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Toward sustainable agriculture in the tropics

James Erbaugh^{a,*}, Rosina Bierbaum^b, Guillermo Castilleja^c, Gustavo A.B. da Fonseca^d,
Steffen Cole Brandstrup Hansen^d

^a Department of Environmental Studies, Dartmouth College, Hanover, NH 03755, United States

^b School for Sustainability and Environment, Ann Arbor, MI 48109, United States

^c Gordon and Betty Moore Foundation, Palo Alto, CA 94304, United States

^d Global Environment Facility, Washington, DC 20006, United States

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ABSTRACT

Wide-scale transformation promoting sustainable agricultural production in the tropics will be crucial to global sustainability and development. Although contemporary agricultural production has increased alongside international demand, it has resulted in extensive changes in land cover, often at the expense of tropical forests and other native habitats. Conservation and development professionals from civil society, private foundations, multilateral and specialized international agencies, along with academic organizations and, increasingly, the private sector, have cited the urgent need to transform tropical agricultural production to meet current and future food needs without compromising environmental, economic, and sociocultural outcomes for present and future generations. This introduction identifies the processes by which sustainable agricultural production is being implemented and scaled-up in the tropics. We propose a typology that, in broad terms, conceptualizes the implementation of sustainable agriculture in the tropics. Together, these articles demonstrate that implementing the sustainable production of agriculture often occurs through hybrid governance, with actors from the public sector, private sector, and civil society working together to define and implement interventions. Evaluation of sustainable agriculture production in the tropics often relies upon transdisciplinary teams that bring data, analysis, and firsthand knowledge together. Future research would do well to focus on sustainability outcomes as a combination of environmental and human well-being indicators; the composition and outcomes of different intervention mixes; and how implementation cycles influence subsequent definition, governance, and evaluation of sustainable agriculture in the tropics.

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1. Introduction

Sustainable agricultural production is essential to balancing the needs of current and future populations. The benefits of modern agriculture have been significant, keeping food production in step with population growth¹. This parity is partly explained by improvements in productivity, but in tropical countries agricultural expansion is a primary driver of deforestation and land degradation

(Foley et al., 2011; Kastner, Jose, Rivas, Koch, & Nonhebel, 2012; Rudel et al., 2009). The environmental, economic, and social costs of agriculture expansion in the tropics have been significant. Over three-fourths of pre-modern tropical forests are no longer intact and over half are fragmented (Haddad et al., 2015; Pan et al., 2007). Approximately 12% of total global CO₂ emissions are the direct result of deforestation (Friedlingstein et al., 2010), tropical forest loss generated CO₂ emissions greater than those of the entire European Union (Seymour & Busch, 2014), and CO₂ emissions from tropical forests rose to historical heights between the years of 2015 and 2017 (Gibbs, Harris, & Seymour, 2018). Agriculture is the single largest driver of tropical forest and biodiversity loss (Edwards, Tobias, Sheil, Meijaard, & Laurance, 2014). Economic and sociocultural costs of tropical forest cover change also include the loss of ecosystem services provided by forests (Henders, Persson, & Kastner, 2015; Lewis, Edwards, & Galbraith, 2015) and conflict with forest-dependent communities (Dhiaulhaq et al., 2014; Gritten,

* Corresponding author at: 107B Fairchild Building, Department of Environmental Studies, Dartmouth College, Hanover, NH 03755, United States.

E-mail addresses: james.t.erbaugh@dartmouth.edu (J. Erbaugh), rbierbau@umich.edu (R. Bierbaum), Guillermo.Castilleja@moore.org (G. Castilleja), gfonseca1@thegef.org (G.A.B. da Fonseca), shansen@thegef.org (S.C.B. Hansen).

¹ The parity population growth/food production represents a global average which conceals the sharply uneven distribution of the benefits. Approximately 1/7th of the world population remains malnourished (Food and Agriculture Organization, 2009; Thurow & Kilman, 2009).

Mola-yudego, Delgado-matas, & Kortelainen, 2013; Mola-yudego & Gritten, 2010). These high costs challenge the viability of an agricultural model defined by increasing agricultural land cover at the expense of forests and native habitat. However, minimizing environmental externalities of the agriculture sector will be particularly challenging amid continued population growth, which is expected to peak by mid-century, coupled with a growing global middle class. These trends will require doubling food production from today's levels (Foley et al., 2011). For transformation to take place in tropical agriculture, the current and future pattern of commodity production must cease to depend on expanding the area of intensive agricultural land cover.

Support for sustainable agricultural production in the tropics is growing. In the public sector, countries with some of the greatest contemporary tropical forest cover loss have adopted policies that make different forms of forest cover change illegal (Busch et al., 2014; Roitman et al., 2018; Soares-filho et al., 2014). The private sector has witnessed a recent and stark increase in verifiable, deforestation-free commodity production. In 2009, approximately ten multinational companies had publicly announced specific targets to reduce or eradicate tropical deforestation from their supply chains (Peters-Stanley, Donofrio, & McCarthy, 2015). Today, over 400 companies have made similar public pledges, with a combined market capitalization of over USD 6 trillion (Donofrio, Rothrock, & Leonard, 2017). Affinity groups like the Consumer Goods Forum, and international fora like the 2014 New York Declaration on Forests, provide a safe platform for industry actors to address pre-competitive implementation issues stemming from their commitments. Civil society has contributed to sustainable agriculture in the tropics through political support of representatives implementing change, involvement in multi-stakeholder initiatives that shape private sector standards, consumption habits, and grassroots/community organizing (Thorlakson, Zegher, & Lambin, 2018).

It appears that with the right mix of legal, market, and information reforms, major shifts toward the implementation of sustainable agriculture in the tropics is possible. However, the implementation of sustainable agriculture practices is not sufficient for guaranteeing sustainable outcomes, particularly the transformation of food systems (Henders, Persson, & Kastner, 2015; Lambin et al., 2018). Thus, as multisector commitments grow and communities around the world adopt different standards, many questions remain about how sustainable agriculture is defined, governed, and evaluated. This special issue provides information on how, where, and with what outcomes sustainable agriculture is being implemented in the tropics.

The implementation of interventions aimed to increase the sustainability of agriculture can be conceptualized in three general stages (Fig. 1). First, a set of actors—either within or across the public and private sectors and civil society—determine a definition of sustainability and how this definition translates into objectives. As an essentially contested concept, sustainability requires redefinition regarding its application (Gallie, 1955). Defining sustainable agricultural production demands geographical and temporal context (Mog, 2004). There are hundreds of different standards by which sustainable agriculture is defined, and although it represents best practice, pairing definitions with measurable objectives is not yet commonplace (Lambin et al., 2018; Rasmussen, Bierbaum, Oldekop, & Agrawal, 2017). The second stage for implementing sustainable agriculture production focuses on governance. Through a combination of rules and norms (North, 1990; Ostrom, 2005), actors and related associations implement new laws or policies, economic or social incentives, and/or information provision (Agrawal, Hajjar, Liao, Rasmussen, & Watkins, 2018; Lemos & Agrawal, 2006). These three forms of intervention are not available to all actors or organizations, but sectoral actors and organizations often bundle them together to generate policy mixes intended to steer agricultural activity toward a definition of sustainable production (Lambin & Thorlakson, 2018; Newton, Agrawal, & Wollenberg, 2013). Finally, in the third stage, actors seek to monitor and evaluate interventions aimed at promoting sustainable agriculture in the tropics. The methods used for evaluation and how this information is shared are crucial in this process (Merry, 2016).

This conceptualization of implementing sustainable agriculture is subject to many of the same critiques of policy stages theory (Sabatier, 2007). For example, it does not address how actors and organizations determine definitions, interventions, or evaluation strategies; it in no way seeks to infer causality (i.e. definitions lead to implementations); and it cannot identify the many interactive cycles that define the implementation of sustainable agriculture (Nakamura, 1987; Sabatier & Jenkins-Smith, 1993). It does, however, provide an organizing function useful for the study of how sustainable agriculture is implemented and this special issue that promotes comparison, evaluation, and critique of the contributions individually and as a whole.

2. Sustainable agricultural production in the tropics

This special issue limits consideration to the production of internationally traded agricultural commodities common to wet

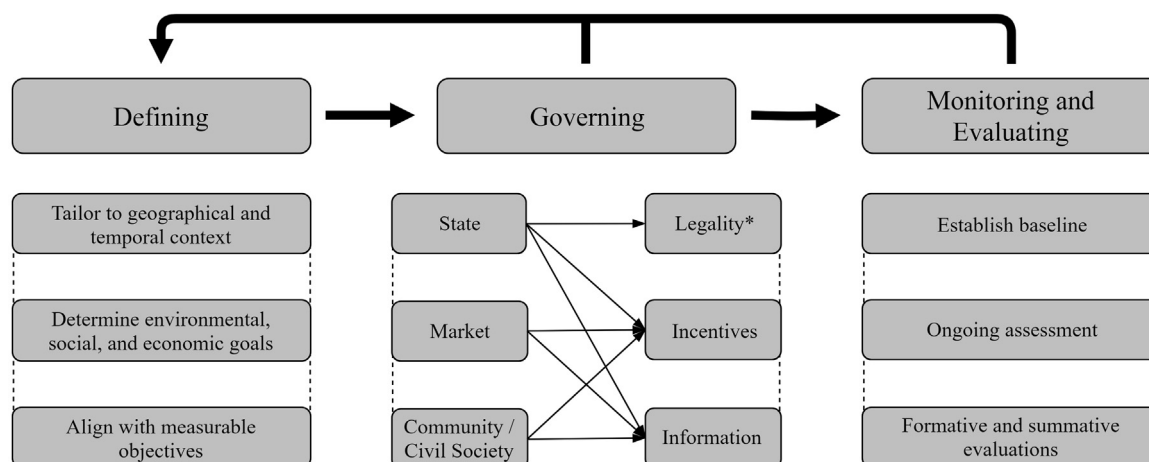


Fig. 1. Typology of implementing sustainable agriculture practices. *Interventions based in "legality" refer to formal rules that deal with scoping and aggregation of resource use (Ostrom, 2005).

tropical forest ecosystems. Thus, it is neither particularly relevant to agricultural production in the dry tropics or non-forest ecosystems, nor does it address the sustainable production of subsistence or commercial crops that are primarily used and/or traded locally. The editors imposed this limitation to produce a tractable and coherent body of contemporary research on the most important drivers of forest cover change with the greatest relevance to biodiversity conservation and climate change mitigation (Gibson et al., 2011; Lambin & Meyfroidt, 2011; Pan et al., 2007). Between the years 2000 and 2011, soy, beef, palm oil, and timber products alone accounted for 40% of all forest cover change in the seven countries with the greatest rates of forest cover loss, most of which was in wet tropical forests (Henders et al., 2015). Addressing the sustainability of producing internationally traded agricultural commodities in wet tropical forest ecosystems will require multisector collaboration to change some of the most lucrative production systems in the world.

The necessity of wide, multisector collaboration on sustainable agriculture production in the tropics motivated the publication of this special issue. The guest editors, who include representatives from practitioner, funding, policy, and academic organizations, invited contributions from a similarly diverse set of professionals. Invited professionals similarly included policymakers, practitioners, and researchers. The set of manuscripts presented here represent the best of their contributions. Individually, each manuscript examines different aspects of defining, governing, and monitoring/evaluating sustainable agriculture production in the tropics. Together, they establish a body of contemporary knowledge, current limitations, and future directions for the sustainable production of agricultural commodities in the tropics.

2.1. Defining sustainable agriculture

The implementation and study of sustainable agriculture production in the tropics are predicated upon formal and informal definitions. Definitions of sustainability range from global to local scales. Nested definitions often increase in specificity, adding environmental and social goals as well as measurable objectives as scale decreases. To facilitate monitoring and evaluation, environmental and social goals can be paired with measurable objectives.

This special issue advances current literature on the definitions of sustainable agriculture in the tropics through research on how different commodity sectors establish working definitions of sustainable production and how those definitions translate into practice. First, evidence across sectors finds that definitions for sustainable agricultural production are often driven by the private sector, with occasional co-optation of sustainable standards by the public sector (Lambin & Thorlakson, 2018). In this special issue, Buckley, Newton, Gibbs, McConnel, and Ehrmann (2018) provide a comprehensive examination of roundtables for sustainable beef and their associated multi-stakeholder initiatives. Many of these roundtables seek to provide standards for the sustainable production of beef, including zero deforestation commitments, supply chain initiatives, as well as promoting information sharing and tracking. Second, sustainability definitions may arise from the public or private sector, but they are a product of interrelated state and market forces. Pye (2018) examines sustainability standards related to oil palm certification in Southeast Asia, demonstrating how current roundtable sustainability standards preference industrial production processes and come at the cost of local empowerment. Research in this special issue further exemplifies the diversity of definitions for sustainable agricultural production, which vary from unmeasured voluntary standards, as with many roundtable agreements, to legally mandated production rules, as with national forest codes (Buckley et al., 2018; le Polain de Waroux et al., 2017; Pye, 2018). Other contemporary research on

sustainability standards for agricultural production reinforces the diversity in stakeholders, formality, standards, and objectives across nations and sectors illustrated in this issue (Rasmussen et al., 2018).

2.2. Governing sustainable agriculture

The process of steering agricultural production to sustainable outcomes is achieved through different combinations of state, market, and civil society interventions. Archetypal roles that define the public sector, private sector, and civil society often differ in the practice of implementing sustainable agriculture interventions. Fig. 1 identifies how the state (public sector), market (private sector), and community (civil society) are related to three forms of intervention: legality, incentives, and information. Through these different interventions, political, corporate, or civil society actors seek to implement a definition of sustainable agriculture production.

Sustainable agricultural production in the tropics is often implemented through hybrid governance (Lemos & Agrawal, 2006). Hybrid governance refers to mixes of interventions that occur through states, markets, and civil society. Groups of market-based and/or political actors often establish definitions for the sustainable production of a commodity (Buckley et al., 2018; Gardner et al., 2018; le Polain de Waroux et al., 2017; Pye, 2018). A combination of formal policies and non-state market-driven incentives (Cashore, 2002; Cashore, Auld, & Newsom, 2004) often comprise governance interventions that seek to promote sustainable agriculture production in the tropics. Though occasionally part of roundtable discussions (Buckley et al., 2018), community or civil society groups most often serve a watch-dog function. Civil-society actors are not often directly involved in the full process of implementing sustainable agriculture production, including definition as well as implementation (Buckley et al., 2018; Gardner et al., 2018; Pye, 2018). Manuscripts in this special issue provide several lenses from which to understand and critique this general trend.

This special issue includes research on state-led as well as non-state marked driven interventions for sustainable agriculture production in the tropics. Le Polain et al. (2017) examine the effect of environmental regulation aimed at conserving forest cover in South America, on soy and beef production and trade across different forest biomes in Brazil, Argentina, Bolivia, Paraguay, and Uruguay. They also examine how differences in regulation strictness on forest cover change affects pasture and soy expansion over time and across different forest biomes. Buckley et al., 2018 examine the process by which roundtables for sustainable beef, operating through multi-stakeholder initiatives, seek to influence commodity production through the attainment of “political legitimacy” (Bernstein & Cashore, 2007). Pye (2018) focuses on the way in which the public and private sectors work together to define and implement sustainability standards for oil palm in Southeast Asia, and how this form of hybrid governance occludes involvement of civil society. Gardner et al. (2018) show how commitments to zero deforestation hinge on corporate transparency and the provision of information. Although each of these contributions provide a different angle from which to examine the governance of agricultural sustainability in the tropics, they together demonstrate the varied mix of intervention types and tactics used. Further, they each raise questions about the appropriate role of civil society in the creation and implementation of standards.

2.3. Monitoring and evaluating sustainable agriculture

Monitoring and evaluating sustainable agriculture proceeds through baseline assessments that inform summative and forma-

tive evaluations. Outside the narrow scope of implementing sustainable agricultural production, monitoring and evaluation of sustainability indicators—biodiversity, carbon sequestration, socioeconomic resilience, etc.—provides valuable information which can inform agriculture monitoring and evaluation more broadly. It is in this stage that transdisciplinary teams often form to combine knowledge with impact estimates to understand the mechanisms and effects of sustainable agriculture interventions.

As the papers in this special issue demonstrate, monitoring and evaluating sustainable agriculture production relies on the availability of information. Gardner et al. (2018) provide a comprehensive assessment of the operationalization and evaluation of zero deforestation commitments. They highlight how supply chain transparency is vital for ensuring that such commitments are more than posturing. Le Polain et al. (2017) and Chaudhary and Brooks (2017) complement findings by Gardner et al. (2018) through their respective evaluations of land cover change and biodiversity loss resulting from agricultural production. Le Polain et al. (2017) find that, except for pasture expansion in the Amazon, soy and pasture expansion patterns were unaffected by changes in forest conservation regulations; however, beef imports from forest biomes with more stringent regulations demonstrate a significant decrease. Chaudhary and Brooks (2017) use a species-area relationship model to show that the tolerance of endemic species to human induced land cover change is lower than non-endemic species. They further highlight countries with high levels of projected extinctions and how different trade flows and agricultural practices project certain species extinctions by taxa. Understanding the effects of agricultural production in the tropics is vital; understanding how those effects are generated and subsequently how they might be moderated or mediated by governance that focuses on sustainability requires transparency in agricultural production, political processes, and trade flows.

3. Future directions for research and sustainability in practice

Continued, multisector, and transdisciplinary efforts are necessary to implement and improve sustainable agriculture production in the tropics. As the demand for food increases, questions of how and where food is produced and with what effects for people and environment will increase in importance. The manuscripts in this special issue point to a variety of topics that can contribute to the study and evaluation of sustainable agriculture production in the tropics.

Articles within this special issue demonstrate the importance of understanding how actors operating through the public sector, private sector, and civil society interact to generate definitions, working standards, and commitments to sustainable agriculture production. This special issue raises questions about the role of civil society within multi-stakeholder initiatives; how commitments are formed in relation to corporate transparency; when, where, and why commodity roundtables enact rigorous standards; and how definitions result in the operationalization of sustainable practice. Absent from this special issue is a focus on how scale influences definitions at different administrative levels within and across national contexts; how timeframes and considerations of intergenerational equity are reflected in different sustainability definitions; and how civil society has defined sustainability standards beyond the local level. Although current research has outlined the diversity and types of definitions, standards, and objectives related to sustainable agricultural production, it is yet to fully engage with how definitions and their subcomponents are formed, by whom, with what focus, and with what outcomes for governance and evaluation.

This special issue advances research that shows the implementation of sustainable agricultural production relies on hybrid

governance structures. The way in which public sectors, private sectors, and civil society to generate interventions is a growing field of research within land change science and environmental social science more broadly (Lambin et al., 2014; Meyfroidt et al., 2018; Turner, Lambin, & Reenberg, 2007). Understanding the different types of policy mixes that are being implemented in different geographical contexts can help identify opportunities for studying sustainable and adaptive governance (Agrawal & Carmen Lemos, 2015). Research beyond this special issue can focus on interactions within public sectors, private sectors, and civil society that contribute to how interventions related to sustainable agriculture production unfold across space and time. Additionally, important examples of sustainability governance from a variety of important tropical crops, including rice, sugar cane, coffee, and cacao, among others, are not featured here. Research that examines different policy mixes for the sustainable production of tropical agricultural commodities will remain a vitally important field in sustainability science.

Future research on sustainable agriculture production in the tropics will combine socioeconomic and environmental data to understand how sustainability governance affects important outcomes, including human well-being, biodiversity, livelihoods, and land cover change. Contributions in this special issue that examine outcomes focus on environmental indicators, a trend common in the wider literature on sustainable agriculture and land cover change. The availability of spatially explicit and high-resolution data to examine environmental outcomes surpasses that of socioeconomic data (Yue, Gao, & Yang, 2014). Beyond the need to examine social and economic sustainability with quantitative data, the contributions to this special issue and the larger literature on sustainable agriculture production in the tropics often do not include the voices of those who are directly affected by and practice sustainable agriculture (Janker, Mann, & Rist, 2018). These two future areas for research are related. Including the voices and views of people most affected by sustainable agriculture interventions can assist in operationalizing and evaluating the social and economic sustainability of tropical agriculture.

The future of defining, governing, monitoring and evaluating sustainable agriculture in the tropics will require dedication from professionals in a variety of fields. This special issue was written by academic, conservation, development, policy, and grant making professionals. Although the authors do not provide an exhaustive set of professionals, together their diverse insights advance knowledge about sustainable agriculture in the tropics. Future research endeavors would do well to similarly appeal across professional lines to address topics that are inherently transdisciplinary and of vital importance.

Declaration of Competing Interest

The authors declare no conflicts of interest.

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