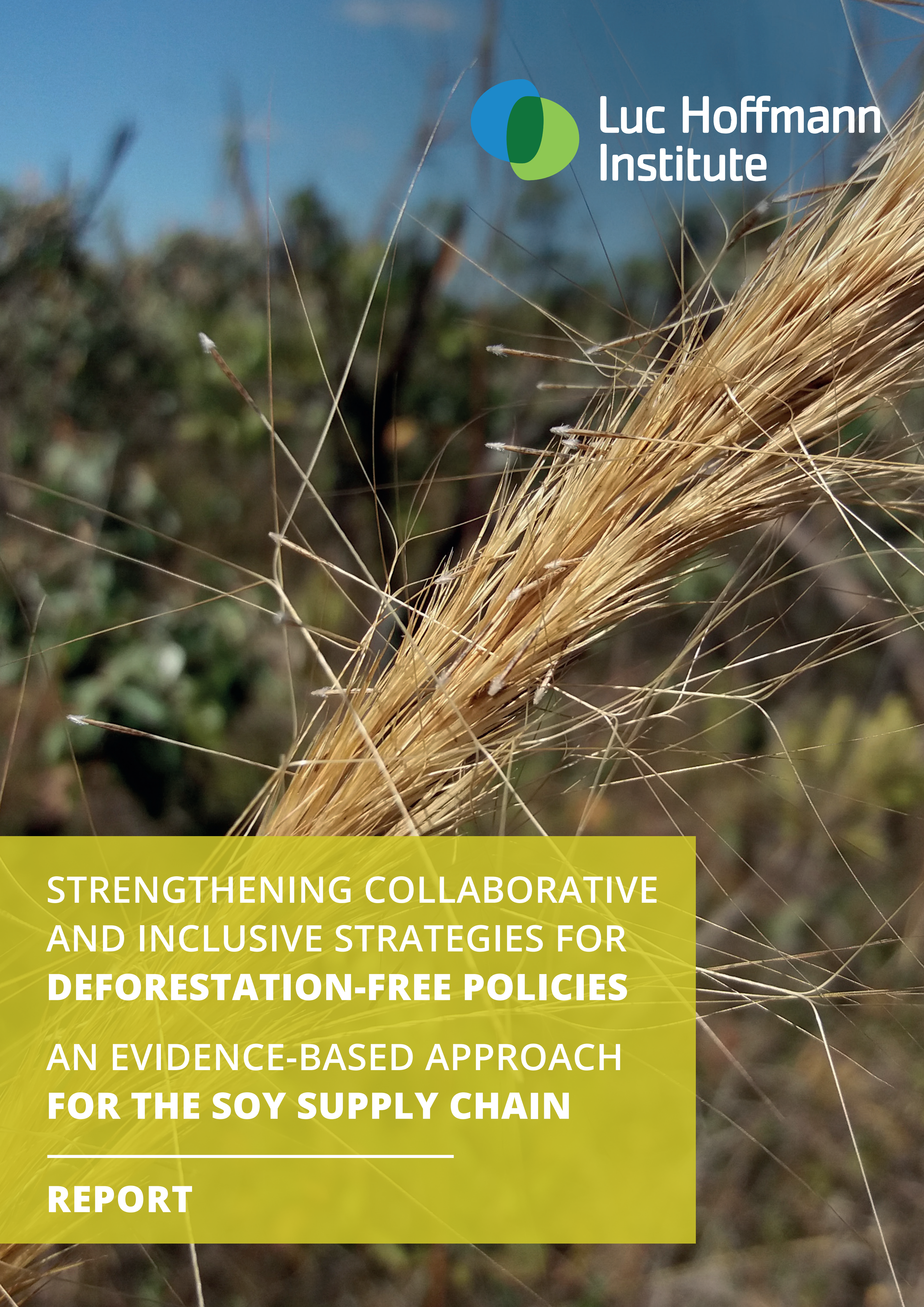

Luc Hoffmann Institute

STRENGTHENING COLLABORATIVE AND INCLUSIVE STRATEGIES FOR **DEFORESTATION-FREE POLICIES**

AN EVIDENCE-BASED APPROACH **FOR THE SOY SUPPLY CHAIN**

REPORT

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Pictures by Malika Virah-Sawmy
Front cover: Golden grass in the Brazilian Cerrado, a dry forest ecosystem
Back cover: The Brazilian Cerrado, a dry forest ecosystem

This work is part of a collaboration among the Gordon and Betty Moore Foundation and other partners designed to eliminate the loss and degradation of tropical and sub-tropical forest ecosystems that results from the production of globally traded agricultural commodities by ensuring that key commodities (beef and soy) are sourced only from deforestation-free areas. For more information see **www.moore.org.**

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EXECUTIVE SUMMARY

Achieving sustainability in supply chains is often socially complex and technically challenging, in other words what is known as a 'wicked problem'. It requires strategies under conditions of complexity, volatility and uncertainty as well as often high divergence of values and objectives in a frequently uncoordinated and dispersed supply chain. In this report, we explore the socially and technically complex aspects of the soy supply chain and discuss how these features make sustainability challenging.

This report is targeting organisations and individuals interested in and responsible for improving sustainability in the soy supply chain. The report is based on the findings of a co-produced project between a consortium of universities and sustainability practitioners in the soy sector. In this co-produced project, we have used a range of approaches to support sustainability in the soy sector, with a focus on the Cerrado in Brazil, including: i) interviews with stakeholders to ascertain their perception of barriers and opportunities in soy sustainability; ii) mapping sustainability commitments of soy stakeholders and analysing challenges with current policies; iii) developing new methods for land-use and supply chain footprint; and iv) using the evidence to develop a role-playing game that models the dynamics between land-use and supply chain systems. The recommendations in this report can support organisations working in this sector in moving a step closer to more collaborative and inclusive approaches in the soy supply chain. We give a special focus to deforestation-free soy policies, taking account of the 'wickedness' of the problem.

Finding 1:

Achieving sustainability in the soy supply chain is socially complex. The evidence indicates that achieving sustainability in the soy supply chain system faces a high degree of social complexity in three main ways: (i) producers' perception of their right to deforest; (ii) unwillingness to pay and hence share responsibility for sustainable soy in the supply chain; and (iii) lack of representation of indigenous and local communities in the sustainability agenda.

Recommendation: Effective conflict management and long-term benefits will be enhanced by better integration of the socially complex aspect of soy sustainability to achieve more collaborative and inclusive strategies. Further, because of the social complexity of soy sustainability, managing it is fundamentally a social process in which skilled facilitated approaches are needed to work intelligently with power differences and conflicts. More practically, in terms of deforestation-free policies, coordination appears urgently needed to support negotiations on definitions of what 'deforestation-free' means in an inclusive and collaborative way. This inclusive approach would bring in not only soy supply chain actors, but also related sectors involved in land-use change (see Finding 2) as well as socially impacted groups. A transparent and inclusive evaluation of the trade-offs of different definitions for different stakeholders would help the collaborative process (see Finding 4). Independent, trusted and skilled facilitators would be needed to aid parties in becoming ready to negotiate for a truly collaborative process (Box 1).

Finding 2:

Technically complex elements in the soy production and supply chain systems are contributing to stakeholders' differences in problem statements, objectives and tactics. Two key challenging aspects of the soy supply chain system that contribute to stakeholders' differences in problem statements, objectives and tactics are: (i) complex land-use dynamics including the role of other sectors and land-speculation in deforestation and; and (ii) end market characteristics of soy, that is, soy being a hidden ingredient needed in high volumes for animal feed to produce 'cheap' meat.

Recommendation: A shared understanding of the dynamics between land-use and supply chain systems would help stakeholders understand each other's positions well enough to have intelligent dialogue about the different interpretations of the problem. We suggest the use of the role-playing game that we have developed to model the complex dynamics between land-use and the supply chain system, to be played with stakeholders in important biologically diverse regions of South America. This will support a shared representation of land-use dynamics, especially regarding the feedback loops between land-use practices, land speculation and the role of different stakeholders in the supply chain and other sectors in this dynamic (Box 2). Further, to improve shared understanding of supply chain issues, we suggest the sharing the mental models of different stakeholders around soy sustainability issues, also developed in the context of this project. When used in an iterative way, the sharing of mental models can be useful to support interactions and ongoing discussions, helping to address misconceptions, clarify misunderstandings, and permit a deeper understanding of the issues at hand (Box 3)

Finding 3:

Soy policies are leading to many unforeseen consequences because policies are addressing only the technical complexity in isolation from the social complexity of the wicked soy problem. We have identified three main unforeseen consequences in current soy policies which include: (i) erosion of conservation behaviour and resentment towards the conservation agenda; (ii) 'panic' clearing, that is rushed clearing activities in response to expected clearing limitations imposed by new regulations; and (iii) displacement of deforestation onto other regions and other commodities, leading to changes in trading patterns.

Recommendation: We suggest using the role-playing system games, developed in the context of this project (Box 2), to assess the unforeseen consequences of different policy designs. Not accounting for potential unforeseen consequences can otherwise lead to ineffective policy interventions. For example, does working on economic incentives (e.g. tax breaks, payments for ecosystem services or differentiated credit rates) shift the mindsets of actors? And do these mind-shifts lead to aggregated decisions that benefit sustainability, or are there unforeseen consequences for different stakeholders? We also suggest during the role-playing game to debrief on barriers and opportunities for incentives to work for different stakeholder groups in different biodiverse regions.

Finding 4:

Current policies for sustainability in the soy supply chain may face chronic policy failure if there is the perception that maximising success for one stakeholder group is likely to come at the expense of another. Indeed, despite various public-private partnerships to support deforestation free policies, the lack of approaches to integrate public policy, business and local perspectives prevents the identification, design and implementation of strategies to incentivise, create opportunities or regulate for more sustainable business.

Recommendation: Coordination appears urgently needed to support negotiations on definitions of deforestation-free in an inclusive and collaborative way. A participatory process is needed as part of this coordination. The identification and evaluation of trade-offs of different definitions and possible solutions would help the negotiation and decision-making process to explicitly address the values and objectives held by key stakeholder groups. It would also effectively reduce the perception that maximising success for one stakeholder group is likely to come at the expense of another.

Finding 5:

Integrating footprint measurements with trade flow models has been increasingly used as a way to promote more transparent supply chains, but it but should be used with particular care in socially complex contexts. The use of footprinting measurements – which aim to provide essential information on the negative environmental impacts that have occurred in production, manufacture or consumption – can be useful in decision-making but there should be transparency also around what the footprint data will be used for, why and when early in the planning process with stakeholders so that footprint as a tool and dataset is embedded in inclusive and collaborative strategies.

Recommendation: We recommend that by capturing a broader range of footprints identified by stakeholders, it will be possible to incorporate a larger number of actors' objectives and values in decision-making. In particular, we recommend that such information could be embedded in softer decision-making systems, such as role-playing games, in order to help stakeholders, tangibly realise the trade-offs of different solutions in relation to these environmental and social impacts (See Finding 4).

Figure 1: Simplified summary of findings and recommendations

AMBIGUITY AND DIVERGENCE	TECHNICAL COMPLEXITY	UNCERTAINTY	VOLATILITY
FINDINGS	**FINDINGS**	**FINDINGS**	**FINDINGS**
Producers’ perceptions of their right to deforest Lack of shared responsibility in the supply chain Absence of indigenous and local communities’ voice	Complex dynamics driving deforestation End market characteristics of soy make sustainability challenging	Unforeseen consequences of policies have been: Erosion of conservation behaviours and resentment of conservation agendas Panic clearing in response to new regulations Displacement of problems elsewhere and onto other	New policies causing volatility in the supply chain but inertia in improving sustainability Perception that maximising success for one stakeholder group comes at the expense of another
RECOMMENDATIONS	**RECOMMENDATIONS**	**RECOMMENDATIONS**	**RECOMMENDATIONS**
Develop inclusive policies Strengthen collaborative strategies	Negotiate based on collective representation of the soy system	Assess unforeseen consequences of new policy designs through participatory multi-agents (role-playing) games	Engage in participatory, evaluation of the trade-offs of different definitions and solutions for different stakeholders
OUTCOMES EXPECTED	**OUTCOMES EXPECTED**	**OUTCOMES EXPECTED**	**OUTCOMES EXPECTED**
Legitimacy Trust Ownership Credibility	Better communication	Avoid ‘bad’ surprises	Stimulate empathy Future-focused decisions

INTRODUCTION

Supply chains have been described as the arteries of our global society. Today, these food arteries have become incredibly efficient – as well as complex, fast-changing and globally dispersed. They also often involve globally dispersed producers at one end and millions of consumers at the other end, with the two ends of the value chain many steps removed from one another. This spatial disconnect between the consumption of agricultural commodities and the location of their production can lead to significant detrimental environmental and social impacts. In view of these impacts, supply chain sustainability is rising in importance in the sustainability agenda.

Achieving sustainability in supply chains is often socially and technically challenging – in other words 'a wicked problem' (Rittel & Webber, 1973), requiring strategies under conditions of complexity, volatility and uncertainty, as well as often a high divergence of values and objectives in a frequently uncoordinated and dispersed supply chain (Figure 2). The terminology of 'wicked problems' was originally proposed by Rittel and Webber, both urban planners at the University of California, as problems that cannot be successfully treated with traditional linear, analytical approaches (Rittel and Webber, 1973). They called these unruly problems 'wicked' and contrasted them with 'tame' problems. According to them, tame problems are not necessarily simple – they can be very technically complex – but the 'tame' problem can be tightly defined, and a solution fairly readily identified or worked through (Rittel and Webber, 1973). By contrast, a linear approach does not lend itself well to a wicked problem because these problems are riddled with a high degree of complexity, uncertainty, and divergence and ambiguity in viewpoints and values (Rittel and Webber, 1973; Figure 2).

Supply chain sustainability is often socially complex because of differences in stakeholder values and objectives, and it is this aspect that often overwhelms policy approaches (Conklin 2006; Australian Public Service, 2007). A result of this divergence can be a high level of stakeholder conflict. The evidence in this report indicates that achieving sustainability in the soy supply chain system also faces a high degree of social complexity. Such conflicts are also often embedded in wickedly complex production and supply chain systems, characterised by non-linear dynamics, multiple feedback loops, and multi-causality, which together can result in dramatic differences in stakeholders' problem statements, objectives and tactics (Rittel & Webber, 1973; Mason et al. 2018).

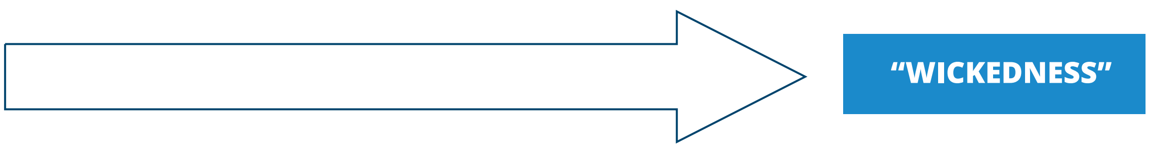
Further, because wicked problems are multi-causal with many interconnections to other issues, it is often the case that measures introduced to address one aspect of a problem lead to unforeseen consequences elsewhere (Rittel and Webber 1973; Larrosa et al. 2017). Currently, policies for sustainability in soy supply chain are also leading to many unforeseen consequences because policies are addressing only the technical complexity in isolation from the social complexity of wicked problems. Further, current policies for sustainability in the soy supply chain may face chronic policy failure if there is the perception that maximising success for one stakeholder group is likely to come at the expense of another.

This report is targeting organisations and individuals interested in and responsible for improving sustainability in the soy supply chain. The report is based on the findings of a co-produced project between a consortium of universities and sustainability practitioners in the soy sector. In this co-produced project, we have used a range of approaches to support sustainability in the soy sector, with a focus on the Cerrado in Brazil, including: i) interviews with stakeholders to ascertain their perception of barriers and opportunities in soy sustainability; ii) mapping sustainability commitments of soy stakeholders and analysing challenges with current policies; iii) developing new methods for land-use and supply chain footprint; and iv) using the evidence to develop a role-playing game that models the dynamics between land-use and supply chain systems.

The recommendations in this report can support organisations working in this sector in moving a step closer to more collaborative and inclusive approaches in the soy supply chain. We give a special focus to deforestation-free soy policies, taking account of the 'wickedness' of the problem.

Figure 2: Volatility, Uncertainty Complexity, and Ambiguity (often referred as VUCA in business or wicked problem in policy) are key features of supply chains; adapted from Head (2008).

Volatility in the nature and dynamics of change in supply chain.	Low	Moderate	High
Uncertainty in relation to risks, consequences of action, and changing trade patterns	Low	Moderate	High
Complexity of elements of sub-systems, multiplex of forces, confounding of issues, no cause-and-effect linear chain	Low	Moderate	High
Ambiguity and divergence in problem statements, objectives, values and tactics	Low	Moderate	High



MAIN FINDINGS AND RECOMMENDATIONS

Finding 1:

Achieving sustainability in soy supply chains is socially complex.

It is a key conclusion of the literature around wicked problems that the social complexity of wicked problems, rather than their technical complexity, overwhelms policy approaches (Conklin 2006; Australian Public Service, 2007). Yet solutions in the field of supply chain sustainability are often designed to mainly address their technical complexity, ignoring their social complexity. The evidence indicates that achieving sustainability in the soy supply chain system also faces a high degree of social complexity in three main ways: (i) producers' perception of their right to deforest; (ii) unwillingness to pay and hence share responsibility for sustainable soy in the supply chain; and (iii) lack of representation of indigenous and local communities in the sustainability agenda.

Firstly, a key socially complex aspect of soy sustainability is the Brazilian producers' perceptions of 'their right to deforest' (Guerrero et al. 2018, CFA output 4.2). Because of this perception, supply chain policies such as deforestation-free policies have been viewed by producers as 'ranging from unrealistic and unreasonable, to unfair and illegal' (in Guerrero et al. 2018, CFA output 4.2). This perception affects 'relationships among other supply chain actors as well as producers' responses to the environmental agendas' (in Guerrero et al. 2018, CFA output 4.2). For example, 'traders, Brazilian consumer-facing companies and some NGOs see these (deforestation-free) policies as penalising producers that are already conserving and not those who have already deforested and that do not acknowledge the burden already borne because of the Forest Code' (in Guerrero et al. 2018, CFA output 4.2). Brazil's Forest Code, a set of laws passed originally in 1965, and modified in 2012 and 2018, aims to protect the country's vast forest landscapes by requiring landowners to permanently maintain a proportion of the land as forest (80% in the Brazilian Amazon and 30% in the drier Cerrado). The laws were built around a system to register farmers with claims to forested lands in these key ecosystems.

In contrast to their counterparts in Brazil, European consumer-facing companies see this 'right to deforest' given by the Forest Code as problematic, because while some level of deforestation is considered legal in Brazil it does not mean that it is acceptable for consumers in a European context. 'This paradox of 'what is right' creates challenges for deforestation-free policies, and for how they are communicated' (in Guerrero et al. 2018, CFA output 4.2).

Based on this perception of the 'right to deforest', producers see that without compensation or economic incentives a deforestation-free policy will not work (Guerrero et al. 2018, CFA output 4.2). A second key barrier therefore preventing producers' engagement in soy policies such as deforestation-free is the perceived economic impact that such policies can have (Guerrero et al. 2018, CFA output 4.2). Other supply chain actors in Brazil are also concerned by this and in general see this economic impact further affected by a lack of alternative regional development opportunities, and a lack of market and other types of economic incentives (Guerrero et al.

2018, CFA output 4.2). Lessons from soy certification show however that there is significant lack of willingness from downstream actors and customers to pay for the cost of soy sustainability (Virah-Sawmy et al. 2018, CFA Output 1.2.1). The end market characteristics of soy, including the fact that soy is a hidden ingredient that is needed in vast volumes for animal feed to produce 'cheap meat' (Virah-Sawmy et al. 2018, CFA Output 1.2.1) may contribute to the lack of willingness of customers and retailers to share that cost. In other words, both the social and technical complexity of the soy supply chain – including the end market characteristics of soy – affect the willingness to pay for sustainability.

While soy producers feel excluded and penalised by the environmental agenda, local and indigenous communities are also experiencing many negative impacts from the soy industry (Virah-Sawmy et al. 2018, CFA Output 1.2.1). For example, there is evidence of increasing income inequality between soy farmers, often coming from the elite class from the South of Brazil, and local farmers from the Amazon and Cerrado (Weinhold et al. 2013). As Weinhold et al. (2013, p142) note that 'even as all levels of local populations benefit economically from the growth of soybean production, large landowners accrue, or are perceived to accrue, relatively more gains (in the Amazon)'. Second, with the macroeconomic and policy shifts in Brazil from the 1980s, larger soy farms that became established then in the central west of Brazil became far more competitive. As a result, only soy farms above 500 square hectares became profitable – which led to a significant number of small-scale family farms going out of business, especially those in the South (EnREDando, 2008; García-López and Arizpe, 2010). This inequality is reflected in the agriculture sector, which shows that for Brazil, 1% of farms generate more than half of the gross income of the sector (Navarro and Campos, 2013). Thirdly, soy expansion in Brazil and its associated impacts on smallholder farming have led to massive concentration of land ownership and consequently raise huge concerns over local community and indigenous land rights. The consequences of this are varied and complex and it is an important area of concern for bottom-up initiatives against soy farming (García-López and Arizpe, 2010). Such complex impacts on local communities and indigenous land rights render the soy sector extremely socially complex (Virah-Sawmy et al. 2018, CFA Output 1.2.1).

The evidence would suggest that by ignoring social complexity, some stakeholders may have created more adversarial conditions for sustainability – not only by entrenching producers' positions that certain policies such as deforestation-free soy are 'unrealistic and unreasonable, to unfair and illegal' (in Guerrero et al. 2018, CFA output 4.2), but also by exacerbating distrust and unwillingness to engage (see later in unforeseen consequences). In this, it is important to bear in mind that while sustainability conflict cannot be fully resolved in the sense that conflict is eliminated, approaches are needed for working intelligently with power differences and conflicts (Conklin, 2006). This should enable different sides to embrace and practice listening, reflection and learning, intelligent dialogue, and negotiating and mediating from a place of empathy and system awareness towards the emergent future (Weisbord and Janoff, 2003, 2007; Scharmer, 2007; Dilts, 2016). Skilled facilitation is needed because these conflicts are deeply sensitive and often linked to unequal power relations and diverging attitudes and values that are rooted in social and cultural history. In this, skilled facilitation can aid parties in becoming ready to negotiate.

Recommendation: Effective conflict management and long-term benefit will be enhanced by better integration of the socially complex aspect of soy sustainability to achieve more collaborative and inclusive strategies.

Further, because of the social complexity of soy sustainability, managing it is fundamentally a social process in which skilled facilitated approaches are needed to work intelligently with power differences and conflicts. More practically, in terms of deforestation-free policies, coordination appears urgently needed to support negotiations on definitions of deforestation-free in an inclusive and collaborative way. This inclusive approach would include not only soy supply chain actors, but also related sectors involved in land-use change (see Finding 2) and socially impacted groups. A transparent and inclusive evaluation of the trade-offs of different definitions for different stakeholders would help the collaborative process (see Finding 4). Trusted and skilled facilitators and negotiators would be needed for an effective collaborative process (Box 1).

BOX 1: SOME KEY PRINCIPLES FOR COLLABORATIVE AND INCLUSIVE STRATEGIES

1) Distributed decision-making and effective coordination is needed, as wicked problems go beyond the capacity of any one organisation to understand and respond – and therefore often require work across agency boundaries. This includes working in a devolved way with the community, government and commercial sectors (Australian Public Service, 2007; Mason et al. 2018). In this, the hosting organisation leading and coordinating strategies matters. This is because the perceptions of key stakeholders regarding the credibility and legitimacy of the hosting organisation will determine their likelihood to participate and engage fully (Cash et al. 2003).

2) The right stakeholders need to sit at the table. One formula for selecting the right people to co-design and co-facilitate the change process can be for example 'ARE IN': those in Authority, and those with Resource, Expertise, Information and Need To – for a variety of reasons, including for example that they are impacted or have influence (Weisbord and Janoff, 2003). Leaving out key groups or involving them too late can quickly undermine collaborative strategies. But as the partnership evolves, the focus may change, meaning that new groups may need to be included and others may drop out.

3) Because of social complexity, solving a wicked problem is fundamentally a social process in which skilled facilitated approaches are needed to work intelligently with power differences and conflicts (Conklin, 2006) so that different sides can embrace and practice listening, reflection and learning, intelligent dialogue, and negotiating and mediating from an empathic and system awareness place towards the emergent future (Weisbord and Janoff, 2003, 2007; Scharmer, 2007; Dilts, 2016). Facilitation is the process that supports parties in becoming ready to negotiate on sustainability policies. Once parties are ready to negotiate, mediators can help stakeholders reach a settlement between themselves that they can both agree on. Considerable time and resources are needed to embrace socially complex issues.

4) System science tools are needed to help stakeholders have a shared understanding about the problem, and shared commitment to the possible solutions. Shared understanding does not mean we necessarily agree on the problem (Conklin, 2006; Jones et al. 2011). Shared understanding means that the 'stakeholders understand each other's positions well enough to have intelligent dialogue about the different interpretations of the problem, and to exercise collective intelligence about how to solve it' (in Conklin, 2006).

5) Trade-offs associated with alternative interventions needs to be better understood as a basis for decision-making. In particular, there are benefits for a participatory process to map trade-offs so that stakeholders can participate in discussions on an equal footing and make informed decisions. This helps in the transparency of the underlying basis for stakeholder positions and their goals; the values and goals of the scientists involved in the process; and the available evidence together with its uncertainties and gaps (Redpath et al. 2013; Mason et al. 2018).

BOX 1B: WHAT DOES HIGH VERTICAL INTEGRATION IN THE SOY SUPPLY CHAIN IMPLY FOR SUSTAINABILITY?

The soy value chains reflect the broader trend of globalisation in the agri-food sector (Virah-Sawmy et al. 2018). This is characterised by:

1) Industrial-scale soy production by agribusinesses in South America;
2) Increasing international trade for soy due to replacement of more expensive local feed alternatives and rising meat demand;
3) Industrial meat production in developed and emerging countries and hence dependence on feed; and
4) Finally, vertical integration of activities along the value chain. A consequence of this broader trend of globalisation is that market concentration along the soy value chain from upstream to downstream is high, in particular with soy traders, meat producers, and retailers (Figure 3 & 4).

In these value chain networks, large buyers are dependent on large sellers. On one hand, the soy value chain potential for influence over sustainability due to sector concentration and therefore leverage influence of a few actors is significant (Virah-Sawmy et al. 2018). On the other hand, because both large purchasers and large suppliers face significant switching costs, they are, therefore, 'captive', and none of the value chain actors can impose sustainability demands on the rest of the supply chain as seen in other value chains, without incurring cost themselves (Virah-Sawmy et al. 2018). Thus, soy sustainability is likely to be possible only through shared responsibilities and agreement.

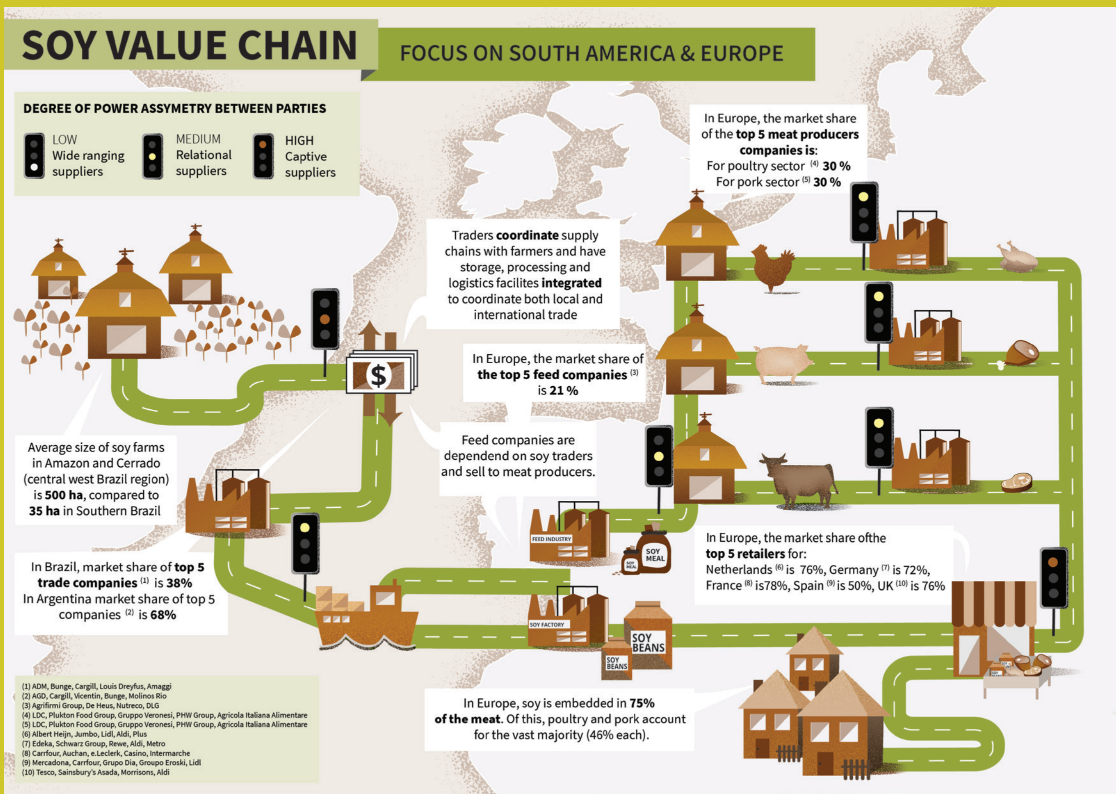


Figure 3: The value chain: a focus on South America and Europe shows high market concentration in the soy supply chain which may result in a sustainability gridlock because none of the value chain actors can impose sustainability demands on the rest of the supply chain, without incurring costs themselves (Virah-Sawmy et al. 2018).

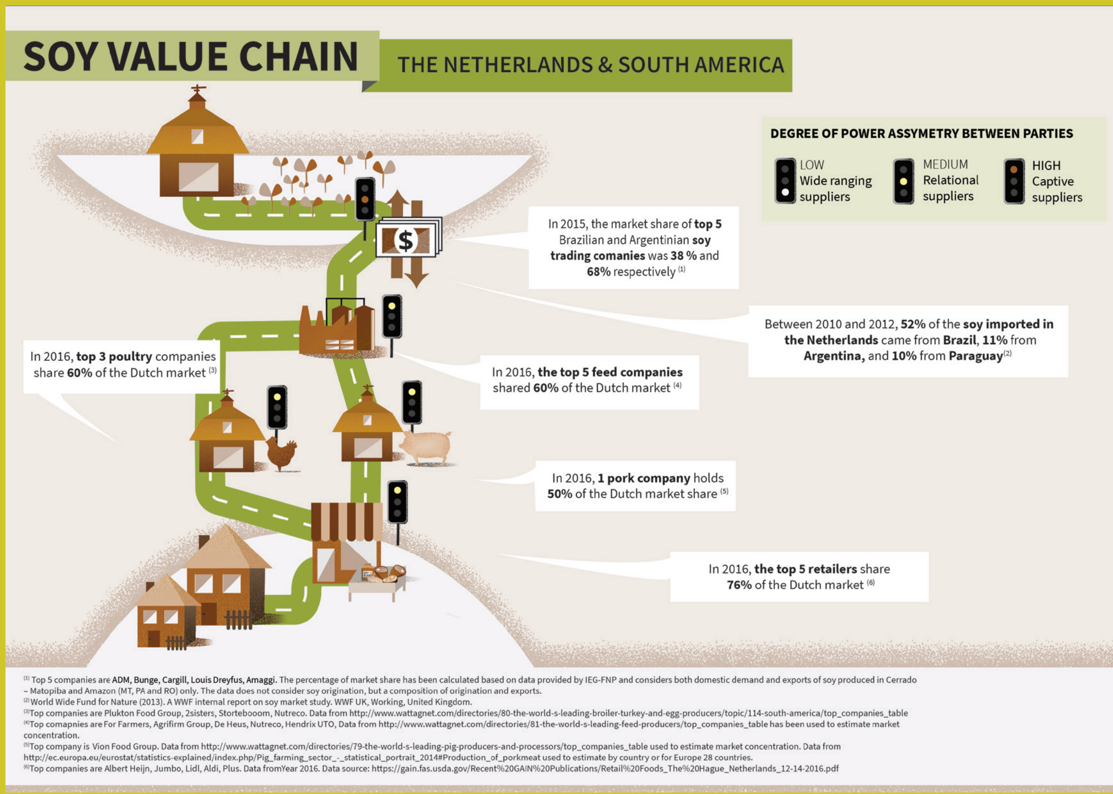


Figure 4: The value chain: a focus on South America and the Netherlands shows very high market concentration in the soy supply chain, demonstrating high market concentration in the soy supply chain. This may result in a sustainability gridlock because none of the value chain actors can impose sustainability demands on the rest of the supply chain, without incurring costs themselves (Virah-Sawmy et al. 2018).

Finding 2:

Technically complex elements in the soy production and supply chain systems are contributing to stakeholders' differences in problem statements, objectives and tactics.

Wicked problems are notoriously difficult to clearly define. In fact, 'the nature and extent of a wicked problem depends on which stakeholders have been asked; that is, different stakeholders perceive the problem differently. Often, each version of the policy problem has an element of truth — no one version is complete or verifiably right or wrong' (in Australian Public Service, 2007, Rittel and Webber, 1973). These diverging viewpoints arise often because of the wickedly complex nature of socioecological systems, characterised by nonlinear dynamics, multiple feedback loops, and multi-causality, which together often result in stakeholders' differences in problem statements, objectives, and tactics (Rittel & Webber, 1973; Mason et al. 2018). Two key complex aspects in the soy production and supply chain systems that are giving rise to stakeholders' differences in problem statements, objectives and

tactics are: (i) complex land-use dynamics including the role of other sectors and land-speculation in deforestation; and (ii) end market characteristics of soy, that is, soy being a hidden ingredient needed in high volumes for animal feed to produce 'cheap' meat (see Finding 1).

The debate concerning the drivers of deforestation in the Amazon and the Cerrado are good case examples of the difficulty in defining the soy problem. On the surface, soy is viewed by many as the driver of deforestation. Nonetheless, evidence that it is and that it is not is being used on both sides of the argument – those calling for the soy sector to act more responsibly, and those saying it is doing enough. For example, our own results on the biodiversity footprint of soy in the Cerrado indicate that during the period 2000 to 2014, it is the combination of a range of types of land use including planted pastures, and soy and other crops that generate most of the biodiversity impact (Duran et al. 2018, CFA output 1.2.1). However, soy had the greatest biodiversity impact per unit of land because the soy crop had expanded to encroach on pristine forest frontiers like Matopiba (Duran et al. 2018, CFA output 1.2.1). So where does this take us? Soy is the direct driver at the forest frontiers but works indirectly with other commodity production in forest-agriculture landscapes. In both landscapes, some argue it is soy producers who are practising multi-crop farming – and these arguments reflect the complexity of defining the 'soy' problem.

Two principal pathways have been described in explaining the indirect impacts of soy:

- **(1)** Influencing land markets: by occupying enough pasture to significantly reduce local beef production, then raising beef profits. Alternatively, as soy became profitable, the land value increases and farmers are incentivised to clear their land to increase their property value; and
- **(2)** Influencing land displacement elsewhere: by expanding into pasture, soy displaces livestock production, with its associated land clearing, to frontier regions. Although the relative importance of the different pathways hasn't been fully understood, existing evidence suggests that soy's environmental impacts are increasingly driven by influencing land markets.

However, is land appreciation a soy farmer's problem, or a larger system problem – and does it matter? Yes, it does – because the quality of collective action will depend on how we integrate different perspectives on root problems with an open mind. If seen only as a farmer's problem, retailers with deforestation-free commitments may put pressure solely on soy farmers and soy land-use. If seen also as a Brazilian land opportunity challenge or a global 'cheap meat' challenge, then perhaps all stakeholders, not only soy farmers, can meet each other on an equal playing field. Shared representation of a system can thus support co-created solutions that are often deeply transformative.

A common understanding of these larger complex system dynamics means that 'the stakeholders understand each other's positions well enough to have intelligent dialogue about the different interpretations of the problem, and to exercise collective intelligence about how to solve it' (in Conklin, 2006). Participatory approaches such as role-playing games and sharing of mental models, both of which this science-policy project have contributed to, are known to support discussion among stakeholders over a collective system representation that can lead to: 1) improving communication and decision-making processes (Abel et al. 1998; Jones et al. 2010; Dray et al. 2012;

Game et al. 2018); 2) identifying and overcoming stakeholders' knowledge limitations and misconceptions associated with a given driver (Morgan et al. 2002); 3) developing more socially robust knowledge to support negotiations over unstructured problems in complex, multifunctional systems (Kolkmann et al. 2005); and 4) identifying assumptions in order to focus additional information and research.

Recommendation: A shared understanding of the dynamics between land-use and supply chain systems would help stakeholders understand each other's positions well enough to have intelligent dialogue about the different interpretations of the problem. We suggest the use of the role-playing game, that we have developed to model the complex dynamics between land-use and supply chain system, to be played with stakeholders in important biodiverse regions of South America. This will support a shared representation of land-use dynamics – especially regarding the feedback loops between land-use practices, land speculation and the role of different stakeholders in the supply chain and other sectors in this dynamic (Box 2). Further, to improve common understanding of supply chain issues, we suggest sharing the mental models of different stakeholders around soy sustainability issues, also developed in the context of this project. When used in an iterative way, the sharing of mental models can be useful to support interactions and ongoing discussion, helping to address misconceptions, clarify misunderstandings, and permit a deeper understanding of the issues at hand (Box 3).

BOX 2: COMPANION MODELLING OR ROLE-PLAYING GAMES TO SUPPORT A COLLECTIVE REPRESENTATION OF THE SOY SYSTEM

On one hand system tools such as systems dynamics, Bayesian networks and coupled component models, have explored the technical aspects of complex problems such as multi-causality, interdependencies, and non-linearities. On the other hand, bringing out (eliciting), sharing and discussing different mental models (how people organise concepts such as deforestation-free supply chain in their mind) can be beneficial for social complexity – as it allows researchers to map commonalities and differences in the way the problem is understood, and in perceived pathways to change from the viewpoint of different stakeholders (Abel et al. 1998; Dray et al. 2012).

Role-playing games (also known as companion modelling) is an approach that has the advantage of allowing players to explore both social and technical complexities in tandem. Indeed, the 'major difficulty when dealing with wicked problems lies in understanding not only technical aspects of the system, but also players' segmented perceptions of the system, and their agendas, that at times appear to conflict, at other times genuinely do so' (in Garcia et al. 2016). Thus, what is critical with role-playing games is to represent 'the system and stakeholders including their power and knowledge asymmetry' (in Garcia et al. 2016). Players can observe 'how the system structure generates effects over time, and how actor behaviours manifest in consequences' (in Garcia et al. 2016). Such games in real world decision contexts offer an opportunity for deep interaction between actors in a system where we know power effects are in play and can change in this process. Collective debriefings allow 'lessons to be drawn on the reasons for success and failure of different strategies on different stakeholders' (in Garcia et al. 2016).

As part of this co-produced project, we have used science-policy information to develop a soy game for stakeholder engagement (CFA output 4.2). The game models how soy farmer decisions are influenced by interactions with multiple markets and traders (market barriers), multi-commodity farming and changing commodity pricing (economic barriers), and the contrasting governance interventions across a forest and a savanna biome (representing the Amazon and the Cerrado respectively) that affects their notion of land rights (cultural barriers). Emerging results indicate that those landscapes are in a lock-in towards forest transitions and leakage, due indeed to these strong market, economic and cultural forces. The role-playing game can be used as a stakeholder engagement to test preferred strategies of different supply chain actors that can be leveraged to move away from this current lock-in.

Figure 5: First validation of the soy game in Brazil

Finding 3:

Soy policies are leading to many unforeseen consequences because policies are addressing only the technical complexity, in isolation from the social complexity of wicked problems.

Because wicked policy problems are multi-causal, with many interconnections to other issues, it is often the case that measures introduced to address one aspect of a problem lead to unforeseen consequences elsewhere — and on the target aspect through feedbacks in the system (Rittel and Webber 1973; Larrosa et al. 2017). Not accounting for potential unforeseen consequences can thus lead to ineffective policy interventions. We have identified three main unforeseen consequences in current soy policies, which are: (i) erosion of conservation behaviour and resentment towards the conservation agenda; (ii) 'panic clearing', that is rushed clearing activities in response to expected clearing limitations imposed by new regulations; and (iii) displacement of deforestation onto other regions and other commodities, leading to changes in trading patterns.

Supply chain actors have reported that current environmental laws, policies, or commitment towards zero deforestation have led to perverse outcomes in the system (Guerrero et al. 2018, CFA Output 4.2). These unforeseen consequences have included the erosion of conservation behaviour, resentment towards the conservation agenda, and an increase in quick and unnecessary land clearing in response to a perceived threat of policy-induced changes to land clearing rights (aka "panic" clearing) (Guerrero et al. 2018, CFA Output 4.2). In this, there is a risk that deforestation-free policies penalise those who have previously adopted conservation behaviours and thus lead to unintended consequence in producers' mind shifts away from sustainability.

Deforestation-free policies can also lead to other unforeseen consequences such as the displacement of the problem elsewhere. For example, deforestation-free interventions within a limited geographic scope (e.g. the Soy Moratorium, – a pact between some consumer facing companies, soy traders, government and the civil society, aims at preventing the sale of soy from deforested areas in the Amazon region) have restricted the production of commodities in one place, therefore decreasing supply of those commodities and encouraging displacement of production to other locations. The unforeseen consequences were possibly the movement of large-scale soy and cattle producers to other regions such as the Cerrado of Brazil, the Chaco region of Argentina, Paraguay and Bolivia to acquire land for deforestation in areas where there are less strict regulations (Lambin et al. 2018).

The fragmented nature of sustainability activities can lead to changing governance context which may then restructure trade patterns and supply chain flows. Regions with more lax deforestation regulations may redirect the commodities to domestic markets (Lambin et al. 2018). For example, laxer regulations in the Cerrado compared to the Amazon may contribute to Cerrado soy being directed to domestic soy market. This change in trade patterns may explain why Brazil itself is responsible for 45% of impacts on endemic biodiversity in the Cerrado, the greatest overall impact of any one country (Green et al. 2018, CFA output 1.2.1).

And even when deforestation-free commitments apply to entire sectors or regions, deforestation risks remain due to increase in the risk of leakage via other commodities. For example, under the Soy Moratorium, on-property leakage may have occurred when soy farmers continue to deforest for non-soy land uses such as cattle ranching (Lambin et al. 2018). Not accounting for such potential unforeseen consequences can thus lead to ineffective policy interventions.

These unforeseen consequences are often the case because policies are addressing only the technical complexity in isolation from the social complexity of wicked problems (Larrosa et al 2017). They also arise to the fragmented nature of sustainability activities. These policies may create a lot of volatility in the supply chain system – but inertia in achieving sustainability. For example, our work with stakeholders on barriers and opportunities for improving sustainability in the soy supply chain revealed a lot of market inertia around deforestation-free policies in that 'traders lack incentives to make change happen, consumer-facing companies are averse to making the first move, and where producers' mindsets and the lack incentives result in unwillingness to engage in a conservation policy that goes beyond the requirements of government legislation' (in Guerrero et al. 2018, CFA Output 4.2).

Recommendation: We suggest using the role-playing system games, developed in the context of this project (Box 2), to assess the unforeseen consequences of different policy designs. Not accounting for potential unforeseen consequences can lead to ineffective policy interventions. For example, does working on economic incentives (e.g. tax breaks, payments for ecosystem services or differentiated credit rates) shift the mindsets of actors? And do these mind-shifts lead to aggregated decisions that benefit sustainability or are there unforeseen consequences for different stakeholders? We also suggest during the role-playing game to debrief on barriers and opportunities for incentives to work for different stakeholders' groups in different biologically diverse regions.

BOX 3: RESULTS OF THE METHODOLOGY THAT FOCUSES ON THE ELICITATION OF THE 'MENTAL MODELS' OF STAKEHOLDERSAROUND DEFORESTATION-FREE SOY POLICIES

Eliciting, sharing and discussing different mental models of stakeholders around complex concepts such as a deforestation-free supply chain can be beneficial for social complexity, as it allows the mapping of commonalities and differences in the way the problem is understood, and on perceived pathways to change from the point of view of different stakeholders (Abel et al. 1998; Gray et al 2012). Mental model construct is different to stakeholder surveys as the former explores why people think the way they do and the reasoning behind people's choices. Through this science-policy project, Angela Guerrero has interviewed a number of stakeholders, businesses and NGOs in order to construct stakeholders' mental models of deforestation-free policies in the soy supply chain (Guerrero et al. 2018; CFA Output 4.2).

The evidence from analysis of these mental models points to a deadlock in achieving sustainability and collective action in the soy supply chain chain because 'traders lack incentives to make change happen, consumer-facing companies are averse to making the first move, and where producers' mindsets and the lack incentives result in unwillingness to engage in a conservation policy that goes beyond the requirements of government legislation' (in Guerrero et al. 2018, CFA Output 4.2).

However, the results also point to opportunities that can assist initiatives for deforestation-free soy as they develop strategies to break this deadlock (Guerrero et al. 2018, CFA Output 4.2).

These include:

- Understanding companies' decision-making processes can ensure that strategies developed are effective in helping companies translate commitments into company policies. In this, environment and social impacts posed by business operations are not the only important determinants of the type of supply chain initiatives that are chosen (Rueda et al., 2017). Other factors – such as level of vertical integration including leverage of suppliers, competitive environment in which businesses operate, consumer and civil society awareness, strength of local enforcement, and end market characteristics – also play a key role in decision-making (Rueda et al., 2017; Virah-Sawmy et al. 2018). In other words, likelihood to achieve success also depends on these factors – which can also determine whether soy achieves priority in the busy sustainability agenda of companies. It is possible that working on these factors can result in very different commitments – from very loose ones, that we now see in the soy space, to highly ambitious ones (Guerrero et al. 2018; Virah-Sawmy et al. 2018, CFA Outputs 1.2.1 and 4.2).

- •Economic incentives (e.g. tax breaks, payments for ecosystem services or differentiated credit rates), as suggested by some respondents, can help engage producers without having to break the cultural barrier. In fact, these incentives can work in harmony with the values held by farmers and reduce the over-reliance of enforcement of the Forest Code as a governance mechanism. We suggest using the role-playing games to test whether such policy design adjustments, i.e. working on incentives, may indeed challenge or even shift the mindsets of actors. This will help assess whether these incentives will lead to aggregated decisions that can ultimately alter the emergent intent of any given system of interest. We also suggest during the game to debrief on barriers and opportunities for incentives to be put into place.

- •Working on contested issues that if answered can help address some of the perceived barriers. One of these is the role of illegality in soy production. Working on these contested issues can easily be achieved through the role-playing game we have designed.

- •Working with governments and the financial sector can play a key role in putting pressure on companies globally, and in supporting and incentivising producers locally. This requires collaboration and better information on impacts of deforestation, so that investors and shareholders can take actions to avoid risks.

Finding 4:

Current policies for sustainability in soy supply chain may face chronic policy failure if there is the perception that maximising success for one stakeholder group is likely to come at the expense of another.

Many governments, private sector companies and their investors have committed to deforestation-free supply chains. The commitments form part of collective action, for example of the Tropical Forest Alliance of the Consumer Good Forum, which is a global public-private partnership to reducing tropical deforestation related to key global commodities by 2020. Another example is the Amsterdam Declaration, which was signed by Denmark, France, Germany, Italy, the Netherlands, Norway and the United Kingdom to lend public support to the implementation of existing private and public sector commitments to achieve fully sustainable and deforestation-free agricultural commodity supply chains in Europe by 2020. However, to date, the lack of approaches to integrate public policy, business and local perspectives prevents the identification, design and implementation of strategies to incentivise, create opportunities or regulate for more sustainable business (Green et al. 2018).

For example, delivery of deforestation-free soy is dependent on the supply chain flow. In other words, a signatory country for deforestation-free supply chain will not be able to achieve their commitment, if they do not know the soy flow in their supply chain. In this regard, if the dominant soy producers, traders and downstream actors in a particular country are not signing these commitments, then the deforestation-free commitment of this particular country could be meaningless. Taking for example the Netherlands as a case study, Green et al. (2018) show that a large proportion of soy imported to the Netherlands, a country that is part of the Amsterdam Declaration, is being sourced from traders without zero-deforestation commitments. By default, this means that the Netherlands will not be able to fulfil or verify its deforestation-free commitments without understanding its supply chain flow. On one hand, it shows that any supply chain approach needs a systematic and coordinated methodology across public and private spheres to address the technical complexity. But if viewed only as technically complex, the Netherlands could nudge businesses to source from only traders or countries that have zero-deforestation commitments increasing the perception that maximising success for one stakeholder group is likely to come at the expense of another. Such a solution, in addition, could also lead to unforeseen consequences such as changes in trading patterns.

Another issue is that pledges vary in their definitions of deforestation-free commitments, including time-bound interventions and criteria to achieve verifiable outcomes (Lambin et al. 2018). Angela Guerrero's interviews with soy stakeholders also confirm that there are variable definitions of deforestation-free commitments in the soy system, including between parent companies and their local entities (Guerrero et al. 2018, CFA Output 4.2). Her work indicates 'that the definitions, include 'no opening of land of any kind' (producer association), 'no conversion of natural habitats' (international NGO), 'no conversion of natural vegetation' (trading company), 'no conversion of native vegetation' (local NGO)' (Guerrero et al. 2018, CFA Output 4.2). These variable definitions and preferences frustrate attempts to align coordinated action towards deforestation-free soy supply chains (Guerrero et al. 2018, CFA Output 4.2). Critically, these variable definitions do not just reflect technical complexity, but also the social complexity.

Recommendation: Coordination appears urgently needed to support negotiations on definitions of deforestation-free in an inclusive and collaborative way. A participatory process is needed as part of this coordination. The identification and evaluation of trade-offs of different definitions and possible solutions would help the negotiation and decision-making process to explicitly address the values and objectives held by key stakeholder groups. It would also effectively reduce the perception that maximising success for one stakeholder group is likely to come at the expense of another. This helps to increase legitimacy, credibility and ownership of solutions.

BOX 4A: PARTICIPATORY TRADE-OFF ANALYSIS FOR DECISION-MAKING AS PART OF NEGOTIATING PROCESS ON DEFINITIONS OF DEFORESTATION-FREE

To facilitate a participatory decision-making process, we recommend the use of a participatory trade-off analysis that can facilitate transparent, logical and defensible decisions (Gregory et al. 2012). This process focuses on addressing the values and objectives of those involved in the decision-making process. This is accomplished through a core set of steps that will help to structure and guide the thinking about the definitions of deforestation-free and of solutions. These steps include: the identification of objectives (i.e. outcomes sought from deforestation-free definitions); identification of potential management alternatives; exploration of the consequences of the alternatives in relation to the objectives; and examination of the trade-offs between objectives for different stakeholders. Such trade-off analysis has several advantages – it permits analysis of problem components in detail, facilitates a shared understanding of the complexities and particulars of the problem, helps identify knowledge gaps, and because the approach is undertaken formally and cooperatively, it supports defensible decision-making. It can be used as part of the process to support negotiations on definitions of deforestation-free in an inclusive and collaborative way.

Figure 6: Using role-playing system game to negotiate land-use change in the Amazon and the Cerrado

Finding 5:

A broader range of footprints is needed to incorporate a larger number of actors' objectives and values in decision-making about negative impacts.

Integrating footprint measurements with trade flow models has been increasingly used as a way to promote more transparent supply chains (Gardner et al. 2018). The use of footprinting measurements – which aim to provide essential information on the negative environmental impacts that have occurred in production, manufacture or consumption – can be useful in decision-making, but should be used with particular care in socially complex contexts. We reflect on our approach of delivering biodiversity footprint of supply chain to stakeholders in the soy system.

Mapping the full life-cycle of commodities and the set of actors involved provides essential information on the impacts and responsibilities, which has been one of the aims of this project. Environmental footprints are excellent tools to raise awareness about the impacts associated with commodity production and can prompt environmental action. They also attract the attention of decision-makers. Indeed, revealing where environmental impacts have occurred, and the damage done, can provide insights that guide future land-use decisions. Indeed, Angela Guerrero's interviews with stakeholders revealed that NGOs have played an important role in how companies (consumer-facing companies and soy traders alike) are responding to calls for deforestation-free policies (Guerrero et al. 2018), partially due to their advocacy in raising awareness on environmental impacts.

We argue, however, that in socially complex situations, environmental footprints should be used with particular care. Specifically, there should be transparency around what the footprint data will be used for, why and when early in the planning process with stakeholders so that footprint as a tool and dataset is embedded in inclusive and collaborative strategies. Different footprints are valued differently for different stakeholders. By capturing a broader range of footprints, it will be possible to incorporate a larger number of actors' values in the decision-making process.

Recommendation: We recommend that by capturing a broader range of footprints identified by stakeholders, it will be possible to incorporate a larger number of actors' values in decision-making. In particular, we recommend that such information could be embedded in softer decision-making systems such as role-playing games – in order that it helps stakeholders see the trade-offs of different solutions in relation to these environmental and social impacts, for informed decision-making. (See Finding 4).

BOX 5A: BIODIVERSITY FOOTPRINT OF SOY EXPANSION IN THE BRAZILIAN CERRADO: WHAT DO WE KNOW ABOUT THE CASE OF BIODIVERSITY? By Paz Duran, lead scientist

Assessing the biodiversity consequences of habitat conversion has been historically challenging and doing this for the Cerrado was no exception: species use habitats differently and they also respond to habitat changes (hence land-use change) in different ways. Capturing such distinctions and translating them into a metric that allows the understanding of the costs to biodiversity of land-use change is difficult. But a new study as part of this project has shed some light on how to do it and what this means for the Cerrado (Duran et al. 2018, CFA output 1.2.1).

The study uses an approach based on a 'habitat suitability model', which allows integrating spatially-explicit information on the ecology of individual species with specific anthropogenic land use. The study used experts' knowledge on species' habitat preferences to estimate how land-cover change in the Cerrado affects the persistence of species. With this information the researchers could assess biodiversity impacts of different land use types in the period of 2000-2014 (Duran et al. 2018, CFA output 1.2.1).

A key novelty of this biodiversity impact metric is that it allows the assessment of species-level impacts. The study revealed that, from the over 2,000 species assessed in the Cerrado, plants have suffered the greatest reduction of suitable habitat between 2000-2014 as a result of land-use change. On average, plants lost an alarming 16 % of their suitable habitat extent, compared to mammals (6 %), birds (6 %) and amphibians (5%). But, when the historical habitat losses are considered (since pre-industrial times), mammals are the most affected group – with just 23% of their original habitat extent remaining. In particular, data on the habitat preferences of the South American Tapir show their habitats as restricted and by losing further suitable habitat, even if only to a relatively small degree, its chances to persist decline faster. Lastly, when focusing on species that occur within the Cerrado only, birds were the most affected group. Considering the amount of suitable habitat loss that endemic birds have experienced, the study estimates that by 2014 the chances of persistence of this endemic group had halved.

But, what is driving biodiversity loss? The methodology used by the study can indeed disentangle biodiversity impacts of specific land uses. This can reveal the relative effects of different human activities, such as soy production or cattle ranching. Interestingly, results show that, while planted pastures and other cropland were together responsible for the largest extent of converted habitat and consequently the biggest absolute biodiversity footprint, soy has had the greatest biodiversity impact per unit of area. In other words, relative to other land uses, soy has had an outsized effect on species' persistence per each unit of converted habitat.

These results can be explained by looking more closely at the dynamics of land use. On the one hand, while a major proportion of soy expansion has occurred within already cleared land, a substantial fraction has expanded into unconverted and well-preserved habitat, therefore resulting in a high biodiversity loss for each hectare of habitat converted under soy. This clustered expansion, known as the new soy agro-frontier, has taken place across four states located in the northern Cerrado habitat, known as 'MATOPIBA' (from Mato Grosso,Tocantins, Piauí, and Bahia).

Like this study, previous evidence has also suggested that the dynamics of soy expansion are rather complex (Richards, 2015), and consequently its environmental impacts cannot be fully captured through assessments of direct land conversion.

BOX 5B: BIODIVERSITY FOOTPRINT OF SOY SUPPLY CHAIN IN THE BRAZILIAN CERRADO

Assessing the biodiversity impacts of supply chain flows is a real challenge because it requires building a model that can incorporate data on biodiversity impacts of land-use with data on trade flows. Green et al. (2018) developed a novel approach that modelled trade flows, which provide information on the amount of a commodity produced in a particular location (in this case, Brazilian municipality) and its subsequent flow through a supply chain included embedded soy in meat. They then attributed the impact of commodity production to its consumption by extending the model to account for the impact on biodiversity, using information from the land-use footprint (Duran et al. 2018). The trade data includes the input-output trade analysis model (IOTA), which combines commodity-level data, in physical units, with sectoral-level expenditure data, in monetary units, to represent the entire supply chain through to final consumption whilst retaining high-resolution information on origin of production (Green et al. 2018).

The results indicate that in the case of soy in the Cerrado, Brazil's domestic consumption accounts for 45% of impacts on endemic biodiversity in the Cerrado, the greatest overall impact of any one country. International demand, especially from China, drives the second highest impact — accounting for 22% of biodiversity impacts for the same volume of soy produced in the Cerrado as for domestic consumption in Brazil. This difference in impact for the same volume of soy produced is due to the fact that Brazilian consumer demand is met to a greater extent by municipalities in the southern and more heavily impacted central parts of the Cerrado, whereas Chinese demand is more tightly concentrated in the northeast. What might be ensuing is that supply chain flows from regions with more stringent deforestation regulations may be directed to Europe, while those with laxer regulations are then simply redirected to domestic markets (Lambin et al. 2018).

CONCLUSION

While there are signs of greater awareness and efforts to achieve sustainability in the wicked problem of soy supply chains, there is a risk that the negative impacts are shifted from international markets to domestic markets depending on the stringency of regulations. There is much scope for optimism, but major international efforts are required to ensure a uniform and globalised approach, taking into account both social and technical complexities. In particular, we urge organisations and individuals interested in and responsible for improving sustainability in the soy supply chain to see that sustainability is fundamentally a social process, in which skilled and independent facilitated approaches are needed to work sensitively with power differences and conflicts.

Participatory research methods – such as the role-playing system games and sharing of mental models we propose – can support the development of integrated, transparent, inclusive and collaborative approaches. Such research methods work by building a collective representation of the soy system, allowing stakeholders to tangibly view the trade-offs for different stakeholders, and assess the unforeseen consequences of different policies. In this way, stakeholders understand each other's positions well enough to have intelligent dialogue about the different interpretations of the problem – and to embrace collective intelligence in moving confidently towards a future of sustainable soy for the benefit of all.

References

Abel, N., Ross, H. and Walker, P. 1998. Mental models in rangeland research, communication and management. Rangeland Journal 20:77-91

APSC — Australian Public Service Commission. 2007. Tackling Wicked Problems: A Public Policy Perspective. Canberra: APSC, available at *http://www.apsc.gov.au/publications07/wickedproblems.pdf*

Conklin, J. 2006. Dialogue Mapping: Building Shared Understanding of Wicked Problems, John Wiley & Sons, Chichester, West Sussex.

Dilts, R. 2016. Generative Collaboration: Releasing the Creative Power of Collective Intelligence. Published by Success Factor Modeling.

Dray, A. et al. 2006. The AtollGame experience: from knowledge engineering to a computer-assisted role-playing game. Journal of Artificial Societies and Social Simulation 9:6.

Duran et al. 2018. Putting species back on the map: devising a robust method for quantifying the biodiversity impacts of land conversion. Submitted paper to Diversity and Distribution, 2018.

EnREDando 2008. En el marco del conflicto entre el Gobierno y entidades agropecuarias en Argentina No somos campo, somos tierra: Ambiente y Sociedad. Accessed December 15 2008.

Game, E.T., Meijaard, E., Sheil, D. and McDonald Madden, E. 2014. Conservation in a wicked complex world; challenges and solutions. Conservation Letters 7(3):271-277.

Garcia, C., Dray, A. and Waeber, P. 2016. Learning begins when the game is over: using games to embrace complexity in natural resources management. GAIA-Ecological Perspectives for Science and Society 25(4): 289-291.

García-López, G.A. and Arizpe, N. 2010 Participatory processes in the soy conflicts in Paraguay and Argentina. Ecological Economics 70(2): 196-206

Gardner, T.A. et al. 2018. Transparency and sustainability in global commodity supply chains. World Development (in press).

Green et al. 2018. Linking global drivers of agricultural trade to on-the-ground impacts on biodiversity. Submitted paper to Nature sustainability, 2018.

Gregory et al. 2012. Structured Decision Making: a practical guide to environmental management choices. Wiley-Blackwell, Oxford.

Guerrero et al. 2018a. Identifying Barriers and Opportunities for Reducing Biodiversity Risk in the Soy Supply Chain. A Contacted project report to WWF. Submitted paper to Global Environmental Change, 2018.

Guerrero et al. 2018b. Mental models on reducing deforestation in supply chains: Insights from the soy sector. Submitted paper to Global Environmental Change, 2018.

Kolkman, M. J., Kok, M. and van der Veen, A. 2005. Mental model mapping as a new tool to analyse the use of information in decision-making in integrated water management. Physics and Chemistry of the Earth 30:317-332.

Head, B. W. 2008. Wicked problems in public policy. Public policy 3(2): 101.

Jones, N.A et al. Mental models: an interdisciplinary synthesis of theory and methods. Ecology and Society, 16: 1.

Lambin, E. et al. The role of supply-chain initiatives in reducing deforestation. 2018. Nature Climate Change 2018: 1.

Larrosa, C. et al. 2016. Unintended Feedbacks: Challenges and Opportunities for Improving Conservation Effectiveness. Conservation Letters 9(5): 316-326.

Mason, T. H. et al. 2018. Wicked conflict: Using wicked problem thinking for holistic management of conservation conflict. Conservation Letters, e12460.

Morgan, M. G et al. 2002. Risk communication: a mental models approach. Cambridge University Press, New York, New York, USA.

Navarro, Z. and Campos, S.K. 2013. A “pequena produção rural” no Brasil CENTRO DE GESTÃO E ESTUDOS ESTRATÉGICOS-CGEE A pequena produção rural e as tendências do desenvolvimento agrário. Brasília CGEE: 13-28

Redpath, S.M. et al., 2013. Understanding and managing conservation conflicts. Trends in ecology and evolution, 28(2): 100-109.

Richards, P. 2015. What drives indirect land use change? How Brazil's agriculture sector influences frontier deforestation. Annals of the Association of American Geographers 105(5): 1026-1040.

Roberts, N. 2000. Coping With Wicked Problems. Naval Postgraduate School, Monterey, California, Department of Strategic Management Working Paper.

Rittel, H.W.J. & Webber, M.M. 1973. Dilemmas in a general theory of planning. Policy Science 4: 337 155–169.

Scharmer, C.O., 2008. Uncovering the blind spot of leadership. Leader to Leader, 2008(47): 52-59. http://www.allegrosite.be/artikels/Uncovering_the_blind_spot_of_leadership.pdf

Virah-Sawmy, M. et al. 2018. Sustainability gridlock in a global agricultural commodity chain: reframing the soy-meat food system. Submitted to Journal of Sustainable Production and Consumption, 2018.

Weinhold, D., Killick, E. and Reis EJ. 2013. Soybeans, poverty and inequality in the Brazilian Amazon. World Development 52: 132–143

Weisbord, M.R. and Janoff, S. 2000. Future Search: An Action Guide to Finding Common Ground in Organizations and Communities. 2nd Edition, Berrett-Koehler, San Francisco, 2000.

Weisbord, M.R. and Janoff, S. 2007. Don't Just Do Something, Stand There!: Ten Principles for Leading Meetings That Matter

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