuel governance. In Indonesia, they have been confrontational as most environmental NGOs are North-based, emphasize ecosystem conservation, and often antagonize most smallholders' development aspirations. In all three cases, these non-dominant agents' typical resources have been mobilizable troops and information about large-scale biofuel production's social and environmental impacts, sometimes counting on skillful local leadership. Although these actors occasionally benefit from foreign donors, their action is mainly circumscribed to their national contexts—except for the North-based environmental NGOs in Indonesia (and, to a lesser extent, in Brazil[2]), which operate internationally. In this sense, smallholder networks such as Via Campesina seem to represent more of a platform for recognizing peasant identity, expressing views, and promoting solidarity than for substantial exchange of resources, as it happens with large NGOs or agribusiness.

Finally, the scientific community finds itself split in all three cases. It is interesting to note that enthusiastic support for biofuel promotion and bioeconomy development has come mostly from researchers in the exact sciences and engineering (see Afiff 2014), while criticism has come primarily from the ecological and social sciences. The fact that recent technology-oriented papers continue to overlook

[2]Such North-based environmental NGOs operate in Brazil mostly on the issue of deforestation, which has had little relation with biofuels development. Brazilian environmental NGOs, on the other hand, operate on a broader spectrum of issues and usually take as much social as ecological dimensions into account (see Bastos Lima and Persson 2020).

biofuels' drawbacks and promote them uncritically provides a clear illustration of that divide.

In the end, how transnational is the agency of those involved in biofuel governance? Arguably, it is somewhat transnational, but not much. The biofuels case seems to corroborate the Neo-Marxist and Neo-Gramscian authors' argument that there are global classes with similar approaches, views, and policy beliefs, but operating primarily within state contexts (Cox 1987; Gill 1991). This observation is not to deny the emergence of an increasing number of transnational agents such as large NGOs and multinational corporations. However, these have not been the key agents of biofuels governance. Concerning ideas, material capabilities, and institutions alike, most seem to stem from the national-state level—or supra-national, in the EU case. Since biofuels have mainly been a state-led agenda, transnational actors have played in conformity with this and mostly acted within national contexts—even if occasionally in more than one. As such, their agency may have been *multinational*, but not *transnational*.[3] Even if the views and policy beliefs they hold can be considered transnational, their actions, for the most part, have not.

8.3.3 Inferences: Agency Patterns in Biofuels Promotion

This comparative assessment has shown that those countries not only have had similar approaches to biofuel development, policy choices, and sets of main winners and losers, but also a consistent pattern of dominating views and agent types. The case studies also provide evidence to the claim that institutional outcomes are strictly dependent on who holds the dominant positions among advocacy coalitions and in policy-making. It seems fair to argue that Brazil has obtained some minor but still positive results in smallholder inclusion mainly because representative social movements found their way to policy-making. Inversely, the lack of success with jatropha in India seems to owe largely to the exclusion of local actors from decision-making. In a way, India and Indonesia have displayed a more top-down domestic biofuel governance along the lines of administrative rationalism, based on state authority and formal (scientific) expertise. In contrast, the Brazilian approach displayed more signs of democratic participation (see Dryzek 2005).

There has been a clear tendency for dominant coalitions to pursue biofuel production strategies that increase their access to resources while hampering weaker actors. This approach seems partly motivated by policy beliefs that suggests it as the right way to go, but there is more to it. Their dominant approaches have also included shortsightedness, negligence, or ignorance about the needs of others, as in the case of rural dwellers and "wastelands." Finally, to an extent, it is also a purposeful act to undermine their opponents' strength—this latter rationale becoming more relevant when there is an adversarial coalition promoting a competing approach, as in the case of Brazil.

[3]See Robinson and Harris (2000) for an in-depth discussion on this differentiation.

Given biofuel agendas' reliance on public policy, it should come as no surprise that governments and private companies have framed them primarily in terms of energy security and other national or public interests. This rhetoric has a key importance in democratic societies. Changes in public opinion and shocks external to the policy field (such as electoral losses) are the most common causes of major policy changes—as Brazil's case now vividly demonstrates (see Weible et al. 2011). The policy sciences literature considers two other possible causes: policy-oriented learning (though this usually affects only secondary beliefs) and negotiated agreements. However, actors who benefit from the status quo generally have no incentive to negotiate unless specific conditions such as a hurting stalemate are in place (Sabatier and Weible 2007, p. 206). In the current configuration of emerging economies, weaker actors such as the rural poor and indigenous peoples tend to be the only ones being "hurt"—often literally. This imbalance explains why biofuel agendas have managed to continue relatively unabated despite mounting criticism.

8.4 The Bioeconomy: Addressing or Aggravating North-South Inequalities?

The development strategies of emerging economies may help them catch up with highly industrialized countries—what has been termed equalizing development (see Chap. 2)—or hold them back, possibly even pulling them down to a weaker position.

Drawing from an eclectic selection of authors that have over time discussed the structural socio-economic or political features that distinguish developed and developing countries, a global North from a global South (e.g., Dirlik 2007; Hurrell and Sengupta 2012; Wallerstein 2011; Horner and Nadvi 2018), this analysis uses five criteria to assess equalizing development: (i) domestic value-added in the production chain; (ii) endogenous innovation with ownership and control over technology; (iii) economic gains in absolute terms; and (iv) relative economic gains, i.e., compared to developed countries in the same bioeconomy value chain; and, a fifth, political factor that the biofuels sector particularly reveals to be relevant: (v) vulnerability to international determinants. Countries have promoted biofuels partly to reduce oil import dependency—and, thereby, exposure to price fluctuations or political decisions and instability in oil-exporting countries. However, biofuels production has exposed some of them to unilateral foreign rule-making attempts on their national development.

From the perspective of equalizing development, Brazil's biofuel development has been mostly positive. First, endogenous innovation on agricultural technology—in this case, particularly on sugarcane but also on soy—has allowed for a top biofuel sector in terms of productivity and market absorption. It has spilled over to promote Brazilian flex-fuel car technologies and other uses from sugarcane, such as electricity co-generation or up and coming bio-products such as cane-based plastics (see

Chap. 5). Second, biofuels have saved foreign exchange and reduced Brazil's vulnerability to international oil price fluctuations by cutting gasoline and diesel imports. Third, ethanol has brought both absolute and relative economic benefits through—until recently, and potentially again in the future—exports of a value-added product to developed countries. Indirectly, higher edible oil and sugar prices partly caused by large-scale supply diversion to biofuels also are beneficial to Brazil's exports, if not necessarily to low-income food consumers.

Indonesia's situation is somewhat similar, though with an important caveat. Its biodiesel sector has reduced petroleum consumption, the import bill, and its vulnerability to international price volatility. Biodiesel policy has also promoted value-chain development and the creation of downstream industries based on palm oil, even if it is still primarily sold in its crude form (CPO) (Wiyono and Slette 2013). Nevertheless, being largely export-oriented and dependent on foreign investments, Indonesia's biodiesel industry has been particularly vulnerable to policy decisions outside its reach. For instance, they include the unilateral standard-setting of foreign importers (e.g., the EU) and occasional restrictions from multilateral financing organizations such as the World Bank. Such vulnerability seems characteristic of developing countries' weaker positions and an aspect that Indonesia has not yet left behind in its development. Although this country has become increasingly assertive, as seen in its defiance of (the mostly Europe-led) RSPO certification, this attitude relies much more on the availability of other emerging markets (namely India and China) operating as less stringent importers than on Indonesia's domestic economy. Its vulnerability would surface at once if the EU were to articulate a joint position with China and India on oil palm sustainability. Indonesia, surely, is gambling on the improbability of that.

Finally, India has profited from its ethanol industry but faced an unfavorable situation in its jatropha-biodiesel strategy. India's ethanol production has reduced oil consumption, the need for imports, and vulnerability to price fluctuations, as in the other countries. Biofuels have also promoted value addition and development of downstream industries on sugarcane molasses, which otherwise were sold as feed to Europe (see Chap. 6). Meanwhile, its biodiesel policy has so far been counterproductive to India's efforts to reduce disparities with developed countries. First, because jatropha biotechnology, processing, and biodiesel manufacturing have been mostly owned and controlled by North-based private companies. Second, by restricting biodiesel exports, the Indian policy has provided a perverse incentive for such companies to keep exporting raw materials and perform all value addition abroad. Third, it has given these companies control and use of India's scarce land and freshwater resources. In exchange, only minor economic gains have locally accrued, from raw-material cultivation, the least income-generating and most resource-intensive stage of the value chain—and still, no biodiesel has been commercialized in the country so far.

Table 8.4 compares Brazil's, India's, and Indonesia's biofuel sectors based on their socio-environmental performance and their contribution to equalizing development. The socio-environmental criteria were selected as the most crucial issues identified in Chap. 2 and assessed through the case study analyses (see Chaps. 5–7). The scores

Table 8.4 Assessment of biofuel production in Brazil, India, and Indonesia in terms of socio-environmental performance and equalizing development

Socio-environmental impacts	Brazilian sugarcane ethanol and soy/beef biodiesel	Brazilian mixed-feedstock biodiesel	Indian sugarcane ethanol	Indian jatropha biodiesel	Indonesian oil palm biodiesel
Climate change mitigation	+1	+1	+1	+1	0[a]
Forest and natural ecosystems conservation	0	0	0	0	−1
Ecological impacts from within agricultural systems (e.g., resource depletion, pollution, agrobiodiversity loss)	−1	−1	−1	−1	−1
Equitable access to land and ownership/control of means of production	−1	−1	−1	−1	0
Allocation of policy benefits and burdens	−1	+1	0	−1	−1
Poverty reduction	0	+1	+1	0	+1
Total	−2	+1	0	−2	−2
Equalizing development	Brazilian sugarcane ethanol and soy/beef biodiesel	Brazilian mixed-feedstock biodiesel	Indian sugarcane ethanol	Indian jatropha biodiesel	Indonesian oil palm biodiesel
Domestic ownership and control over technology	+1	+1	+1	−1	+1
Value-added	+1	+1	+1	−1	+1
Absolute economic gains	+1	+1	+1	+1	+1
Relative economic gains (in the case of biofuel exports)	+1	0	0	0	+1

(continued)

Table 8.4 (continued)

Equalizing development	Brazilian sugarcane ethanol and soy/beef biodiesel	Brazilian mixed-feedstock biodiesel	Indian sugarcane ethanol	Indian jatropha biodiesel	Indonesian oil palm biodiesel
Reduced vulnerability to international market volatility or foreign policy-making on one's development (i.e., extraterritorial control)	+1	+1	+1	0	−1[b]
Total	+5	+4	+4	−1	+3

[a]Although diesel's replacement for biodiesel reduces greenhouse gas emissions, part of the time oil palm cultivation incurs emissions from land-use change; therefore, in this simplified assessment, it is given a neutral performance on this criterion

[b]Indonesia is increasingly turning its biodiesel supplies towards the domestic market, but most of the time it has been severely exposed to European extraterritorial policy-making on sustainability

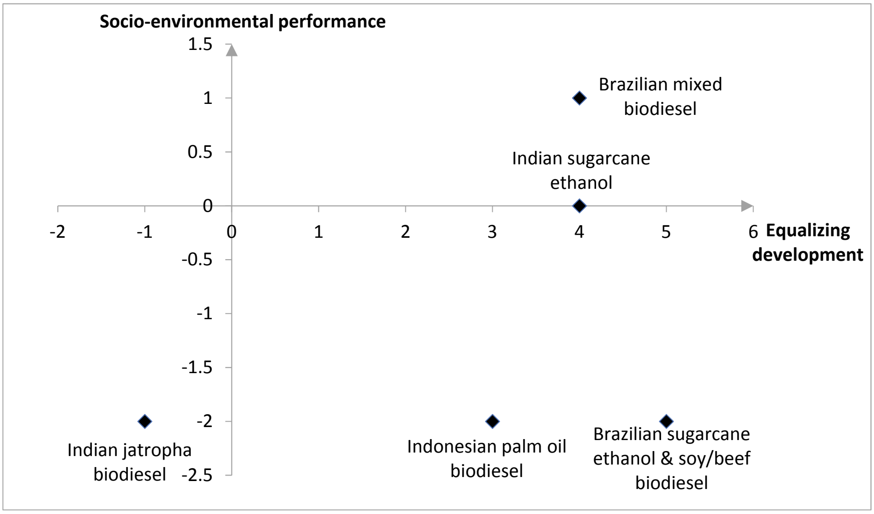

Fig. 8.1 Performance of biofuel sectors in terms of socio-environmental impacts and equalizing development

are not quantified; they are simply regarded as positive (+1), negative (−1), or neutral (0). Figure 8.1 displays the results within the four ideal-types developed in Chap. 2. In Brazil's case, given that biodiesel was initially produced with strong smallholder involvement and crop diversity, that mixed-feedstock product is rated differently from how biodiesel currently is produced, based virtually all from the large, established soy and beef agroindustries.

This comparison reveals no single pattern in biofuel production performance as a proxy for the broader bioeconomy in emerging countries. Most such strategies contribute to equalizing development, but as India's biodiesel experience shows, that is not always the case.

However, such a catching up with developed countries through bioeconomy promotion has often been done at high socio-environmental cost. The Brazilian biodiesel policy, as originally conceived, has been the only one among the examined experiences that sustainably tackles North-South inequalities—confirming the praise it received both from international organizations and civil society (see FAO 2008; Gomes et al. 2010; Elbehri et al. 2013). The Indian sugarcane-ethanol industry also shows good performance, but it is limited in terms of supplies, and therefore this path can be pursued only to a small extent. Finally, the largest sectors, such as Brazilian sugarcane-ethanol, soy- and beef-based biodiesel, and Indonesian palm-biodiesel all have substantively contributed to catching up with developed countries but causing significant social and ecological problems. If their classification as equally unsustainable contrasts with their international public image—Brazilian sugarcane ethanol commonly regarded as highly sustainable as opposed to Indonesia's palm-biodiesel—this just reveals how most sustainability assessments are unduly biased, emphasizing certain biophysical considerations (climate or forest ones) while overlooking agrobiodiversity conservation, water use, and social issues.

8.5 Conclusions

This comparative assessment suggests that emerging economies show some commonalities in their approach to biofuels promotion and bioeconomy development. For one, emerging economies have adopted a clear state-centric approach. Generally, bioeconomy strategies and plans worldwide have been characteristically public-sponsored and state-led, as shown clearly in the case of biofuels as these enter the key domains of energy and agricultural governance. These sectors tend to be considered strategic and are typically characterized by decisive state intervention domestically and little willingness to compromise at the international level (see Florini and Sovacool 2009; Clapp 2006; Lesage et al. 2010). However, in emerging economies, the state has been assuming an even broader set of roles, including as a market actor through large state-controlled fuel companies and development banks. This pattern contrasts with that of less developed countries, which tend not to have such economic muscle or institutional capacity. It is also different from that of highly industrialized countries, which have well-established private sectors frequently playing those market roles—even if developed country states continue to provide vital support. As emerging economies gain more international relevance and influence over multilateral organizations' agendas, these forms of state-centric development may become more common, especially as financial and other economic crises repeatedly undermine trust in market liberalism.

Emerging countries' approach to the bioeconomy also has a more distinct focus on social issues than on the biophysical ones (usually climate and wild biodiversity conservation) that highly industrialized countries tend to emphasize. In this regard, emerging economies are similar to other developed countries (see Martínez-Alier 2002). Yet, despite emphasis on socioeconomic development and lip service paid to equity issues, their strategies to tackle social problems through biofuels have by default been top-down and conservative, as a direct consequence of who sets the agendas: coalitions of government and agribusiness agents, with little or no participation of civil society. Rural development has been pursued primarily through trickle-down economics, overlooking structural issues, and most often adopting a paternalistic approach where the rural poor are referred to in policy discourses as primary beneficiaries but do not participate in the policy-making process. The only exception among the analyzed cases has been Brazil's biodiesel policy in its early years when rural social movements participated in its governance, though this sector, too, later gave way to control by large conglomerates (soy and beef).

As such, emerging countries have used the bioeconomy to pursue equalizing development and bridge the North-South gap, but at the expense of increased domestic inequities. Perhaps partly from their condition as emerging powers and an eagerness to achieve a higher position in world affairs, these countries have characteristically been keener on addressing international inequalities and catching up with developed countries than on addressing their internal domestic discrepancies, such as in access to natural resources and income. This bias arguably owes to the fact that development policy in these countries is crafted mainly by elites who do not suffer from the poverty that still pervades large segments of the population. More than that, those elites often *benefit* from such inequity and therefore have no incentive to address it, let alone prioritize it. This dominance largely relies on instrumental and structural advantages (e.g., finances, technology, better agenda-setting positions) over other actors who could attempt to do differently, but both state and private actors have also utilized discourses that legitimize their approach. Dominant discourses often involve references to the public interest in the forms of national energy security and development, international competitiveness, or an emphasis on climate change amid different sustainable development concerns. In this way, domestic injustices are not necessarily denied, but they are conveniently overlooked while public attention is diverted elsewhere.

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Chapter 9
The Politics for a Fairer Bioeconomy

Abstract Bioeconomies are yet to meet their sustainable development potentials. Thus far, mostly unsustainable production has prevailed, due to reasons on four different levels. First, domestic regulatory and economic incentives have favored conventional, input-intensive monocultures and big agribusiness-controlled systems. Second, some norms have been crucial in underlying those policies: (i) the economic but not political inclusion of smallholders and low-income countries; (ii) the pre-eminence of climate and wild biodiversity conservation over other sustainability issues, assuming "renewable" to mean "sustainable" and disregarding the performance of bio-based production on other social and environmental criteria; and (iii) an implicit urban bias that limits rural development strategies and prioritizes the provision of resources to cities. Third, state and private agroindustry agents who espouse those norms have formed winning coalitions to concretize policy beliefs held in common. Ultimately, there are feedback loops between agency, governance architectures, and allocation and access patterns. Therefore, the prevailing production patterns' very distributive outcomes can be identified as a cause underlying their dominance. As such, social equity reveals to be not just a normative goal but also a key determinant of governance. To not aggravate inequalities and be more sustainable, bioeconomy promotion needs policies that reconfigure allocation patterns and promote structural change.

Keywords Bioeconomy · Biofuels · Emerging economies · Inclusiveness · Social equity · Value chains

9.1 Introduction

This book began with the observation that sustainable development's social pillar, with its considerations on equity and other human dimensions of environmental change, has been systematically marginalized, both in scientific research and in sustainability policy. Biofuels, an emerging bioeconomy sector *avant la lettre*, has been no exception to that.

Still, despite remarkable growth, worldwide political and economic engagement, and significant global impacts on people and the environment, bioeconomy sectors

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mostly continue to be blind spots of governance analyses. Assessments of biofuel social impacts have hardly examined links to the institutional and political contexts in place. Although scientists and multilateral agencies for years have pointed out the high stakes of large-scale biofuel production, its expansion continues unabated and mostly unchanged, and now broader bioeconomy strategies are emerging and seeking to build on top of the existing sectors. To draw lessons from experience thus far, this book has asked *why certain biofuel production patterns have prevailed at the expense of others.*

This chapter draws on the in-depth assessments in this book to answer that question. It will also provide recommendations for institutional redesign and further research. The next section discusses some main conclusions; it characterizes the social sustainability of prevailing biofuel production systems, delves into bioeconomy governance politics, explains how agents operate and why these new sectors remain a non-regime at the international level. The chapter also expounds on the relevance of access and allocation patterns to understand governance and why certain (unsustainable) strategies have prevailed. Later, the chapter discusses how bioeconomy strategies can become more equitable, including specific policy design recommendations and governance lessons. It ends with recommendations for further research and some final considerations on adequately taking on board social dimensions for a fairer bioeconomy.

9.2 Unraveling the Politics of Bioeconomy Governance

9.2.1 The Prevalence of Conservative and Unsustainable Agri-Food-Biomass Systems

Although the various biofuels and bioeconomy products are diverse from a technical standpoint, their prevailing production systems have been remarkably similar and rather conservative. For one, biofuels have brought about moderate innovation to energy systems: they maintain conventional fuel distribution and transportation infrastructure while replacing oil products with renewable energy. However, they have merely added technologies and new markets to pre-existing agricultural systems upstream in the production chain.

Agricultural or feedstock cultivation systems have undergone little to no structural changes. They have also maintained nearly all their pre-existing environmental impacts, skewed power relations, and uneven allocation patterns. Agri-food systems may have become agri-*fuel*—sometimes agri-food-fuel or, more generally, agri-food-biomass—systems. They are about to increasingly become biomass-based "value webs," where multiple chains coexist to deliver a plethora of goods (Virchow et al. 2016; Scheiterle et al. 2018). Nevertheless, there has generally been no change regarding who owns, does, or gets what. (The "what" has somewhat changed, but the "who" has not. The winners and losers remain mostly the same.) The expansion of these systems has often meant further land dispossession and reduced access to water or food for vulnerable groups such as rural communities and indigenous peoples. Rather than tackled, structural socio-economic inequalities have been fueled and reinforced by thriving new bioeconomy markets.

Industry-controlled monocultures and contract farming schemes have been the two main production arrangements currently undergirding the bioeconomy. The former are vertically integrated systems where agribusiness directly controls both feedstock cultivation and bio-based production. Especially as crop mechanization advances, such vertically integrated production systems become increasingly socially exclusive. If the rural poor participate, it is merely as plantation workers, often without job security. Although such jobs may *alleviate* poverty, the latter's structural causes are maintained. The industry gains from all bioeconomy value-chain—or value-web—development while dispensing only minor benefits in the form of low-paid rural jobs. In reality, the poor often have been left worse off due to insecure and health-degrading work conditions. Meanwhile, the impacts on and eventual erosion of small-scale mixed farming are not accounted for, even though it usually creates far more employment. Mixed farming also generates higher economic value per hectare and tends to be more sustainable, yet it hardly receives attention in the form of political, financial, or R&D support (IAASTD 2009; HLPE 2013a).

Conventional contract farming, in turn, has been nearly as inequitable. Despite keeping nominal control over the land and other production resources, smallholders effectively lease it to the contracting industry. Contracts are often negotiated on an individual basis, with knowledge imbalances and frequently in contexts of monopsony (i.e., only one buyer available) and vulnerability from smallholders in poverty—conditions that give the industry disproportionate bargaining power. Farmers are "hired" but usually without safety nets or any standard employee rights, such as collective negotiation. They can easily be laid off after a contract, although getting back to mixed farming after shifting to input-intensive monocultures may prove very challenging if not impossible. Besides, farmers become dependent on a single cash-crop—in the bioeconomy case, a crop that might not have any alternative use as either food or fodder (e.g., jatropha, castor bean). Such an exclusive dependence makes smallholders even more vulnerable to market fluctuations and to a single buyer that may not respond well to such economic volatility. The COVID-19 pandemic, for instance, laid bare such vulnerability by throwing many Indonesian oil palm farmers into a "survival crisis" as markets turned off (Chu and Das 2020).

In the best-case scenario, contracted farmers are to perpetually remain raw material providers, producing under terms dictated mainly by the industry while the latter benefits from all value-added. In practice, however, industries have abandoned thousands of smallholders due to uneconomic biofuel production. Many contracts for feedstock cultivation have thus configured cases of "adverse incorporation," i.e., inclusion where poor farmers end up worse off, sometimes with both their food and economic security compromised (see Hickey and Du Toit 2007).

Both approaches have been conservative in the sense that they do not tackle the existing unequal distributive patterns and power relations of conventional agri-food systems—they instead expand on them. They constitute forms of what Moore

(1966) seminally termed "conservative modernization," i.e., updating some technical and economic arrangements without challenging existing social or political inequalities. Instead, the process of (technical) change, guided by the winning side of those relations, precisely maintains those advantages—and, thus, the inequalities they produce—in place. We can therefore identify a dominant paradigm of *conservative ecological modernization* in current bioeconomy promotion.

However, unsustainability has not arisen only from the social pillar. The overall environmental performance of large-scale biofuel production, too, has overall been rather negative. Although fossil fuel substitution helps with climate change mitigation and can improve air quality, the expansion of industrial agriculture for feedstock cultivation has fueled numerous environmental issues such as soil, freshwater, and (agro)biodiversity depletion. While biofuels' *use* seems beneficial, their production patterns have been grossly unsustainable from social and ecological standpoints.

9.2.2 Institutional Causes Behind Unsustainable Bioeconomy Development

The prevalence of unsustainable bioeconomy development, such as socially and environmentally unsound biofuel production, is inextricably linked to its governance. Institutions have been crucial for the thrust and prevalence of specific biofuel expansion patterns in at least three ways. First, national public policies have driven and largely shaped how biofuels are produced and consumed. They have been determinant both to the failures and to more successful cases. Second, biofuel expansion has counted on a surprisingly supportive institutional environment at the international level, despite public controversies. Third, some underlying norms at both national and international levels have been particularly critical for the bioeconomy's current limitations on promoting equity and sustainability. It is worth fleshing out each of these causation links.

Despite its global dimension, one cannot sufficiently understand the current biofuel expansion without reference to national policy frameworks. Public policies have enabled, financed, and largely steered biofuels and other bioeconomy sectors so far. Even if additional drivers such as foreign market demands have sometimes been at play, domestic regulatory and economic incentives have usually been the main—and the only *sine qua non*—cause of biofuel expansion. Such incentives have included national consumption goals, blending mandates, facilitated regulations on investment, tax breaks, targeted public credit, and a range of other instruments. Without these, the current development of biofuels and other bioeconomy value chains would not have been nearly as attractive—or at all possible.

Critically, those public institutions have not only promoted but also *shaped* such value chains. Biofuel policies have systematically allocated nearly all incentives to private agribusiness while placing most burdens on public banks and state-controlled oil companies. However, that support has not always been indiscriminate. Incentives have sometimes included social or environmental requirements, such as incorporating smallholders or avoiding deforestation. Although this has sometimes backfired, in other cases—notably that of Brazil's *social fuel seal* on biodiesel (see Chap. 5)—those requirements were crucial to improving the outcomes. In either case, public policies have been the primary determinant of the sustainability performance of bioeconomy promotion through biofuel value chains.

In contrast, an absence of rules in a lean, neoliberal framework has characterized international biofuel governance. Its norms have included: (i) an uncritical assumption that biofuels should be produced through conventional agriculture and on a large scale; (ii) the need to promote them as internationally traded commodities; and, implicitly, (iii) an understanding that multilateral rules on biofuels should be kept to a minimum, usually limiting themselves to technical standardization, thus allowing countries to freely pursue their agendas irrespective of the global impacts they might have.

Based on these norms, state and non-state actors from major producer countries have set up many new organizations (e.g., the Global Bioenergy Partnership, the International Biofuels Forum) as well as working groups within pre-existing agencies (e.g., IEA Bioenergy) to promote cooperation and also deployment in non-member countries. Meanwhile, more inclusive fora such as UN agencies have been vocal and engaged on biofuel sustainability issues, but "non-decisions" have prevailed due to the refusal of major producers to agree on any international rules that could limit their agendas. This broadly permissive institutional setting is in stark contrast with the concerns expressed internationally in scientific and policy circles (see FAO et al. 2011; HLPE 2013b). Such an international vacuum of rules has been particularly crucial to developing countries. They experience most food insecurity and land grabbing issues, and foreign investments drive most of their biofuel expansion (see Chap. 4; see also Schoneveld 2010; Smith 2010; German et al. 2011). Furthermore, the absence of an international regime has led to unilateral sustainability policy-making filling the regulatory gap via extraterritorial control over supply chains. However, besides its much more limited applicability, this arrangement exacerbates political power inequalities as producer countries become subject to sustainability rules without having a say in their making (Bastos Lima and Gupta 2014).

More broadly, three underlying norms have constrained bioeconomy governance and limited the potentials of value-web development. First, the involvement of weaker actors such as smallholders or low-income countries has been a prevailing norm, almost a development mission, based implicitly or explicitly on such ideas as participation, social inclusion, and empowerment. However, that has been limited to an economic understanding of these concepts. Weaker actors are included but usually not their views, interests, or preferences. Inclusion and exclusion are seen as a black-or-white dichotomy; it is assumed that inclusion is good and exclusion is bad, that inclusion always reduces inequalities, and that the excluded always want to be included (Hospes and Clancy 2011). Hence, there is supposedly no need to conduct any meaningful consultation. However, not only does this overlook the risks of adverse incorporation, but it also leads to top-down strategies where dominant actors impose their views and rules on weaker ones under uneven power relations.

The second underlying norm to bioeconomy governance to date is a limited and politically conservative view of sustainable development—in line with conservative ecological modernization and so far not going beyond it. For one, biofuels have mostly been technocratic "solutions" of reassurance to incumbent dominant actors and their arrangements. That includes reassurance to the conventional, automobile-centered transport systems, as well as to the mainstream productivist approach to agriculture, which emphasizes yields while overlooking its broader social or environmental performance (see IAASTD 2009; Horlings and Marsden 2011).

The biofuels case corroborates several critiques leveled against the prevalent ecological modernization praxis (see Chap. 1). It provides a telling illustration of how such a narrow view of sustainability indeed leads to unsustainable practices. Capital-intensive approaches have privileged wealthier agribusiness actors. While overlooking power relations, they have exacerbated inequities; and by favoring only expert-based scientific rationality, they have supported the one-way treatment dispensed to smallholders and the dismissal of their traditional knowledge.

Moreover, there has been a nearly exclusive emphasis on climate issues—what one could term a "climate eclipsing" of nearly all other environmental issues—and *wild* biodiversity conservation, that is, ignoring biodiversity *within* farming systems. Biofuel policies have systematically overlooked issues such as the depletion of agro-biodiversity, soil, and freshwater caused by industrial feedstock cultivation. "Sustainable" becomes thus reduced to being a synonym of "climate-friendly," "climate-smart," or of "low-carbon" development.

Finally, underlying most biofuel production strategies as an implicit norm is a bias towards urban-centered development. Despite the prevalent rural development discourse, its promotion has generally been limited to giving incentives for feedstock cultivation. Biofuel policies have hardly included any instruments to promote rural entrepreneurship, local value addition, or to address rural energy poverty. Instead, rural areas' natural and human resources have been mobilized to provide more energy to urban centers and mostly to higher-income motorists. Environmental pollution and resource depletion from feedstock cultivation are felt primarily in rural areas, while highly skilled work and resource consumption mostly benefit city dwellers. This norm remains implicit, but the reality is that bioeconomy promotion thus far has almost invariably widened the rural-urban divide.

9.2.3 The State-Agribusiness Nexus in Bioeconomy Value Webs

Institutions usually do not come about spontaneously. Those prevailing norms, policy frameworks, and even the absence of an international bioeconomy regime have resulted from dominant actors' agency—and, therefore, mainly represent their views. In this regard, the biofuels case offers a significant example of conflation between state and agribusiness interests. Far from being absent or relegated to the background as scholarly emphasis on "agency beyond the state" may suggest (see Cashore 2002; Pattberg 2007; Biermann et al. 2009; Biermann and Pattberg 2012), states have shown to be the principal agents of bioeconomy promotion, particularly in emerging countries (see also Schmalz and Ebenau 2012; Van Apeldoorn et al. 2012). In these countries, the private sector has worked mostly *through* the state rather than independently. Instead of advocating for deregulation or focusing on private governance mechanisms, agribusiness in bioeconomy matters has devoted most resources to influencing public policy. For instance, palm oil producers walking out of the Europe-led Roundtable on Sustainable Palm Oil (RSPO) in Indonesia did not launch their certification mechanism. Instead, they have supported government-made certification: the Indonesian Sustainable Palm Oil (ISPO).

Strong coordination between states and agribusiness around the bioeconomy stems from at least two reasons. For one, both sets of actors have shared some common norms (e.g., urban-centered development, sustainability understood as ecological modernization, economic but not political inclusion of weaker actors) and policy-core beliefs. In the case of emerging economies, both agribusiness and states have also been keener on pursuing economic growth, technological innovation, increased geopolitical influence, and catching up with developed countries—in short, "equalizing development" (see Chap. 8)—than on fixing domestic inequities or protecting the environment. Moreover, resource complementarity between state and agribusiness has made them interdependent. While agribusiness has depended on public regulations and economic incentives for producing biofuels and bioproducts, emerging economy states have not been able to fulfill their aspirations without resorting to the private sector's material capabilities such as technologies, investment capital, and—notably in Brazil's case—farmland.

Still, states are not monolithic entities. Democratic governments, in particular, must respond to multiple pressures and may accommodate the interests of different social groups (Poulantzas 1978; Jessop 1990; Gallas et al. 2011). Nevertheless, bioeconomy governance has largely excluded more critical views and actors from the agenda-setting processes. The interests of weaker stakeholders (e.g., rural communities, indigenous peoples) have been regularly underrepresented. Agribusiness' superior material capabilities explain that imbalance to an extent, but not entirely. Such a lack of government responsiveness and democratic representativeness, which illustrates the limited political strength of more critical actors, arguably also owes to their limited connection with the ruling political parties and civil society.

States are not machines—people and political groups with particular views and policy beliefs staff public apparatuses. Various non-state actors may influence policymaking, but policies still depend mostly on what the political parties in power want and decide (Hibbs 1977; Allern and Saglie 2012; Pedersen 2012; Nelson 2013). Among the analyzed cases, only in Brazil have critical actors been able to play a meaningful (albeit limited) role in bioeconomy governance. That resulted from the close links between smallholder movements and the Workers' Party, which ruled from 2003 to 2016 and introduced inclusion-oriented policies, giving Brazil's biodiesel program its social hues. It was representative of Latin America's broader left-wing turn—or "Pink Tide"—with social policy improvements and achievements in reducing poverty and inequality in the 2000s (see Castañeda 2006; Schmalz and Ebenau 2012; Hogenboom and Jilberto 2014). As that lost steam by the mid-2010s and many governments of more pro-business inclinations came to power in the region, it remains to be seen how that state-agribusiness nexus will evolve.

Concerning civil society support, one must regard the prevailing discourses that state-agribusiness coalitions have put forth and used to secure their dominance in democratic systems (see Falkner 2009; Williams 2009; McMichael and Schneider 2011). While highlighting employment creation and the macroeconomic benefits of the bioeconomy, private agroindustries also depict themselves as national champions in a competitive international market, in a nationalistic appeal for public support. In practice, they adapt the (self-serving) claim that "what is good for General Motors is good for the United States", offering contemporary bio-based versions of it in emerging economies. That nationalistic emphasis continuously underscores their discourses and, if anything, it has become even stronger as national-populist governments came to power in countries such as Brazil and India. Also elsewhere, governments and agribusiness have mostly framed large-scale biofuel production in terms of public interests such as job creation, energy security, and climate change mitigation. In contrast, critical discourses have lacked sufficient penetration within civil society at large. Critiques or alternative formulations for the bioeconomy have remained relatively marginal. During government elections, they usually hardly constitute a challenge to dominant discourses.

That said, the case studies have shown how failure from the part of private industries to meet government expectations (e.g., smallholder inclusion) has occasionally led to counter-movements from the state. In Brazil, the state increasingly used its prerogatives as a major financier to set additional rules on biofuel value chains. In both Brazil and India, it also started engaging directly in biofuel production, taking market share from the private sector, while in Indonesia it has increasingly attempted to do so. This pattern shows an expansion of the typical state dominance in emerging economies' energy markets (see De Graaff 2012), from oil to renewable fuels and now also in the agribusiness sector. Such an expanded role is in tune with the perceived prominence of a "neo-developmentalist"—as opposed to neoliberal—state in those countries (Morais and Saad-Filho 2012; Schmalz and Ebenau 2012; Van Apeldoorn et al. 2012), and with its similar strides in other strategic areas such as mining. However, this in itself has not (yet) meant a challenge to the neoliberal global order (Schmalz and Ebenau 2012; Van Apeldoorn et al. 2012). On the contrary, the recent past shows that, in times of increasing protectionism, emerging economies may sometimes be strong advocates of free trade at the international level.

9.2.4 *Strategic State Behavior and International Non-regimes*

Non-regime and non-governance cases remain as large blank spots in the governance and institutional analysis literature (Biermann et al. 2009; Biermann and Kim 2020). As Dimitrov et al. (2007) noted, regime analysis has focused extensively on policy areas where regimes have surfaced. However, insufficient attention has been paid to areas where no regimes have been formed, creating a lack of control cases. Moreover, non-regime cases can shed light on the political dynamics that underlie regime formation. This section uses the case of biofuels—arguably a non-regime (Bastos Lima and Gupta 2013)—to explain how such instances come to be and consider what seems to prevent regime formation.

First, it is useful to observe that biofuels make a case where the literature would have predicted international regime formation. The sector is marked by interdependence among countries, market failures, negative externalities from domestic policies, and potential for mutual gains from multilateral cooperation—all of which are factors known to contribute to regime formation (Keohane 1984; Young 1989; Hasenclever et al. 1997; Dimitrov et al. 2007). Nevertheless, only a thin neoliberal framework has emerged in biofuel governance (Bastos Lima and Gupta 2013). While it has provided some interstate cooperation, there are no mutually agreed rules and, therefore, no rule-consistent behavior—defining requirements for a regime (see Chap. 3).

In a preliminary assessment of non-regimes, Dimitrov et al. (2007) identified three possible impediments to regime formation: the absence of reliable scientific information, value conflicts among states, or internal conflicts within domestic politics. However, none of these factors seems to explain the absence of a biofuels regime satisfactorily. There has been plenty of scientific information on their economic or environmental impacts. Multilateral cooperation on biofuels shows that value conflicts among states are not too significant in this area. Although there are conflicting views on biofuels within countries, these have generally not been strong enough to undermine or destabilize the countries' central positions and agendas on the issue, as the case studies in this book have shown.

Instead, three other interrelated reasons may help explain the absence of an international regime in the case of biofuels: (i) strategic economic and geopolitical interests, (ii) lack of political consensus[1] about the externalities of domestic policies, and (iii) national sovereignty concerns. Countries engaged in large-scale biofuel production have perceived it as central to their national energy security interests, geopolitical ambitions, and job creation in agriculture—employment always a significant item in government agendas. These domestic policies have likely had global impacts, but they mix with other drivers, and thus the causality is not clear (see Bastos Lima and Gupta 2014). This debate has led to nuanced views and a lack of consensus among policy- and decision-makers, even if scientists and multilateral organizations

[1] This does not refer to scientific consensus, but to consensus among policy- and decision-makers.

seem closer to such a consensus and have long called for changes in those domestic policies.[2]

International regimes that put reins on domestic policies, although hard to negotiate, are not nonexistent, as the Kyoto Protocol and its emissions caps showed—among various other examples. However, while global ecological impacts are more easily seen as "negative," transnational economic impacts such as those of domestic biofuel policies on agricultural commodity prices are much more nuanced despite the clamor made about "starving the poor to fuel cars." While there is a fairly broad consensus about the desirability of, say, mitigating climate change and avoiding biodiversity loss, the idea of keeping agricultural commodity prices low is not nearly as consensual. Furthermore, restrictions on crop or land diversion to biofuels would mean, in practice, compelling major agricultural countries to stick to producing and exporting food. They would have to forgo the development of other crop-based industries and a bioeconomy "just" to keep international agricultural commodity prices at a certain level because other countries have become dependent on (cheap) food imports. It can certainly be asked why the latter have become so vulnerable to international price volatility and dependent on food imports (see Clapp 2009). If anything, the COVID-19 pandemic has brutally exposed the need for addressing structural vulnerabilities of access to food in the neoliberal food security order (Clapp and Moseley 2021). However, requesting producer countries to refrain from a broader utilization of their crops, multipurpose agriculture, and bioeconomy development would affect their national sovereignty to a degree they are generally unwilling to accept.

To what extent are these factors specific to biofuels, and to what extent can they be generalized to regime formation in other areas? Issue-area specificity is a crucial debate in non-regime theory (Dimitrov et al. 2007). Still, some generalization may be possible. Arguably, national interest and sovereignty concerns are relevant to any issue-area considered to be strategic. In strategic areas, the country's economic status or geopolitical power is at stake, as seen in global energy governance, international climate change negotiations, or discussions about the liberalization of agriculture. For instance, despite the crucial importance of energy production, trade and consumption for economies or to the environment on a planetary scale, global energy governance remains weak, scattered and, for most practical purposes, nonexistent (Florini and Sovacool 2009; Gupta and Ivanova 2009; Lesage et al. 2010). Even rules of the World Trade Organization (WTO) generally exempt oil and gas sectors (Abdallah 2006; Cottier et al. 2010). As such energy resources are strategic both for economic and geopolitical interests, countries are hardly willing to compromise in this area—except when international institutions are perceived to be non-intrusive and to work in the best interest of all participants, as in the case of the Organization of the Petroleum Exporting Countries (OPEC) (see Kaufmann et al. 2004; Carey 2009; Karlsson-Vinkhuyzen 2010). For instance, in international climate negotiations, US

[2] See FAO et al. (2011) for a joint statement by several multilateral organizations against large-scale biofuel production based on food crops, and HLPE (2013b) for the call of a high-level panel of experts gathered by the FAO for further sustainability policy-making on biofuels.

unwillingness to compromise has been credited partly to its decreasing status as a world power and fears of being overtaken by emerging economies, notably China (Gupta 2010; Hurrell and Sengupta 2012; Roberts 2011). Finally, agriculture, too, is perceived by many countries as a strategic sector for employment creation, foreign exchange earnings, or cultural and landscape conservation (see Potter 2006; Piketty et al. 2009). Unsurprisingly, it has hindered advances in the Doha Round of negotiations under the WTO, which is ongoing since 2001 (Clapp 2006). Therefore, even though environmental changes and an increasingly interdependent economy have turned energy and agricultural sectors into global concerns, their strategic nature has curtailed international regime formation attempts.

This analysis thus suggests that, even in the presence of ample scientific evidence, of domestic policy externalities perceived as negative, and of possibly mutual benefits from multilateral agreements, regime formation on strategic sectors still depends on:

- Reaching a minimum level of consensus about transnational impacts *and* on whether and how to avoid them;
- A willingness to compromise on national sovereignty proportional to the desirability of avoiding those impacts and to the opportunity costs this would create;
- Accommodating for the economic or geopolitical interests associated with the strategic resource sectors being regulated (e.g., finding a substitute strategy).

As biofuels policy meets none of the requirements above, one may ask why there is any biofuel governance at all (see Chap. 4). Arguably, in contrast to regimes, governance requires just like-minded actors to share a common purpose and agree on mutually advantageous strategies (e.g., the US and Brazil seeking to establish a global ethanol market; see Afionis and Stringer 2020). Unlike regime formation, it does not necessarily require agreement on behavior rules, the balancing-out of trade-offs and compromises, or sacrifices of any sort (see Chap. 3). Therefore, non-regimes and non-governance are not determined by the same factors.

9.2.5 Consequences of Inequity: The Relevance of Allocation and Access to Governance

This book has argued that social equity is a normative goal as well as an essential determinant of vulnerability, agency, and a range of other elements relevant to governance. Thus far, the experience with actual bioeconomy development makes a compelling case for taking allocation and access issues more seriously into account.

First, biofuels have shown that lack of attention to allocation and access issues can easily lead to widespread human rights violations. Such violations include not only compromised access to essential resources such as water and food but also to exercising human rights to housing and decent work (see CESCR 1991; International

Labour Conference 2008). These have been particularly critical issues to indigenous peoples and rural communities constrained by large-scale feedstock expansion. Besides lost access to essential resources and often physical violence, under the guise of job creation many have been submitted to unsafe and insecure work conditions, frequently at the expense of their livelihoods.

Second, omission on equity has led to decreased recognition of indigenous and customary property rights. Without social safeguards, biofuel expansion has often been a process of "accumulation by dispossession" (Harvey 2004), transferring *de jure* or de facto control over land, water, and other resources from local communities to private companies or the state. As such, legally recognized land property rights of indigenous peoples are trampled, while land tenure insecurity is exploited instead of being addressed (see also Russo Lopes et al. 2021).

Third, failure to include disadvantaged actors in policy- and decision-making leaves critical knowledge gaps that can compromise bioeconomy value-web development. The jatropha and castor bean experiences showed how lack of consultation led to dysfunctional chains built on incorrect assumptions. They found support among scientists and other formal experts but proved false and would have been clarified if local knowledge had been taken into account. Such knowledge gaps refer not only to traditional know-how but also to a proper understanding of how small-scale farmers and their mixed farming systems operate.

Fourth, lack of political participation decreases social acceptance and may thus compromise bioeconomy development initiatives. The biofuels case has shown that social acceptance is crucial not just from energy consumers (see Wustenhagen et al. 2007; Sengers et al. 2010; Bronfman et al. 2012) but also from producers, who may have trade-offs to make and livelihoods at stake. Lack of acceptance or buy-in usually leads to uncooperative behavior, efficiency losses, waste of public money, and sometimes outright social conflict, as seen particularly in India's experience in "marginal lands." In contrast, participation in decision-making has shown to increase interest and engagement from local actors. They feel their views and preferences are taken into account, as seen in Brazil's earlier biodiesel experience.

Fifth, this research shows that vulnerability aggravates poverty and vice versa, as in a vicious cycle. By lacking proper access to information, capital, and legal processes—or, to put it simply, by being poor—actors are more prone to making disadvantageous bargains, risky deals, and compromises that otherwise they would likely not make. In turn, losing control over their means of subsistence and production (e.g., land, agricultural resources) and being allocated with roles that create excessive risks and dependency (e.g., on one source of income, one buyer), disadvantaged actors become even more vulnerable. Such vulnerability is not only to environmental and socio-economic change but also to making even more disadvantageous deals in the future, as if going down a vicious spiral of powerlessness.

That dynamic reveals the political implications of access and allocation patterns and their close relation to agency. Some multilateral organizations indeed highlight that one of the most noxious effects of poverty is powerlessness (UN ESCAP 2007; UNRISD 2010). Crucially, by being allocated with more burdens, fewer benefits, less control, and less advantageous roles, and eventually having their access to resources hampered further, actors also lose some of their capacity to act. They enjoy less power to pursue their preferred development paths, advocate for policy, or resist and counter mainstream discourses. They become less capable in terms of "power to" and even more susceptible to become victims of "power over" from other, dominant actors. This connection between outcomes and power, in a way, holds the key to explaining why certain biofuel production patterns have prevailed, as discussed in the next section.

9.2.6 Unraveling the Power Spirals

Dimensions of equity, institutional architecture and human agency frequently are studied in separation from one another. However, this research has shown the importance of recognizing how they are functionally integrated and interconnected in governance. As argued in Chap. 3, systemic loops link the outcomes of all three dimensions—adding some complexity to the usual "agent-structure debate," which tends to emphasize the institutional milieu and often overlooks the influence of material dimensions on agency.

Biofuel governance demonstrates that the roots of inequity are often found in agency. Agency, in turn, frequently has an eye on the allocation and access patterns the institutions put in place will foster. Powerful actors have been shown to systematically retain most benefits, to secure the most advantageous roles (in governance and value chains or webs), and to actively keep the underlying foundations of inequality all in place. Inequity and the worsening of inequalities operate through power feedbacks. These feedbacks strengthen actors who already are in dominant positions while further undermining the remaining resources and means of action that weaker actors had so far retained (e.g., communal lands, water access, local forms of organization around their mixed farming systems). In this regard, inclusion has often meant to politically surrender their alternative development visions and preferences in exchange for immediate and otherwise unavailable benefits—a Faustian bargain—in inequitable value chains and exclusive governance arrangements.

The case study chapters detailed how dominant agents utilize both short and long power feedback loops. Through the former route, agents have directly promoted activities that primarily benefit themselves without recurring to institutional entrepreneurship, i.e., without attempting to change the existing institutional setting. That has included agribusiness' unilateral use of material capabilities—or of "power to"—to expand over others the agri-food-biomass systems it controls. Similarly, the direct actions or infrastructural warfare (e.g., land invasions, destruction of crop fields, buildings, or other property) of either agribusiness or peasant movements undermine each other's strength and thereby the impacts created by their activities (see Chap. 5; see also Russo Lopes and Bastos Lima 2020). Meanwhile, long feedback loops, through the institutional setup, have also been extensively present in the emerging bioeconomy governance. They involve various forms of institutional entrepreneurship and policy advocacy (e.g., producing public incentives for the preferred forms of biofuel production). Long feedback loops also work through discursive strategies to sway public opinion and retain governmental support in democracies, such as framing the expansion of large-scale feedstock monocultures as serving national interests.

The conclusion is that prevailing institutions not only reflect the preferences and policy beliefs of dominant actors. They also create a self-reinforcing system involving inequitable distribution, uneven power relations, and biased institutions designed to perpetuate such inequity *ad aeternum*. At least until external factors or transformative innovations break the loops. However, these transformative institutional innovations have been scarce in bioeconomy value webs, as the sector so far has concerned itself mostly with technical improvements (Sanz-Hernández et al. 2019).

In the emerging economies analyzed, the multi-layered explanation of why unsustainable biofuel production patterns have prevailed can thus be synthesized as the following. The main culprit has been domestic public policies underpinned by two fundamental biases: (i) a bias towards urban-centered development, and (ii) norms that fail to account for social equity or environmental concerns other than climate change mitigation and wild biodiversity conservation. In turn, these institutions result from the superior agency of powerful private actors (notably agribusiness) who benefit from the status quo and from the dominance of state actors who prioritize (international) equalizing development over domestic equity promotion or environmental protection. This prioritization should not be simplistically regarded as the pursuit of economic growth or "development." Rather, it emerges from clusters of economic and political ambitions of historically disadvantaged countries in an unequal international context. These ambitions also include promoting endogenous technological innovation, reducing vulnerability to price shocks and undue foreign control, and gaining greater geopolitical influence. However, for that, states have frequently depended on private agribusiness to provide financial, technological, and production capacity to attain those goals. Thus, biofuel production in emerging economies helps bridge the gap that separates them from developed countries, but unsustainably and with a great deal of elite capture. Without intervention, this is likely to remain unchanged in any further bioeconomy development.

9.2.7 Implications for Bioeconomy Promotion

Bioeconomy strategies are likely to become increasingly prevalent. While biofuels may be just a stepping-stone towards more advanced renewable energy technologies, a transition towards multipurpose agriculture and the development of biomass-based industrial sectors arguably are here to stay (Bastos Lima 2018). Biofuel policies and production, therefore, are all the more critical as they establish the basis and create path dependencies for all future bioeconomy development.

The experience with biofuels shows that not only environmental change but also the strategies devised to address this change produce unequal outcomes with clear winners and losers. This ongoing experience already offers both technical and political lessons. The technical lesson is that, without explicitly incorporating social equity requirements and multiple environmental criteria, labeling development initiatives as "green" or as part of a bioeconomy is likely to give undue legitimacy and thrust to unsustainable practices. The main risk is to overemphasize the issue that helps drive the "green" strategy (as climate change has done to biofuel production or marine pollution could do for bioplastics) and overlook all the rest. This risk also exists in other forms of renewable energy promotion, frequently assumed to be automatically sustainable. Social dimensions are particularly vulnerable because economic inclusion without political participation is likely to be on terms that favor the stronger actors who set the agenda. As the focus has been on absolute standards (i.e., poverty reduction or eradication) rather than relative ones (i.e., equity), inequitable power and economic relations can remain unaddressed or may even be fostered.

The political lesson is that the predominance of such a biotechnology-centered, conservative ecological modernization disproportionally benefits some actors while marginalizing alternative sustainable development views. As such, it should not be regarded uncritically as something politically neutral. However marketed as driven by altruistic interests in poverty reduction, global development or the environment, large-scale biofuel production has been promoted mainly by actors who economically and politically benefit from it. While promoting that reformist approach of conservative ecological modernization, these actors have limited the expression of more radical views by either co-opting or robbing weaker actors of their material *and conceptual* means of staking claims and advocating for alternatives. That includes access to natural resources and public finances as much as "tamed" interpretations of initially critical concepts such as social inclusion, empowerment, and participation.

Without a change of course, the promotion of a bioeconomy is likely to exacerbate social and political inequities. From an environmental perspective, purported "solutions" might turn out worse than the problems they aim to solve. The way ahead does not require rejecting the bioeconomy per se but how it has been promoted, without taking social equity and political dimensions into account. Only by integrating these dimensions can governance institutions be redesigned to promote full-fledged, socially transformative sustainable development.

9.3 Promoting a Fairer Bioeconomy

9.3.1 Better Institutions for Sustainable Bioeconomies

Institutional redesign can substantially improve the sustainability of biofuel production and other emerging bioeconomy sectors. It requires shifting policy incentive patterns *and* the underlying norms that have shaped the development paths considered (see Finnemore and Sikkink 2001). This section starts with general recommendations for sustainable bioeconomies, then it narrows down to rural and agricultural contexts, and finally to biofuels specifically.

First, to improve equity in governance and production processes, sustainable development theory may need to express its social requirements more clearly. That might be particularly key for emerging bioeconomy sectors, which have sustainability at heart almost by definition. The concepts of allocation and access offer a useful analytical framework, but clear normative principles are also needed. Such principles are particularly necessary for allocation, as access (in its absolute terms, i.e., as minimum standards) already counts on a human rights framework that is widely accepted (even if insufficiently implemented). In contrast, there are no such widely embraced principles on tackling inequality, except through taxation of the rich and subsidies for the poor—and still facing widespread resistance in low- and high-income countries alike. Globally, official development assistance tries to deal with some inequality elements, but it is far from sufficiently addressing the problem.

Therefore, as argued in Chap. 3, Rawls' (1971) principles of difference and redress—stating that inequalities are only acceptable when to benefit disadvantaged ones and that undeserved inequalities invite redressing—could well serve to underscore sustainability policy. In practice, this also requires changing the prevailing norm of seeking economic without political inclusion and limiting empowerment to economic empowerment (i.e., poverty reduction). For in their political senses, inclusion and participation require gaining a measure of *control* over resources and governance institutions from which actors were previously excluded (Stiefel and Wolfe 1994, p. 5; Cornwall and Brock 2005; Cook et al. 2012; UNRISD 2016). Likewise, empowerment requires reconfiguring power relations to reduce vulnerabilities and inequities (Zimmerman 2000; Cornwall and Brock 2005; McEwan and Bek 2006; Cook et al. 2012; UNRISD 2016). That means including weaker actors in agenda-setting and decision-making positions, realizing they have particular preferences, worldviews, value systems, and a right to self-determination. Participation would thus empower them to improve control over the resources on which their livelihoods depend. Similarly, it would enable them to pursue their preferred development paths and "varieties of environmentalism" (Guha and Martínez-Alier 2000) rather than adopt and follow alien approaches based on others' norms and interests. This application of Rawls' principles at the political level to redress historical political disempowerment can, in turn, lead to the embodiment of equity also at the economic level through production systems that genuinely benefit the poor.

Besides incorporating such equity considerations, more sustainable outcomes would also require that bioeconomy policies broaden their considerations of environmental issues. Issues such as agrobiodiversity, soil degradation, and impacts on the nitrogen cycle have been comparatively overlooked in mainstream sustainable development parlance and policy-making. That has led to unsustainable energy and agricultural production that, nevertheless, gets labeled as "green" or environmentally sound solely based on being renewable and because of their anticipated (but not always confirmed) climate benefits. It should be clear that "renewable" is not necessarily a synonym for "sustainable." Environmental assessments and green profiling need to take multiple criteria into account, such as perhaps the whole set of "planetary boundaries" (Rockström et al. 2009)—or of the "planetary doughnut," inclusive of social issues (Raworth 2017)—rather than seeking legitimacy based only on one or two indicators. The UN Sustainable Development Goals have tried to represent this plurality of concerns to be regarded even if they, too, have been markedly vulnerable to cherry-picking by actors who then claim to be addressing the whole of sustainability (Siegel and Bastos Lima 2020).

In the specific case of agriculture, it is crucial to shift its current productivist orientation and the prevailing urban bias. It is well-known that sustainability requires a transition from input-intensive monocultures towards agroecology and mixed farming, potentially building upon indigenous and peasant systems (Tilman et al. 2002; IAASTD 2009; Altieri and Toledo 2011; Horlings and Marsden 2011). More recently, the global assessment report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services has made vividly evident the need for transformative change in agriculture (IPBES 2019). Furthermore, sustainable rural development requires that rural areas be developed not as corporate-controlled resource pools drained for urban consumption but as living places with decent employment, infrastructure, and access to services. That requires enhancing both physical and institutional capacities in rural communities. It means expanding the focus from productivity gains to promoting local value-added and various forms of environmentally sound rural industrialization. Effective bioeconomy strategies can lift smallholders from the condition of mere raw material providers and also improve non-agricultural jobs in the countryside, which already constitute relevant income sources but are frequently sub-standard (Renkow 2000). In parallel, farmer cooperatives can provide the necessary institutional and local organizational capacity, facilitating knowledge sharing, collective bargaining with government and private actors, and political agency. Such an inclusive and equitable bioeconomy agenda could significantly contribute to promoting sustainable food security and healthy communities in the countryside (see Bastos Lima 2008).

States have vital roles to play—and democratic duties to fulfill—financing and supporting that transition. However, their willingness and capacity are both limited. Emerging economies, in particular, will hardly let go of their aspirations to equalize with highly industrialized countries. To meet sustainability demands without compromising production capacity and trade, the transition could be gradual and first reduce large-scale agricultural production's negative impacts. Private certification systems seek that, but to work at scale and have greater effectiveness such requirements would need to be turned into public policy and become conditions for incentives (Lambin et al. 2018). Still, developing states often depend on (frequently foreign) private agribusiness's material capabilities, and the latter is unlikely to foster alternative agricultural systems that empower small farmers (Bastos Lima and Persson 2020). That is particularly the case for value-adding technologies. Therefore, a way forward would be to increase investments in publicly owned technologies—as has been done to protect other public goods such as healthcare. As such, agribusiness dominance may be checkered for the public interest in the same way done to big pharmaceutical companies by developing generic drugs—approaches that emerging economies such as India and Brazil are very familiar with (see Brezis 2008).

9.3.2 Policy Lessons for Sustainable Agri-Food-Biomass Systems

The bioeconomy offers a significant opportunity to promote sustainable rural development. That, however, requires shifting policy incentives away from corporate-controlled feedstock monocultures and towards diverse agri-food-biomass systems. Ideally, such systems should be based on agroecology and equitable allocation of rights, roles, benefits and burdens that favor disadvantaged actors such as rural communities. In practice, that requires: (i) organizational support and the political inclusion of smallholders in bioeconomy value-web governance to ensure due representation of their views and preferences; (ii) mixing food and feedstock cultivation for greater agroecological and economic diversification, as well as to safeguard local food security; (iii) locally controlled value-added, such as local ethanol distilling, vegetable oil extraction, and biofuel or bioproduct manufacturing, to promote technological development and distribute benefits more equitably. Value-added processing would give farmers higher revenues and leave them with co-products (e.g., oilseed cake, glycerin) that can be used locally or sold in other markets. In time, this could be complemented with new bio-based downstream industries to increase the bioeconomy's benefits even further.

Such goals require public financial, technological, and logistical support. As biofuel and other biomass production systems already rely heavily on public policies, it becomes a matter of tuning such incentives. For one, public R&D could diversify from its nearly exclusive focus on agribusiness crops for large-scale production and also develop suitable technologies for small-scale farmers. In turn, extension services could complement science with traditional knowledge rather than continuously attempt to replace it in a quasi-missionary fashion. Economic incentives could become conditional on meeting specific social and environmental standards based on equitable smallholder inclusion and agroecological indicators (e.g., local capacity enhancement, income generation, water conservation, nutrient cycling).

Furthermore, decentralized biofuel production systems may deserve more exploration. They include small-scale manufacturing for local fuel consumption and collectively owned biofuel industries to feed into the market. Joint, collaborative ownership and control are not unusual to farming sectors in developed countries. Such endeavors would not necessarily require direct subsidies, but they certainly demand credit to cooperatives, technical support for meeting fuel quality standards, and public investments in infrastructure. Similar arrangements can exist for other bioproducts, too. However, sustainable bioeconomy value webs anchored on agri-food-biomass systems need careful design and sufficient experimentation with feedstock crops *before* promoting them commercially to smallholders to avoid exposing the latter to unnecessary risks.

Agency to achieve such policy changes will invariably depend on the opportunity structures of each context. Nevertheless, a rule of thumb is that critics of mainstream biofuel production are unlikely to succeed without offering alternative ways of providing for renewable energy and rural development needs. Ideally, such actors should conceive, test, and replicate ideas and designs for sustainable bioeconomy value webs. For that, they need to form coalitions and seek resource complementarity with other like-minded actors. Contender coalitions must carefully shop for the best venues available and exploit windows of opportunity—both regular political opportunities and fortuitous events—which may give them additional visibility (Huitema et al. 2011).

9.3.3 Improving International Bioeconomy Governance

Biofuels are *not* a case of non-governance (Bastos Lima and Gupta 2013). A fledgling bioeconomy governance therefore exists. However, the absence of a regime and the narrow treatment of such products purely as economic goods have left a large governance vacuum that can be problematic in the face of the severe social and environmental issues at stake. Despite extensive lip service paid to sustainability issues, these have, in reality, all been left to the market or individual countries to resolve—however limited their capacity may be. That may prove dangerous because it does not account for the global impacts of domestic biofuel policies. As argued in Chap. 4, food-insecure countries can do little if bioeconomy policies from major agricultural producers affect international food prices (see Clapp 2009). Other global environmental impacts, such as the cumulative effects of land-use change, may need greater governance attention (see Rockström et al. 2009). At the same time, addressing sustainability issues unilaterally as the EU has tried to do seems paternalistic and biased towards European priorities. Arguably, such extraterritorial control is also unfair to those who are affected but have no say in the drafting of sustainability policy (Bastos Lima and Gupta 2014).

Still, as argued earlier in this chapter, a multilateral biofuels regime is unlikely to be formed any time soon. As such, rather than attempt to detain the inevitable transition towards multipurpose agriculture and the bioeconomy, governance efforts may be more effective—and find higher political viability—focusing on *adaptation* measures that address the vulnerability of poorer countries. Adaptation is vital not only in the face of ecological changes but also of the socio-economic changes underway (in this case, possibly higher agricultural commodity prices). Non-staple cash crops such as coffee, cocoa, cotton, or flowers have long diverted resources away from food production without being vilified for that. Instead, and especially given that most of the world's poor live in rural areas, governance attention seems much more needed on promoting sustainable bioeconomy systems. In this sense, for the sake of greater resilience, too, it is critical to promote agri-food-biomass systems that reduce rather than augment smallholders' exposure to price fluctuations (see Clapp and Moseley 2021).

9.4 Avenues for Further Research

Although this book has globally appraised the phenomenon of biofuels expansion as the most advanced proxy for the bioeconomy, its in-depth analysis has focused principally on emerging economies. Further research may use this analytical framework to assess how biofuel or bioeconomy politics has varied in highly industrialized countries or less developed countries. That would give information on those particular contexts and help point out differences and similarities between these country groups—offering an up-to-date understanding of the current global context beyond simple North-South bipolarity.

Further research could also expand the scope of socio-political analysis to next-generation biofuels and other novel bioproducts such as bioplastics. So far, these newer products have been assessed mostly in technical terms and, to a lesser extent, ecological and economic ones. However, their expansion requires research on what related institutions are emerging, the agents behind their promotion, and the impacts of their eventual large-scale uptake on allocation and access. These sectors can be examined within themselves and in terms of the socio-political feasibility and implications of a broader bioeconomy transition.

Lastly, there is a clear need for more research on the socio-political dimensions of sustainable development governance. The spread of a sustainability paradigm and bioeconomy promotion makes that need even more urgent, as a focus limited only to technical "solutions" might create worse cures than the diseases they aim to address. It is critical to know who controls those cures. In other words: who owns, does, and gets what in each of the various emerging "green" sectors within the bioeconomy and beyond.

9.5 Final Considerations

Although biofuels and the bioeconomy offer significant sustainable development opportunities, this book has argued that the agenda has been "locked" by dominant state and agribusiness actors down on an unsustainable path. It has shown that allocation and access issues cannot be dissociated from agency and governance architectures, for those issues feed back into agency and architectures, and significantly influence them. Therefore, any development approach—irrespective of labels such as "green" or "sustainable"—must also be understood as a political project. Pretended political neutrality silently maintains the status quo by reducing critical concepts such as participation and empowerment to a purely economic sense and sustainability to superficial technocratic refurbishing. In truth, dominant coalitions are hesitant to cede political power to subordinate actors, fearing losing their privileged positions and control over the agenda. That fear is justified, for other actors would indeed do things differently.

However, the global expansion of biofuels may have made "disguised unsustainability" stretch too far. By aggravating mainstream agriculture's negative social and environmental impacts, biofuel policies have helped highlight giant elephants in the room. There is no reason why the more substantial scrutiny dispensed to feedstock crops should be limited to these markets and not extended to other agricultural sectors—or even to the same crops when used for other purposes. Biofuels and the bioeconomy thus offer a window of opportunity for a ripple effect towards greater sustainability. The cure may turn out not worse than the disease but reveal larger problems that need addressing—a wake-up call. All this, therefore, may be just the start.

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