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Sine Qua Nons of Sustainable Bioenergy: Distilling Implications of Under- Performance for National Biofuel Programmes

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Abstract

Biofuels have been promoted worldwide under the assumption that they can support several transformative yet unresolved policy goals, such as transitioning towards a more secure and climate-friendly energy system, while delivering other co-benefits to workers and rural communities. Drawing on the best published evidence to date on performance, a set of companion papers¹ question many of the assumptions commonly attributed to biofuels: their carbon neutrality, their positive effect on rural livelihoods, and (in cases of under-performance) policymakers' ability to effectively govern for sustainability. This paper takes these findings as its starting point and asks, "What next?" for countries wishing to advance national biofuel programmes as one of several options for the necessary divestment from fossil fuels. Deriving recommendations for national biofuel programmes based on past performance is no easy task. The wider literature highlights some of the challenges to such an endeavour – namely, that context matters deeply in shaping outcomes, thereby undermining the potential for standardised solutions; that social and natural systems are complex, rendering interventions indeterminate in their effects; and that deriving proscriptions for future action based on evidence of past performance requires leaps of evidence and faith, thus involving moral hazards. And even in cases where biofuels come close to meeting expectations, taking these successes to scale poses additional challenges inherent in the scaling process itself. By drawing on evidence of performance and the wider literature on change management, we are nevertheless able to distil a set of *sine qua nons* (indispensables) for sustainable biofuel governance. These recommendations should not be treated as a recipe for success, but as minimum conditions and "best bet" approaches requiring testing, deliberation, and refinement through an adaptive, inclusive, and evidence-based approach to policy design and implementation.

¹ "Scaling Up Biofuels? A Critical Look at Expectations, Performance and Governance", forthcoming in *Energy Policy*.

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I. Introduction

Ambitious renewable energy targets are being established by nation states and international institutions, from the International Panel on Climate Change to the 2030 Agenda for Sustainable Development. Biofuels feature prominently in many national energy and climate mitigation plans, as evidenced by the EU Renewable Energy Directive (EU-RED), Nationally Determined Contributions to the Paris Agreement, and companion national energy policies and plans.² This continued faith in biofuels contrasts with their patchy performance to date. While enthusiasm for first generation biofuels may have diminished, expectations remain high about the potential of advanced biofuels, a transition to a bioeconomy, and the use of biofuels in hard to decarbonise sectors such as aviation. Experiences with first generation biofuels have highlighted the interdependencies between the multiple end-uses of biofuel feedstocks (i.e. for food, feed, fibre and fuel) and the multi-functionality of land. There is thus an urgent need to review biofuel performance to date and to distil the governance implications in order to avoid simply repeating the same mistakes.

The companion papers leading up to this synthesis have explored the empirical evidence of biofuels' sustainability in terms of their climate mitigation potential;³ other expectations of biofuels that have been "bundled" with the clean energy agenda by producer and consumer countries;⁴ and the veracity of assumptions related to the ability to produce biofuels while "doing no harm", and the effectiveness of strategies designed to mitigate negative outcomes, where present.⁵ They have also queried the effectiveness of public and private governance in ensuring the social and environmental sustainability of biofuels.⁶ The aims of this paper are twofold: to synthesize these findings, so as to distil lessons learnt; and to draw on these lessons and the wider literatures on change management and scalability to explore implications for biofuel governance. The outcome is an ambitious effort to identify *sine qua nons* in biofuel governance for sustainability. Given what we know about the complexity of social and ecological systems; the importance of values and context in undermining the promise of one-size-fits-all solutions; and the role of

² See: <http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx>; http://biofuels-news.com/display_news/10886/india_sets_out_2022_plan_to_beef_up_biofuels_production/; <http://www.fas.usda.gov/commodities/biofuels> (accessed Oct 10, 2016).

³ Searchinger, forthcoming.

⁴ Hunsberger et al., forthcoming.

⁵ Goetz et al., forthcoming.

⁶ Oliveira et al., forthcoming; de Man et al., forthcoming.

human agency at all levels in undermining the determinacy of programme outcomes, these “indispensables” are not suggested as recipes for success. It is suggested, rather, that without these essential steps, biofuel programmes are *likely to fail* both in their purported aims (e.g., net greenhouse gas (GHG) benefits, energy security, rural development) and in other fundamental dimensions of sustainability (e.g., minimal harm to local ecosystems, respect for basic human rights). Furthermore, adherence to these *sine qua nons* alongside a knowledge-intensive, inclusive and adaptive approach to change management can help bring performance more in line with official policy aims while picking up on critical risks before they lead to premature failure or unacceptable costs.

The paper begins with a review of the evidence derived from each of the companion papers, so as to distil a set of lessons for policymakers. We then review the literature on change management, so as to profile the challenges of taking pilot experiences to scale and managing uncertainty in policy interventions. We then conclude by drawing on both the lessons learnt from the evidence reviewed and this wider literature to pose a set of “*sine qua nons*” for biofuel governance that collectively underlie a more ethical approach to the planning and implementation of national biofuel programmes.

II. The Promise and Pitfalls of Biofuels: Evidence and Lessons Learnt

This section synthesises the evidence presented in five companion papers on the effectiveness and sustainability of national biofuel programmes (“Scaling Up Biofuels? A Critical Look at Expectations, Performance and Governance”, forthcoming in *Energy Policy*), and uses this evidence to distil lessons learnt for efforts to ensure biofuels sustainability. These companion papers focus on several prominent themes characterising international debates over biofuels. The first set of papers focuses on their *impacts*. These are reviewed relative to key policy expectations enshrined in public policies globally: their cli-

mate mitigation potential;⁷ their ability to meet other expectations often “bundled” with climate neutrality;⁸ and anticipated risks – with a focus on how biofuel policies engage with these risks, and whether these risks have been adequately mitigated.⁹ The second set of papers focuses on biofuel *governance*, including the effectiveness of national biofuel policies in achieving social and environmental sustainability, and the extent to which certification as a market-based instrument of governance has filled the gaps in public governance.¹⁰

⁷ Searchinger, forthcoming.

⁸ Hunsberger et al., forthcoming.

⁹ Goetz et al., forthcoming.

¹⁰ Oliveira et al., forthcoming; de Man et al., forthcoming.

Five major findings emerge from these papers (and the literature reviewed), which call into question the effectiveness and social and environmental sustainability of biofuels, and call for a critical assessment of existing and emerging policies and programmes aiming for their expansion.

1. The set of conditions under which biofuels may deliver greenhouse gas benefits is far narrower than initially assumed, undermining their potential as substitute for fossil fuels.

In general, claims for GHG benefits from biofuels have assumed that actual carbon released by burning biomass should not “count” as warming the climate because it is offset by plant growth. However, since the land producing biofuels will in nearly all cases already be supporting plant growth that absorbs carbon and either provides important human benefits, such as food, or carbon storage, the automatic assumption of carbon neutrality of biomass is unjustified. True climate neutrality, or even large net climate gains, are only achievable under a far narrower range of conditions – and thus at a smaller scale – than often thought.¹¹ This significantly undermines their promise in delivering cleaner energy worldwide, while in many cases also yielding other unacceptable costs such as competition with food and timber production.¹² The conditions under which biofuels might deliver cleaner energy include: (1) use of true waste biomass, which is biomass that is burned or buried, or biomass whose uses are sufficiently trivial that they would not generally be replaced in some form; (2) upgrading from less to more resource efficient uses of bioenergy; and (3) use of bioenergy crops produced as a form of land reclamation for a *particular type* of degraded lands: those which receive enough rainfall to produce reasonably abundant plant growth, but do not and will not do so in at least the near future due potentially to very high levels of soil degradation or invasive species. These limitations narrow considerably the amount of land that might be deemed suitable

for sustainable biofuel cultivation, thus limiting their scalability. They also imply that biomass-derived energy with its particular biophysical composition and constraints make a substitution of current energy consumption levels impossible – even if only applied in the transport sector.¹³

Lesson Learnt #1: *Carbon accounting methods need to be improved if they are to reflect real climate mitigation potential.* This means ensuring the opportunity costs associated with alternative uses of land, biomass and carbon are incorporated into the analysis, and pursuing biofuels *as a strategy for climate mitigation* only if the opportunity cost is very small and the benefit very high.

2. The performance of policy aims and expectations that are typically “bundled” with climate change mitigation is patchy, with evidence of success often linked to concerted efforts by governments in producer countries to invest in the sector and to guide biofuel development trajectories.

As for other expectations typically “bundled” with climate mitigation, isolated successes may be identified, but tend to rest on consistent public support to sector growth, structuring and sustainability. *Energy security* aims have been advanced for particular fuels, sectors and countries, yet the contribution of biofuels has only reached 10% in the case of bioethanol in the transport sector, an achievement which is limited to Brazil, USA, and Thailand. This has clearly advanced energy security in those countries by diversifying energy sources, reducing import dependence and saving foreign exchange.¹⁴ Yet these gains are only achieved by ambitious government programmes and public investment, and are concentrated in the transport sector – where they achieved a 4% share of global road transport fuel demand in 2014.¹⁵ This contrasts with a paltry 0.8% share of global final energy consumption.

¹¹ Searchinger, forthcoming.

¹² Searchinger, forthcoming.

¹³ MacKay, 2009: 44; Erb et al., 2016.

¹⁴ Hunsberger et al., forthcoming.

¹⁵ De Andrade & Miccolis, 2011; Oliveira et al., forthcoming; Schoneveld et al., 2010.

Job creation, smallholder market integration and decentralized energy systems are “bundled” expectations of a more social character. Certain estate crops that have proven difficult to mechanise due to technical or political reasons (e.g., oil palm, sugar cane) have generated significant numbers of jobs.¹⁶ Smallholder income has also been shown to have improved through the cultivation of “flex crops” in select cases (e.g., oil palm in Sumatra, Indonesia and sugarcane outgrower schemes in Africa),¹⁷ and isolated successes may also be found in decentralised energy systems.¹⁸ However, for those examples that can be held up as models of smallholder inclusion for the industry as a whole, the role of the state (as regulator and financier; and to a lesser extent capacity builder) seems to be paramount both in achieving and maintaining distributional equity. Furthermore, success is patchy and highly uneven in its effects, even for those cases held up as models of what biofuels can deliver.¹⁹ Employment intensity is highly variable within and across feedstock due to crop characteristics, level of mechanisation and production stage; the uneven success of investments; and the tendency towards a reduction in employment intensity with progressive capitalisation.²⁰ The majority of jobs created are of low quality, and employees often struggle to leverage livelihood benefits from employment due to: the unskilled, casual and migrant character of plantation labour; poor employment conditions; competition with alternative livelihood streams; and variable health consequences of employment.²¹

Two of the companion papers find that policy and market incentives favour large-scale production despite official policy aims.²² This, together with constraints to market entry faced by smallholders, has produced dismal effects for smallholders while enabling more capitalised and intensive operations

and industries to capture the lion’s share of benefits. Smallholders face a host of barriers to market entry, including insecure land tenure, limited financial and natural capital, and absence of economies of scale. Thus, the expectation that biofuels provide opportunities and alleviate poverty for the most disadvantaged farmers remains unmet. When smallholders are incorporated as contract farmers or outgrowers, results are highly uneven. Forms of adverse incorporation are common (e.g., due to unfavourable contract terms) and participating smallholders often fail to gain a higher level of income than they could have earned through alternative livelihood activities.²³ Furthermore, there is little evidence to suggest that energy access in remote rural areas has improved due to decentralized biofuel production and use.

Lesson Learnt #2: *The tendency for macro-economic and industrial interests to align at the expense of social sustainability aims, and the elusiveness of more inclusive sector development pathways, suggest affirmative action policies and targeted public investments are needed to advance participation levels of and benefits derived by smallholders.* Indonesia’s success in inducing a 30–40% participation rate of smallholders in oil palm production was only achieved through proactive government efforts to work with agribusiness to channel technical input and financial support to smallholders, while requiring that a minimum 80% of land under oil palm in nucleus estate-smallholder schemes be allocated to smallholder production.²⁴ Ensuring smallholder participation during the intensification of Africa’s sugarcane industry has also required substantial public investment.²⁵ Such public

¹⁶ Hunsberger et al., forthcoming.

¹⁷ Hunsberger, forthcoming; McKersie & Hichaambwa, 2011.

¹⁸ Hunsberger et al., forthcoming.

¹⁹ German & Parker, 2015; McCarthy, 2010.

²⁰ Binswanger, 1986; Hunsberger et al., forthcoming.

²¹ Colchester, 2011; German & Parker, 2015; Hunsberger et al., forthcoming; Li, 2011; Macedo, 2005; World Bank, 2010.

²² Oliveira et al., forthcoming; Hunsberger et al., forthcoming.

²³ Hunsberger et al., forthcoming; McCarthy, 2010.

²⁴ McCarthy, 2010.

²⁵ German & Parker, 2015.

sector intervention is likely to be essential for overcoming inherent barriers to entry and ensuring widespread participation in the sector. Additional conditions are likely to be necessary, however, to ensure the benefits exceed alternative uses of land and labour or guarantee livelihood benefits from the same.

Lessons Learnt #3: *Outcomes of biofuel programmes and investments are context-dependent and indeterminate, suggesting that efforts to achieve sector sustainability will require a knowledge-intensive process.* Each context is unique – with different feedstocks, locations, land covers, land uses and livelihoods, business models and actor constellations present in each biofuel project or programme having a unique footprint in shaping the ultimate outcomes. Furthermore, given the complexity of these influences, and of the social, political and ecological systems in which they are embedded, even the very best policies and planning efforts will still fail to anticipate the course of events and their outcomes. This suggests the need for a knowledge-intensive process to planning and implementation of national biofuel programmes.

3. Trade-offs between policy goals, rather than “win-wins”, are the norm.

The papers of the special issue also reveal clear trade-offs between the aims and expectations commonly associated with biofuels production and consumption. These include tensions between: different policy aims, such as those between energy security (achieved most efficiently through industrial-scale production models) and the decentralisation of energy and livelihood benefits;²⁶ food, fibre, fuel and carbon storage;²⁷ and sector viability and energy security on the one hand, and social and environmental sustain-

ability on the other.²⁸ Trade-offs also exist between private and public interests, and between scales – with some goals advanced through a more capital-intensive, economically efficient production model, and others advanced through a more labour intensive, geographically distributed production model.²⁹ Yet despite this generalized pattern of trade-offs, “win-win” narratives continue to characterise biofuel programmes.

Lesson Learnt #4: *Trade-offs are inherent in biofuel production, and should be made explicit in planning.* The emphasis on “win-wins” rather than trade-offs undermines meaningful societal dialogue about which values to pursue and what constitute acceptable costs. Only by making these trade-offs explicit will realistic plans and sector sustainability be possible. As a starting point, policy goals and expectations should be “unbundled” to enable independent planning and assessment.

4. Vague and narrowly-defined metrics of “success” pose challenges for evaluating performance, and compromise any efforts to govern for sector sustainability.

This summary brings us to the crucial importance of the metrics used to set policy targets and evaluate outcomes associated with each expectation. Hunsberger et al (forthcoming) identify a tendency for official policy aims to be framed in both vague and narrow terms, posing challenges for evaluating evidence of the extent to which they have been achieved. Vaguely stated policy aims arguably foster divergence between public discourses emphasising only benefits on the one hand, and actual outcomes on the other. This is illustrated by the disconnect between climate change mitigation and livelihood benefits as the primary discourses surrounding biofuels, and energy security and industrial development as the primary outcomes.³⁰ It is also illustrated by Searchinger, who identifies multiple forms of “double counting” that

²⁶ Hunsberger et al., forthcoming.

²⁷ Searchinger, forthcoming.

²⁸ Oliveira et al., forthcoming; Hunsberger et al., forthcoming; Searchinger, forthcoming. Also see Roe and Walpole, 2010.

²⁹ Oliveira et al., forthcoming; Hunsberger et al., forthcoming.

³⁰ Oliveira et al., forthcoming; Hunsberger et al., forthcoming.

underlie assumptions that biofuels can provide a low- or no-carbon fuel without negatively impacting food production or availability of wood products.³¹ These forms of double counting include the failure to consider the carbon cost of displacing alternative uses of biomass (e.g., for food, construction, grazing, increasing carbon stocks in soils and vegetation), and the failure to consider the carbon debts likely to result from the conversion of land identified as “unused potential cropland” (e.g., loss of forest regrowth on abandoned agricultural land that would otherwise play a role in holding down global net deforestation). Double counting derives in part from accounting rules under the Kyoto Protocol, which allow biomass carbon to be ignored from the energy account without requiring that it be counted in the land use account. This rule misinterpreted accounting requirements under the UNFCCC, which allow carbon to be ignored from energy accounts only if it is counted in the land use account. Narrowly framed aims, on the other hand, open the door for positive evaluations of programme effectiveness while obscuring the many other ways in which programmes may undermine those very same aims. This may be illustrated by the variable ways in which employment and smallholder outcomes may be evaluated, and the divergent findings that emerge when adopting different metrics.³² If we are to measure success as the simple fact of jobs being created or smallholders being engaged as outgrowers, then biofuels may be viewed as a resounding success. If, however, we are to consider the ability to leverage livelihood benefits from these forms of smallholder articulation with the biofuel industry, the opportunity costs associated with the reallocation of land and labour, and the multifaceted social consequences of smallholder incorporation (on health, gender, freedom of choice, etc.) and the distribution of risk, then success stories are harder to find. There is no guarantee employment will generate greater returns to land or labour than smallholder agriculture.³³ Rather, a general pattern of greater returns to smallholder production than wage labour may be identified, as well as extreme unevenness in outcomes across households within any given industry or investment.³⁴

Lesson Learnt #5: *Policy goals need to be defined in less ambiguous and more ambitious terms, to align subsequent evaluations of progress towards these goals with realities as they play out on the ground.*

Companion papers demonstrate how myths about biofuels have outpaced concrete achievements and the evidence supporting them – such as the promise of biofuels for climate change mitigation or as an engine of rural development. Only by defining policy goals in less ambiguous and more ambitious terms will planning be realistic, and monitoring and evaluation give real insights into the successes and challenges as they play out on the ground.

5. Current governance instruments fall far short of ensuring sector sustainability.

Turning now to the papers on sector governance, Oliveira et al.,³⁵ in their review of the literature on the political economy of biofuel policies in the US, Brazil and the EU, highlight the shortcomings of domestic policy in governing for social and environmental sustainability.³⁶ They find that biofuel policies are not developed and implemented according to the desire to achieve environmentally sustainable or inclusive growth (as official policy narratives would suggest), but rather according to state interests in energy security and its intersection with private interests in profit. They find that biofuel production advances furthest when relevant industry sectors align with each other and state interests in energy security take precedence over food security, and stalls when major corporate sectors are in tension, state concerns over food security predominate or opportunities for profit are limited. Accompanying these trends is an imbalanced situation in which profit is largely privatised by corporations while many of the costs of industry establishment are borne by the public. Needless to say, the processes involved were found to render other policy mechanisms aiming to advance socially and

³¹ Searchinger, forthcoming.

³² German & Parker, 2015; Hunsberger et al., forthcoming.

³³ Hunsberger et al., forthcoming.

³⁴ See also Deininger et al., 2011; McCarthy, 2010; Obidzinski et al., 2011; Schoneveld et al., 2011.

³⁵ Oliveira et al., forthcoming.

³⁶ Also see Gallagher, 2008.

environmentally sustainability ineffective, to marginalise smallholders and food crop production, and to maintain unsustainable and inefficient energy and environmental practices.

Market-based governance through certification is a poor substitute for government regulation in advancing biofuel sustainability.³⁷ This stems from a host of factors, including the limited coverage of certification (due to its voluntary nature, and low market share); weaknesses and variable quality in the standards themselves (allowing corporations to opt for standards that require less of them, or to claim that their operations are more sustainable than they are); the weak governance of certification systems themselves (e.g., absence of checks and balances or effective dispute resolution mechanisms); and limited government involvement or independent oversight. EU policies and the certification standards that help ensure compliance with them claim to produce sustainability, but fall far short of doing so. EU-RED, which represents a novel attempt at hybridising state and market-based governance instruments, appears to be aligning certifiers with environmental sustainability criteria, but the scope of these criteria is far too narrow to ensure social sustainability.³⁸ Multi-stakeholder roundtables have produced some of the more robust standards, but their market share is limited and their governance subject to the influence of powerful actors in industry and government.³⁹ Thus, while market-based instruments may have a role to play in reducing the costs of norm generation and compliance/enforcement, the proliferation of low quality standards conferring green labels and their voluntary nature (and thus, low market share) undermine their potential. A number of sustainability challenges are also ill-suited to a market-based approach, particularly those that go beyond risk mitigation to advancing social aims, or require a landscape perspective in recognition of ecological implications. As a consequence, certification often serves to mask negative realities on the ground more than advance sustainability.

In summary, companion papers provide ample evidence of the less-than-satisfactory sustainability of biofuels, and the specific ways in which government policies and certification fail in advancing this aim. Corporate interests currently occupy powerful positions in both arenas, advancing industrial growth and macroeconomic indices at the expense of other actors and interests. Yet where the political will exists, public governance has achieved significant advances for smallholders.

Lesson Learnt #6: *Observed deficiencies in current regulatory and market-based governance instruments for sustainable biofuels should be addressed prior to scaling up, to ensure efforts to take existing projects or programmes to scale are effective in achieving established policy aims and do not simply propagate identified problems and risks.* While the strategic articulation of public policies with market-based instruments may prove useful in overcoming some of the constraints of public governance (e.g., reducing enforcement costs, reconciling sustainability criteria with the profit imperative), there is no viable substitute to the state guiding the trajectory of the sector – particularly if pro-poor sector development is a concern. Given the embeddedness of biofuels within agricultural landscapes, ensuring their sustainability will also require a strong suite of policies on environmental protection, labour standards, and rural development. The capacity and willingness of states to monitor and enforce legislation will also be key. In the absence of new ways of doing business, scaling up is a recipe for upscaling not just production, but the problems of existing biofuel projects. Scaling up the status quo can be expected to advance industrial-scale production systems (and the concentration of capital and benefits), and through this energy security and isolated local benefits, at the expense of food production, emissions reductions, ecosystems goods and services, and/or resilient local livelihoods.

³⁷ De Man et al., forthcoming.

³⁸ German & Schoneveld, 2012.

³⁹ de Man, forthcoming; German, 2014; Goetz, 2013.

III. Managing Change: Lessons for National Biofuel Programmes

The highly distilled empirical evidence presented in the previous section points to many challenges limiting the socio-economic and ecological sustainability of biofuels. A growing body of scholarship suggests this applies not only to first generation, but equally to second and third generation biofuels.⁴⁰ While there are isolated successes to draw on, how do we go about figuring out what might work better when much of the evidence and resulting lessons are drawn from failures? To bolster evidence behind alternative courses of action, we therefore look to the wider scaling and change management literatures for additional insights. We will then use these insights, together with evidence and lessons learnt from the biofuel sector, to derive *sine qua nons* for sustainable biofuel production and consumption.

A. To Scale is at Best to Change, and at Worst to Lose What Has Been Working

Geographical, organizational and temporal scales shape prospects for sector sustainability. In the context of biofuels, scale is primarily understood as geographical scale, defined as “the spatial dimensions of a process (...), or a decision”.⁴¹ The sustainability of efforts to upscale geographies of biofuel production and consumption depends on the impacts of several distinct yet interrelated sub-components of (up)scaling: the

expansion of project size; expansion in the land area devoted to bioenergy production; and expansion of other input factors in the production process (e.g., seeds, labour).⁴² Moreover, it is important to acknowledge that as a result of technological innovations (e.g., internet, transport), the proximity between biofuel production and consumption has been altered. Due to biomass’ easy accessibility via world markets, countries who are net consumers of biofuels increasingly incorporate other countries’ and regions’ lands and related biomass production in their strategies to meet national biofuel mandates through imports.⁴³ The perspective of spatial scales underlines the necessity of assessing biofuels production and consumption in the context of wider socio-economic and ecological system boundaries in which it takes place – to identify unintended consequences of local choices on the regional and global level (and vice versa), and determine corresponding responsibilities and accountabilities.⁴⁴ Often confounded with this spatial understanding are three other types of scale that matter for the assessment of sustainability, namely the scale of organizational structures (e.g., small-holder production vs. large-scale plantations; versatile vs. singular feedstock infrastructure), and temporal scales (e.g., long-term or short-term planning; late- vs. early return of investment made).⁴⁵

⁴⁰Mohr & Raman, 2013.

⁴¹Wilbanks, 2007: 279.

⁴²Mohr & Raman, 2013; Tilman et al., 2002; Hunsberger et al., forthcoming; Buchholz & Volk, 2012; Goetz et al., forthcoming; Ekins, 1993.

⁴³Wilbanks, 2007.

⁴⁴Buchholz & Volk, 2012; Wilbanks, 2007; Goetz et al, forthcoming; Dale et al., 2010.

⁴⁵Buchholz & Volk, 2012; Hunsberger et al., forthcoming; Goetz et al., forthcoming.

Scaling up also increases risks and unintended consequences. Expanding land demand and area for biofuels tends to increase pressure to intensify agricultural production, with known challenges for socio-economic and ecological sustainability that range from soil degradation, unsustainable water demand and pollution and reduction in biodiversity, to displacement effects and human rights violations. Related land use and land cover changes – direct and indirect – are reducing the climate mitigation potential of biofuels, while competition with multiple other land uses, such as food production, can threaten basic human securities.⁴⁶ Nonetheless, large-scale production continues to be seen as more cost competitive, profitable and amenable to state and private sector control. It also enhances the leverage of private enterprises vis-à-vis state authorities and international organizations – for instance, when negotiating tax breaks, or accessing carbon markets.⁴⁷ This means that the widespread preference for geographical upscaling runs counter to evidence-based policy making.⁴⁸ There is vast empirical evidence of the risks associated with large-scale projects and production programmes, such as those derived from the difficulty of putting large-scale projects into operation (due to the high upfront costs and longer payback times) or loss of flexibility for responding to challenges in a timely manner due to limited oversight from headquarters.⁴⁹ In cases where agricultural programmes, including biofuels programmes, aim at expanding smallholder production of a particular crop, producers are confronted with price fluctuations or other political economic hurdles. Moreover, the focus on a single feedstock can have huge environmental costs (e.g., reduction of biodiversity, use of agrochemicals).⁵⁰

Scaling up increases complexity. Complexity also increases with scale and poses a challenge for decision-making. The new interlinkages and feedbacks between different scales and types of scale (spatial, temporal, organizational) are often neither foreseeable nor known; nor are the ways in which governance measures at different scales reinforce each other, or work against each other. Moreover, new actors and governance levels get implicated in finance, governance and management, as well as new lands and ecosystems. At different spatial scales, different forms of information are available, and different solutions apply.⁵¹ To deal with this analytical challenge, large-scale programmes tend to be built on the basis of modelled futures and scenarios. Yet, such simplifications make it difficult to arrive at reasonable and realistic policies that can ensure the sustainability of production and consumption at different scales and across contexts. As a result, again, evidence-based policymaking is rare.⁵² A multi-scale perspective drawing on hard data is therefore crucial for guaranteeing biofuels' sustainability.⁵³

B. Managing Change: Addressing Trade-offs, Uncertainty and Learning

Recognising and moderating multiple environmental values and making trade-offs explicit can make policies more realistic and inclusive. As we have seen for the biofuel sector, policy proposals tend to be framed as silver bullets and “win-wins”: initiatives that can deliver multiple benefits to a diverse set of constituencies. While an exclusive focus on benefits may help to leverage funding and bolster political support behind an idea, it contrasts with the growing acknowledge-

⁴⁶ Tilman et al., 2002; Gallagher, 2008; Borras et al., 2010; Franco et al., 2010; Mitchell, 2010; Gasparato & Stromberg, 2012.

⁴⁷ Buchholz & Volk, 2012.

⁴⁸ Sutcliffe & Court, 2005; Cheng & Timilsina, 2011.

⁴⁹ Hawkins & Chen, 2011; Goetz, 2015; Cheng & Timilsina, 2011.

⁵⁰ Oliveira et al., forthcoming; Goetz et al., forthcoming.

⁵¹ Wilbanks, 2007.

⁵² Goetz et al., forthcoming; Searchinger, forthcoming.

⁵³ Trent & Chavis, 2009.

ment that value trade-offs are inherent in multi-objective decisions and that the consequences of any given intervention are experienced, perceived, and understood very differently by different actors.⁵⁴ The benefits of recognising and moderating multiple environmental values and making trade-offs explicit are multi-faceted. In addition to forcing a conversation about policy interventions carrying losses as well as benefits,⁵⁵ the acknowledgement of conflicting views and interests may be a platform for deeper deliberation and negotiation of competing interests and values.⁵⁶ The hard work of reconciling different interests and values can go a long way in cementing political support for interventions, while its absence can leave plans vulnerable by masking underlying grievances and exacerbate ideological divisions in society.⁵⁷ Doing so may also simply make agreements on land use possible.⁵⁸

Learning to grapple with rather than ignore uncertainty will contribute to a nimbler policy environment and advance effectiveness in the long run. Another crucial element of change to be considered in the design of sustainable biofuel programmes is uncertainty. Plans rarely work the way they are conceived, and even the best-laid plans will carry an element of surprise.⁵⁹ Decisions or interventions having multiple objectives only magnify this uncertainty.⁶⁰ This uncertainty may be due to the complexity of natural and social systems, or to the simplifying assumptions underlying interventions and the theories of change underlying them.⁶¹ Gunderson⁶² identifies several common yet inadequate approaches to dealing with uncer-

tainty in resource management: to assume it away; to seek “spurious certitude” (by breaking a problem into trivial questions and policy actions that are unambiguously “correct” despite underlying uncertainties); or to replace the uncertainty of outcomes with the certainty of a process (such as a new policy or regulation, or a technical oversight committee). What these tendencies for simplification mean is that “most policies are really questions masquerading as answers”.⁶³ The road least travelled but thought to be the most effective is to confront the uncertainties head-on: taking them as a given, and making feedback and learning central to policy formulation and implementation.

Social learning is essential for equitably governing trade-offs and managing uncertainty. Adaptive collaborative management (ACM) has emerged as a leading paradigm for reconciling the value and interest disputes and pervasive ecological and social uncertainty characterising land and resource management.⁶⁴ ACM may be defined as an “approach whereby people who have interests [in a particular policy or resource management arena] agree to act together to plan, observe, and learn from the implementation of their plans while recognising that plans often fail to achieve their stated objectives”⁶⁵— or simply “implementing policies as experiments”.⁶⁶ The core elements of ACM are twofold: adaptive in managerial perspective, and collaborative in governance.⁶⁷ *Adaptive* means that learning, in the form of systematic assessment and feedback, is at the core of the process, and that iterative adjustments in management and policy based on this learning, are central.⁶⁸ It may also mean system-

⁵⁴ German, 2015; Hirsch et al., 2010; Keeney & Raiffa, 1976; McCarthy, 2010.

⁵⁵ Hirsch et al., 2010; McShane et al., 2011.

⁵⁶ Brechin et al., 2003.

⁵⁷ German et al., 2011; German et al., 2016; Miller & Erickson, 2006; Walley, 2004.

⁵⁸ Lee, 1999.

⁵⁹ Colfer, 2005.

⁶⁰ Keeney & Raiffa, 1976.

⁶¹ Lee, 2002; Vogel, 2012.

⁶² Gunderson, 1999.

⁶³ Gunderson, 1999: 1.

⁶⁴ Armitage et al., 2008.

⁶⁵ Colfer, 2005: 4.

⁶⁶ Lee, 2002: 2, citing Holling, 1978; Walters, 1986.

⁶⁷ Lee, 1999.

⁶⁸ Armitage, 2008; Colfer, 2005.

atically testing the uncertainties underlying policy assumptions in practice.⁶⁹ Assessment, which should focus on social and ecological outcomes as well as the implementation process itself and incorporate feedback from the local arena to policymakers, is essential to capturing unanticipated consequences and determining appropriate institutional responses to change.⁷⁰ Collaborative, on the other hand, means that change management “is characterised by group decision-making that accommodates diverse views and shared learning” and ensuring that those who are affected by policy choices have a voice in policymaking.⁷¹ Together, these core ingredients of ACM shift the emphasis from one of command-and-control to flexibility and innovation – key ingredients of resilience and adaptive capacity.⁷²

An adaptive, collaborative approach to change management must be politically feasible for it to be effective. While the elements of ACM make it of undoubtable utility in forging a transition towards a more sustainable economy, there are reasons for questioning its political feasibility. Adaptive management may prove to be an unsettling approach for those who think of management in terms of command and/or for whom transparency is undesirable:

“What is learned from the adaptive process reveals not only the way the ecosystem responds but also what the managers are doing, whether it works, and whose interests it serves... Undertaking an experimental approach presents the manager with two faces of learning. There are benefits from increasing understanding of the social and natural interactions. But ... there are risks of disclosure of activities which look inappropriate in the eyes of one or more stakeholders.”⁷³

The experimentation involved may also cause conflict by shaping how people live their lives in landscapes targeted for intervention. If ACM is to shape the way policy is conceived of and implemented, an orderly and intentional approach to resolving conflicting interests and a transition to organisational cultures that welcome the opportunity to learn from failure will be necessary.⁷⁴ In the case of biofuels, policymakers will need to be sincerely interested in the actual impacts and sustainability of biofuels – not just the theorised benefits useful for engendering public support for these programmes or for bolstering claims related to global policy commitments.

⁶⁹ Lee, 1999.

⁷⁰ Armitage, 2008; Bellamy et al., 2001; Colfer, 2005.

⁷¹ Armitage, 2008: 2.

⁷² Armitage, 2008; Gunderson, 1999; Pinkerton, 2007; Parson & Clark, 1995. If learning and governance are to be truly democratized in contexts of unequal knowledge and power, Miller and Erickson (2006) argue that an explicitly political approach to bridge scales and epistemologies is also needed. They identify several important ingredients to such an approach: building critical capacity for policy reasoning among diverse actors; promoting epistemic tolerance and pluralism; enhancing epistemic dialogue and exchange; and appropriately delegating authority across scales of governance.

⁷³ Lee, 2002: 7.

IV. Implications for Policy and Practice: *Sine Qua Nons* for Sustainable Biofuels

In this section, we ask, “What next?” for countries wishing to advance national biofuel programmes. Deriving proscriptions for future action based on evidence of past performance and theories of change is itself fraught with uncertainty. The *sine qua nons* for sustainable biofuel governance presented below are therefore advanced not as silver bullets for guaranteeing success, but as elements which if advanced with intention and good faith, are likely to enhance the likelihood of more successful, sustainable biofuel programmes across a range of indicators.

A. Taking a Step Back: What to Consider Before Deciding to Promote Biofuels

While many countries have decided on biofuels as a response to international climate commitments or domestic agendas (e.g., energy security), the patchy performance of biofuels to date across a range of indicators points to the need for a deeper evaluation before deciding to embark on a national biofuel programme. This evaluation should include, minimally, the following steps:

1. Articulate programme aims and expectations.

What is it that is hoped to be achieved with a national biofuel programme? Which things are the primary motivations that must be achieved if the programme is to be considered a success, and what other co-benefits are hoped for? Finally, how will you know if each of these aims has been achieved (what will be measured)?

For a robust articulation of aims and metrics that may be considered in the interests of society at large, this step should be both inclusive and deeply deliberative in character. This means involving actors representing the interests of those likely to be affected by policy decisions both in and outside of government (including those representing the interests of local land users). It also requires a well-designed process in which decisions are reached through deep deliberation over alternative choices and preferences.⁷⁵ This process should involve several features: a discussion in which all participants are treated as free and equal citizens, which leads to the transformation rather than simple aggregation of preferences, and which involves persuasion rather than coercion, manipulation or deception.⁷⁶ Given the strategic nature of discussions at this stage and the likelihood of unequal “deliberative competence” among actors, non-governmental organisations staffed with those knowledgeable about biofuels but accountable to community interests may need to be called on to represent local interests. Since substitution of current energy consumption levels with sustainable biofuels is impossible even if only applied in the transport sector, this process must also include deliberation about production and commercialization practices that significantly affect overall energy demand.⁷⁷ Particularly in highly-industrialized countries and fast-growing economies, substantial efforts must be made to replace energy-intensive production and commercialization practices (such as industrial agriculture itself) with more labour-intensive but sustainable alternatives that reduce overall consumption.

⁷⁵ Dryzek, 2000; Elster, 1998.

⁷⁶ Dryzek, 2000; Elster, 1998.

⁷⁷ E.g., MacKay, 2009.

2. Assess under what conditions, if any, biofuels can deliver on identified aims, and the trade-offs likely to accompany different feedstock and biofuel production scenarios.

This is an intensive analytical step which, depending on the particular aims articulated in Step 1, is likely to require expertise from multiple disciplines and sectors. In addition to asking questions about whether biofuels can deliver on primary aims, it is important to explore the circumstances under which broad-based benefits may be achieved (e.g., rural livelihood and/or energy security gains maximised). If climate change mitigation is identified as one of the primary motivations, it is of fundamental importance to get the numbers right at this stage given the effect of common accounting errors in producing overly idealistic projections. This means accounting for the opportunity costs associated with the use of land and biomass for biofuels. Only if the opportunity cost of land (or biomass or carbon) is very small and the benefit very high, should biofuel programmes be pursued *as a strategy for climate mitigation*. Given the restricted set of circumstances in which this tends to be true, if climate mitigation is a mandatory goal for the biofuel programme, these programmes should generally focus on sources of waste material.

Another key component of this analysis should be the explicit identification of trade-offs likely to accompany different feedstock and biofuel production scenarios, so that the focus on primary motivations for a national biofuel programme does not blind decision-makers to the costs of different courses of action. To reflect other growing demands for food, fiber and urban development and the highly uneven effects of specific investment strategies, these scenarios should include alternative business models and possible land use-land cover change trajectories for the country in question. Given the prominent role of agronomics in shaping where biofuel feedstock may be grown and which business models are feasible, this analysis should be done for each potential feedstock. It should also draw on actual performance to date rather than depending on the assumptions embedded in models. This analysis should also include the investigation of the livelihood benefits and costs of different models of ownership and con-

trol of production, processing and marketing. This research should aim to explore the feasibility of decentralising ownership and control so as to maximise the social benefits of biofuel programmes.

3. Assess global repercussions of national policy choices, particularly for major consumer countries or blocs.

It is also crucial for countries to consider the global repercussions of national biofuel programmes that aim at increasing the level of national consumption. Can the feedstock be provided locally, or regionally? If not, where is the biomass or biofuel to be imported from? What measures are in place to ensure that it has been produced sustainably? Can the scale of the state-initiated demand for biofuels (e.g., mandates) be satisfied in a socially and environmentally sustainable manner, considering projected demand from other countries? Does the global biofuels regime foster supply chains that moderate the traditional South-North divide, or does it follow a similar division of labour, thereby impeding socio-economic change towards greater equality in world society? As long as no reasonable answers or assurances can be provided for any of these critical questions, sustainably is likely to be jeopardised. Moreover, costs of bioenergy production can be expected to be primarily borne by society and ecosystems of tropical and non-industrial countries⁷⁸ – undermining any advancement in issues regarding global social and environmental justice.

4. Identify the acceptability of trade-offs associated with alternative production scenarios.

While Steps 2 and 3 are largely analytical steps carried out by those with relevant scientific expertise and practical knowledge of the issues and context, step 4 is largely a deliberative one focused on the negotiation of societal values and a pluralistic understanding of what constitutes a desirable and sustainable future. For example, is it socially and politically acceptable to produce biofuels that deliver climate benefits at the expense of food production? If energy security aims can be best achieved through large-scale industrial production and processing, how will these aims be reconciled with social sustainability concerns?

⁷⁸ Buchholz & Volk, 2012.

5. Evaluate whether biofuels are the best bet for achieving identified aims, or whether there are alternative means to achieve the same goals.

Given the poor performance of biofuels in meeting many of the most prominent rationales for biofuel programmes, many scholars have begun to ask whether there are more suitable alternatives to meeting these same policy goals that carry fewer risks and trade-offs. Answering this question requires a comparative analysis of the climate and ecological footprints of different energy options (e.g., biofuel vs. electricity) and the likely social benefits/risks of different energy options for the country in question.

6. Decide whether to move forward with the proposed biofuel programme.

This step is where the decision to move ahead with the proposed biofuel programme, or to take an alternative course of action (e.g., alternative energy options) is made. If alternative means are found to achieve the goals articulated in step 1, and these alternatives carry fewer trade-offs or risks, then these alternatives should be considered as a substitute for a national biofuel programme. If, on the other hand, biofuels continue to out-perform other options for achieving established policy aims following the set of steps articulated above, only then should the expansion of biofuel production be considered. At this point, the additional *sine qua non*s articulated below will come into play in the course of planning and implementation.

B. Adaptive Collaborative Management of Policy Planning and Implementation

If a decision is made to initiate a national biofuel programme, an adaptive and collaborative approach to change is warranted. Being adaptive means that the programme is not fixed from its implementation until its completion; rather it is a knowledge-intensive and iterative process in which monitoring and feedback from directly affected groups serve to guide mid-course corrections to plans and programmes based on actual performance (including both planned and unanticipated impacts). This helps cater for the indeterminacy of interventions involving complex natural, social and political systems. The collaborative charac-

ter means that plans are not formulated, implemented and monitored by centralised bureaucracies alone, but in a collaborative fashion – involving those directly affected at different stages in the process of planning, implementation, monitoring and evaluation.

1. Carry out an evidence-based, participatory and deliberative planning process.

The next *sine qua non* for sustainable biofuels is a planning process that is both evidence-based and pluralistic. The evidence to support planning comes in multiple forms, depending on the stage of planning and implementation. At this stage, the evidence from the analyses carried out in the analytical and deliberative steps articulated above serves as an input to planning processes involving directly affected stakeholders themselves. At later stages, evidence will come from pilot projects intended as “proof of concept” for how a plan plays out in reality as it confronts various technical and financial challenges to implementation, comes into contact with different interest groups, and yields to climatic and ecological realities. In a process designed to consist of iterative cycles (of planning, implementation, monitoring, reflection and re-planning), evidence will also emerge from the experiences accumulated by those involved in the process: communities, the private sector, and government and non-governmental agents of change.

Some of the points of deliberation in this multi-level planning process should include:

- *What forms of biomass/biofuel?* Here, the choice will be constrained by the narrowing of options in prior steps in which the ability of different feedstock produced in different locations is assessed against its ability to achieve strategic policy objectives of the sector. Yet some latitude of choice is likely to remain. These choices and their implications for shaping the trajectory of the sector (e.g., the degree of likely decentralisation of production and processing, degree of mechanisation and its implications for employment intensity, degree of monopsony and its implications for smallholders) should be the subject of deep deliberation with affected communities.
- *What business models?* Here, awareness must be created on the options available, and their impli-

cations for business ownership, control over land and control over production.⁷⁹ Key criteria in the selection of business models and design of resulting agreements should be that they meet the immediate needs of local stakeholders (communities, farmers), and mitigate risks to them (e.g., impacts on land and livelihoods, indebtedness). Here, extra scrutiny should be applied when industrial-scale business models are under consideration given the long-term risks to fundamental rights and to local livelihoods that they pose in most situations.

■ *What kind of land use change?* Biofuel feedstock production can induce many different types of land use and land cover change, each having important implications for the sustainability of biofuels and for local livelihoods. Feedstock choice often has a defining role in shaping the landscapes targeted for biofuels, given their agronomic requirements. Within those targeted landscapes, government policies and regulations should have a defining role in shaping what land cover changes are permitted (to comply with strategic objectives and ensure environmentally sustainable production), while business models will have a defining role in shaping what land uses must be given up to accommodate biofuels. In Mozambique, methodological innovations have been tested to lead smallholders through a process of articulating where different business models might fit within existing land uses, thereby maximising the compatibility of incoming investments with existing livelihood activities.⁸⁰

■ *What type of smallholders?* Central governments, placing an imperative on productivity of market crops over other land use values, often have a very different vision for smallholder agriculture than smallholders themselves. The vast literature documenting negative effects of biofuels on smallholders suggests a need to emphasise the following within biofuel programmes:

a) Diverse family farms rather than monoculture production, as a means to safeguard food security and to buffer risks of market engagement;

b) Flex crops with alternative household uses and markets over single purpose biofuel feedstock, so as to minimise the risks associated with single buyers and to buffer uncertain demand and market prices; and

c) Feedstocks that are compatible with the existing farming system in terms of peak labour demand and other features, so as to minimise labour competition with activities designed to ensure food security.

2. Incorporate intentional efforts to level the playing field for more effective participation of less powerful actors.

Reconciling the strategic interests of nation states with the interests and values of other actors in society (most notably, local land users) requires additional activities to complement those articulated above. The aim should be to establish whether the interests of key players crucial to the realisation of the vision (e.g., government, local communities, private sector) are compatible, and if not, the extent to which they can be reconciled. One can conceive of many possible ways to approach this. From a purely social standpoint, a bottom-up approach might be prioritised in which local livelihood aspirations are identified, and ways for biofuel feedstock expansion to best contribute to advancing these aspirations explored. Yet this approach may not ensure climate mitigation or other strategic interests are achieved. A second approach would be to take as a starting point the production scenarios identified as being feasible in meeting the strategic objectives identified by a diverse set of stakeholders, and exploring their articulation with existing land uses and community aspirations. The second strategy will only help reconcile strategic national interests with those of local land users if there is ample opportunity for affected land users to understand, contest or shape various options under consideration.

Efforts are also likely to be needed to level the playing field of “deliberative competence”, “epistemic pluralism” and “voice” to enable all of those directly affected by biofuel projects and programmes to play

⁷⁹ See German et al., 2016.

⁸⁰ ORAM-Nampula & German, 2014.

a meaningful role in shaping decisions. Enhancing deliberative competence means taking the time to ensure alternative courses of action and their stakes (e.g., for land use, land tenure, livelihoods) are understood, while ensuring affected households and individuals have the ability to advocate for choices viewed as more beneficial to them and carrying fewer costs. Epistemic pluralism requires the creation of a respectful environment in which different values and ways of knowing and being in the world can be articulated and welcomed on their own terms, without having to reach consensus or erase difference.⁸¹ Finally, it means managing very unequal power dynamics, most notably between the government and the private sector on the one hand, and local communities on the other. This means facilitating a planning process absent of coercion, manipulation or deception, but also one in which persuasion only enters the process of deliberation if all participants are able to wield it effectively.⁸²

While a host of tools exist to support these processes,⁸³ community development practitioner-advocates and critically-minded social scientists will know all too well how hard these ideas are to put into practice in the context of programmes initiated by centralised bureaucracies in the modern nation-state. To ensure meaningful participation, separate fora specifically for smallholder producers and communities affected by biofuel expansion are likely to be needed to enable less powerful or outspoken actors to openly articulate their concerns. This will help to give them an independent voice outside of the influence of politically and economically powerful actors, while providing checks and balances on programme-level decision-making. A formal mechanism for the results of these deliberations to feed into multi-stakeholder planning fora will be needed for this to be effective in shaping programme-level dialogue and decisions. Engaging community advocates knowledgeable about the risks and constraints faced by local communities in

the planning process can help bring local concerns and interests more effectively into multi-stakeholder planning fora. Moreover, professional moderation of such processes is central.

3. Ensure the wider (extra-sectoral) governance context is conducive to policy aims established in the biofuel sector, particularly those related to social inclusion and social and environmental risks.

Outcomes of biofuel policies depend significantly on the wider governance context, including foreign investment, land tenure, environmental protection, labour standards, and agriculture and rural development. If regulations and/or enforcement in these other areas are weak, biofuel programmes will likely fail no matter how adaptively and collaboratively they are planned. On the other hand, the processes highlighted under *sine qua non* #2 might also be leveraged to strengthen the broader policy environment.

4. Carry out evidence-based reforms of governance instruments themselves.

The companion papers show clearly that biofuel production will not be sustainable, responsible and pro-poor through the spontaneous actions of actors operating independently with no accountability to other actors or policy aims. The papers by Searchinger, Hunsberger et al. and Goetz et al.⁸⁴ highlight the divergence between official policy aims and actual outcomes, while the papers by Hunsberger et al. and Oliveira et al. highlight the tendency for the sector to evolve towards more capitalised and intensive operations favouring benefit capture by large corporations.⁸⁵ Sector governance is urgently needed to ensure both environmental sustainability and benefits for the rural poor, yet it is clear that current instruments are falling short of meeting this objective.⁸⁶

⁸¹ Dryzek, 2000; Hirsch et al., 2011.

⁸² Dryzek, 2000.

⁸³ FAO, 2012; McDougall et al., 2009; Prabhu et al., 1999; Wollenberg et al., 2000.

⁸⁴ Searchinger, forthcoming; Hunsberger et al., forthcoming; Goetz et al., forthcoming.

⁸⁵ Hunsberger et al., forthcoming; Oliveira et al., forthcoming.

⁸⁶ Oliveira et al., forthcoming; de Mann et al., forthcoming.

In the absence of better accounting methods and governance instruments that hold producers accountable to the collective goods (environmental and social) enshrined in public policy, biofuel programmes will continue to fail in delivering social and environmental sustainability. Moving forward in the absence of concerted efforts to improve public governance of the sector invites continued failure in efforts to achieve the multi-faceted expectations accompanying biofuel programmes.

5. Foster innovation in efforts to advance and secure benefits for the poor.

Additional creativity is also needed in exploring how to cement gains to smallholders in other arenas. Beyond mandating minimum production levels from smallholders, what other initiatives might help advance pro-poor outcomes in the industry, whether by increasing benefits captured at the local level or mitigating risk? What benefits might be achieved by limiting industrial-scale operations to processing rather than feedstock production, while supporting smallholder incorporation into the value chain? By emphasising only flex crops? By requiring that no-go zones be established near private investments to safeguard subsistence needs? By increasing public finance to the independent smallholder sector?

6. Foster an approach to implementation involving learning and iterative improvement.

Even the best-laid plans will encounter challenges, surprises and undesirable effects when implemented. To minimise the effect of these unintended consequences, two crucial ingredients are needed: pilot evaluation of programmes before scaling up, and making feedback and learning a central component to scaling up.

C. Proof of Concept: Pilot Evaluation

Given what we know about the uncertainties induced by the complexity of natural and social systems and the indeterminacy of plans, it is important to evaluate biofuel programmes on a small scale before trying to take programmes to scale. Where established biofuel programmes or pilot projects exist, every effort should be made to capitalise upon these experiences

in learning lessons about what to replicate, adjust or simply avoid – and to highlight the role of formal governance interventions in facilitating this transition. Where biofuel programmes are new, or where innovations in established programmes are envisioned, pilot projects need to be designed, implemented and evaluated before plans are rolled out. These pilots should include each of the feedstock, business models and land use change scenarios envisioned in the planning process, and be designed so as to increase the likelihood of environmentally sustainable and pro-poor outcomes.

Importantly, a robust evaluation of the sustainability of these pilot innovations is needed before deciding which feedstock and biofuel production scenarios to pursue (and related land use-land cover changes to welcome) at scale. Here, evaluations should focus on: the degree to which programme aims have been met at the local scale; the benefits and risks to directly affected households (smallholders, employees, anyone losing land to an incoming investment); and any trade-offs that have become apparent at this stage. It is important that this process be duly deliberative and inclusive of diverse perspectives and knowledge forms, including scientific evidence, official policy aims, and local ways of framing experiences with biofuels.

D. Scaling Up

Once the pilot experiences have met expectations in terms of the aims and standards attached to it, scaling up the proven feedstock and production scenarios can be considered. As the science of scaling suggests that fundamental changes in the nature of the production system can be expected when taking a successful project to scale, it cannot be assumed that the outcomes obtained within pilots will be replicated at scale. Risks and pitfalls are likely to be many and multi-faceted. This points to two crucial steps of analysis and interrogation. First, it is important to take a critical look at existing scenarios and future plans. At every point in the planning process, the question of whether scaling up is the adequate policy choice should be re-assessed in the face of new data, policy alternatives, opportunity costs, and the sustainability goals that such upscaling is expected to deliver. Second, should the decision to scale up remain untested at this point, the benefits of learning lessons from efforts to upscale elsewhere and incorporating

them into programme design become central to planning and change management. This also points to the need to take uncertainties as a given, and make feedback and learning central to policy formulation and implementation.⁸⁷ To do this effectively, a formal monitoring programme will be needed to monitor the performance of indicators linked to official policy aims, alongside deliberative spaces designed to capture feedback from stakeholders directly affected by biofuel programmes. The latter will help to retain the focus on pluralism and inclusivity by extending deliberation from planning to monitoring, as well as to capture unanticipated effects before they lead to programme failure. When problems are identified, whether through the divergence between programme aims and performance or from stakeholder

feedback, further deliberation is needed in exploring how to adjust plans and mitigate negative impacts while building on successes valued locally. An exit strategy should also be contemplated, given the possibility that particular production scenarios are less promising than initially assumed, or that the establishment of new structures and forms of production might lock in a new status quo and thereby lock out alternatives. In cases where experiences meet local expectations but fail in achieving one or more strategic policy goals, the possibility of providing ongoing support to the programme should be considered. Where the opposite is true and local livelihoods are clearly at risk as a consequence of strategic priorities being met, changing the course of action should be considered a must.

V. Conclusions

Biofuels have been promoted worldwide under the assumption that they can support several transformative yet unresolved policy goals, such as transitioning towards a more secure and climate-friendly energy system, while delivering other co-benefits to workers and rural communities. Drawing on the best published evidence to date on performance, a set of companion papers⁸⁸ (from which the findings in this paper are drawn) question this assumption. By distilling the lessons learnt from these companion reviews and consulting the wider literature on scaling and change management, this working paper has sought to formulate a series of *sine qua nons* for national biofuel programmes with the aim of enhancing their social and environmental sustainability. This underlying aim leads us to conclude that these are minimum conditions for success, and national biofuel programs should not be pursued in their absence. These “indispensables” are the minimum conditions for achieving

more equitable and sustainable biofuels, and national biofuel programmes should not be pursued in their absence. The ‘success’ of any biofuel programme that aims to deliver on multiple aims will ultimately need to draw on an adaptive and collaborative approach that treats policy innovation as experimentation, recognizes and addresses power imbalances, and is plural in the processes established to set targets, monitor performance and adjust course in the face of evidence of environmental and social harms. The working paper has also sought to remind the readership that promoting sustainable biofuels must not displace efforts to reduce overall energy consumption in highly-industrialized countries. Perhaps the most fundamental *sine qua non* is thus to pursue options that downscale global demand – as current levels of global energy consumption, if only in the transport sector, cannot be met by biomass-derived agrofuels in a way that meets social aims and environmental goals. ■

⁸⁷ Gunderson, 1999.

⁸⁸ “Scaling Up Biofuels? A Critical Look at Expectations, Performance and Governance”, forthcoming in *Energy Policy*.

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