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Research Article

Reducing deforestation and enhancing sustainability in commodity supply chains: interactions between governance interventions and cattle certification in Brazil

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ABSTRACT

A large number of governance interventions are being developed in order to reduce deforestation and enhance the sustainability of commodity supply chains across the tropics. The extent to which individual agricultural commodity supply chain interventions can achieve scale, and environmental or social objectives, depends in part on the ways in which those interventions interact with other interventions. We use a case-study of the new Sustainable Agriculture Network (SAN) cattle certification program in Brazil to explore the different ways in which governance interventions interact. We examine the broad landscape of policies and programs that affect sustainability in the cattle supply chain in Brazil, and assess whether such interventions support or constrain the scaling up of the SAN cattle program. We conducted semi-structured interviews with key stakeholders from government, private sector, and civil society organizations. We found that multiple interventions are acting in a complementary manner to enhance sustainability and therefore enable the scaling up of the SAN program, by aiding compliance with environmental laws, adoption of good production practices, and improved monitoring. At the same time, limited development, implementation, and complementarity of some interventions could be antagonistic to the SAN program's expansion because they maintain a context in which many actors operate far below the sustainability criteria required by the program. Our holistic approach enables us to identify specific gaps in the complex landscape of governance interventions in Brazil. Greater strategic complementarity and coordination between interventions may catalyze a more coherent and effective pathway to reduced deforestation and enhanced sustainability.

RESUMO

Um grande número de iniciativas está sendo desenvolvida nos trópicos afim de contribuir com a redução do desmatamento e de aumentar a sustentabilidade das cadeias de *commodities*. O aumento de escala e os impactos sociais e ambientais dessas iniciativas dependem em parte de como elas interagem entre si. A partir do estudo de caso do programa de certificação Rede de Agricultura Sustentável (RAS) no Brasil, nós exploramos como esta e outras intervenções interagem. Nós examinamos uma gama de políticas e programas que afetam a sustentabilidade na cadeia da pecuária, e avaliamos se e como tais iniciativas apoiam ou são um obstáculo para o aumento de escala do programa SAN. Para tal, realizamos entrevistas semiestruturadas com atores do setor público, privado e da sociedade civil. Grande parte das iniciativas levantadas agem de forma complementar para aumentar a sustentabilidade na cadeia e ampliar a adoção da certificação SAN, já que contribuem com o aumento da conformidade das propriedades com leis ambientais; promovem a adoção de boas práticas agropecuárias; e melhoram o monitoramento. Ao mesmo tempo, má gestão e implementação de iniciativas e a falta de complementariedade entre elas podem ser antagonicas à expansão do programa SAN. Nossa abordagem holística nos permite identificar falhas na rede de políticas e intervenções no país. O aumento da complementariedade e coordenação entre as iniciativas pode contribuir para a maior efetividade das mesmas sobre o aumento de sustentabilidade na cadeia da pecuária e redução do desmatamento.

Keywords: agriculture; Amazonia; Cerrado; greenhouse gas emissions; livestock; Sustainable Agriculture Network

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Introduction

A large number of governance interventions designed to reduce deforestation and enhance the sustainability of agricultural commodity supply chains are being developed by government, private sector, and civil society actors at a range of scales across the tropics [1,2]. These interventions, implemented in forest and agricultural landscapes, can be characterized as being based on combinations of institutions, incentives, and information [3]. They include national and state forest policies, payments for environmental services programs, agricultural commodity moratoria, third-party certification programs, and agricultural commodity roundtables. The extent to which any one of these governance interventions can contribute to enhanced environmental or social sustainability depends in part on the intrinsic design of the interventions themselves, but also on the institutional, political, and economic contexts in which they are implemented. In particular, part of their success depends upon the ways in which they interact exogenously with other interventions, at both the local and national level [4].

Interactions between interventions can be characterized as being complementary (whereby the interventions are additive or synergistic), substitutive (the interventions fill the same role), or antagonistic (one intervention constrains or undermines the other) [5]. In particular, the proliferation of non-state market-driven (NSMD) governance interventions [6] such as third-party certification programs has led to numerous complex interactions between these interventions and over forms of governance [7]. In some cases, NSMD interventions have helped to enforce existing state policies [8], and/or have been lent financial or institutional support by governments that recognize their potential value [9]. In other cases, governments have resisted NSMD governance as a threat to their sovereignty [9]. Finally, alternative third-party certification programs within the same sector may be complementary or may compete, depending on the scope of the programs, and the extent to which their mechanisms or objectives overlap [8].

A new governance intervention that is introduced into a complex commodity supply chain will therefore interact with many other existing ones. The complex outcomes of these multiple interactions may result in both challenges and opportunities for the new intervention. Despite the evident importance of understanding how a new intervention (such as a policy or incentive

program) will be affected by a particular institutional context, these complex outcomes have rarely been comprehensively explored [5].

In this paper, we explore different ways in which supply chain governance interventions can interact to either support or constrain the scaling up of a new governance intervention. As a case study, we examine the Sustainable Agriculture Network's cattle certification program, in Brazil (hereafter, the 'SAN cattle program'). The case is important for three reasons. First, the cattle sector in Brazil is associated with high deforestation rates and greenhouse gas emissions [10]. Second, Brazil is characterized by a complex policy landscape, with a large number of governance interventions being implemented concurrently at a variety of scales [1]. Third, the SAN cattle program has been identified as representing a high level of sustainability within Brazil's cattle sector, principally because its criteria (e.g. with regards to deforestation and traceability) are more stringent and its definition of sustainability is more comprehensive (e.g. incorporating multiple dimensions of both environmental and social sustainability) than any other intervention in the cattle supply chain [11, 12]. Therefore, to some degree, scaling up the program can be viewed as a proxy for enhancing sustainability across the sector [11]. The case therefore presents an excellent opportunity to explore interactions between interventions, in a context with high sustainability stakes.

As a new intervention, the extent to which the SAN cattle program will achieve its objectives of enhanced environmental and social sustainability will ultimately depend on being able to induce changes in on-farm practices on a significant number of farms across Brazil. The capacity to achieve scale (defined as the number of certified producers and/or the aggregate certified land area) will, in turn, depend on whether other interventions support, incentivize, or enable supply chain actors to engage with the program (i.e. are complementary), or whether they constrain the program's expansion (i.e. are antagonistic). This paper therefore answers the question: How do governance interventions support or constrain the scaling up of the SAN cattle program in Brazil? We address this question through an institutional analysis of multiple governance interventions in Brazil, and their current and likely future influences on our case-study certification program. Our findings may provide insights for the coordination and complementarity of the environmental policy landscape in Brazil more broadly.

Methods

Case-study: the SAN cattle program

The Sustainable Agriculture Network (SAN) is a certification consortium that develops standards to promote social and environmental sustainability in agricultural supply chains globally, by integrating sustainable production with biodiversity conservation, social responsibility, and environmental wellbeing [12]. The main objective of the network is to reduce tropical deforestation and increase sustainability by setting environmental, social, and welfare standards for agricultural supply chains [12]. The network is a multi-stakeholder partnership of nine organizations, including the Rainforest Alliance, in eight countries. The main certification program used by the SAN is the *Sustainable Agriculture Standard*, which has been used to certify agricultural crops such as bananas and coffee since 1992. More than 2.7 million ha of land, and more than 60 different agricultural products in 43 countries, operate under the *SAN Sustainable Agriculture Standard*. Products certified by the SAN are labeled using the Rainforest Alliance (RA) certification trademark [13].

The *SAN Standard for Sustainable Cattle Production Systems* (hereafter, the 'SAN cattle program') builds upon the *SAN Sustainable Agriculture Standard*. The cattle standard is divided into 15 principles and 136 criteria, comprised of the 10 existing SAN principles for the *Sustainable Agriculture Standard* and five principles that were developed specifically for the cattle industry. The 15 principles relate to management systems, ecosystem conservation,

wildlife protection, water conservation, working conditions, occupational health, community relations, integrated crop management, soil conservation, integrated waste management, integrated cattle management systems, sustainable range and pasture management, animal welfare, and reducing carbon footprints. Each of these principles contains multiple criteria [12].

The SAN cattle program was developed by the SAN and the *Centro Agronómico Tropical de Investigación y Enseñanza* (CATIE), with technical support from experts from the *Grupo Ganadería y Manejo del Medio Ambiente* (Livestock and Environmental Management Group – GAMMA). The standard was launched in July 2010 following a 34-country public consultation conducted in line with the ISEAL Alliance Code of Good Practice for Setting Social and Environmental Standards (SAN 2010). The ISEAL Alliance is an NGO that aims to strengthen sustainability standards by setting codes of good practices as a guideline for other standard-setting bodies. A new public consultation to review the SAN cattle program standards solicited a first round of comments between April and June 2013, and a second round between October and November 2013.

The SAN cattle program is the first initiative in the world to comprehensively certify sustainable cattle production, accounting not only for animal welfare and product quality but also for the social and environmental aspects of cattle production. Innovatively, it includes standards that involve the entire chain of custody, which increase the traceability of the product through the supply chain. Moreover, it is broadly considered to be a credible standard due to its strict criteria, which were developed by a third-party certification body rather than by an industry roundtable [11, 12].

The certification process involves a full initial certification audit, followed by two annual audits. This three-year cycle then begins again with another full audit. Producers may opt to have a diagnostic visit before the first full audit, to coarsely assess where the farm is positioned in relation to the criteria. To become certified, farms have to comply with a) 80% of all the criteria, b) at least 50% of the criteria in each principle, and c) 22 critical criteria (with which the farms have to comply completely).

In 2012, four farms were certified for the *Standard for Sustainable Cattle Production Systems*: Fazendas São Marcelo (two properties under a single certificate) and Fazenda Água Sadia, both in Brazil, and El Guapinol in Guatemala. The farms Fazendas São Marcelo and Fazenda Água Sadia are all owned by the JD group and are hereafter called Fazendas São Marcelo (FSM). FSM achieved the *Group Certification Standard* in 2013 (Fazendas São Marcelo's Juruena unit for cattle birth; Fazendas São Marcelo Tangará da Serra unit for growth and fattening; and Fazenda Água Sadia also for growth and fattening). In addition, one factory of the slaughterhouse Marfrig became the first and only abattoir globally to be certified with the *Chain of Custody Standard* in 2012. The supermarket Carrefour began selling SAN-certified beef using the RA label in Brazil in 2013. Other farms in Brazil are currently (September 2015) in the process of seeking certification.

Interviews

We conducted semi-structured interviews with key actors who were working on environmental sustainability in Brazil, and/or were directly involved with the Brazilian cattle supply chain. Interviewees included individuals and organizations from the state sector (e.g. Municipal Secretariats, Ministry of Environment), civil society (non-governmental organizations (NGOs), certification bodies, and researchers), and private sector (producer associations, cattle farmers, slaughterhouses, retailers, and the input industry) (Appendix 1).

A total of 28 organizations and 46 people were interviewed. Interviews were conducted by phone (6 interviews), and in person (28 interviews) in the offices of NGOs, government agencies, and companies, and on certified and non-certified farms in the state of Mato Grosso, between June and August 2013 (Fig. 1). Informed consent was obtained from all interviewees – individuals and organizations.

Interviews comprised questions about each individual or organization's knowledge and opinions about: a) interventions to enhance sustainability and reduce deforestation in the cattle supply chain; b) challenges and possible solutions in the cattle supply chain; c) institutional opportunities for, and barriers to, the implementation and development of the SAN cattle program.

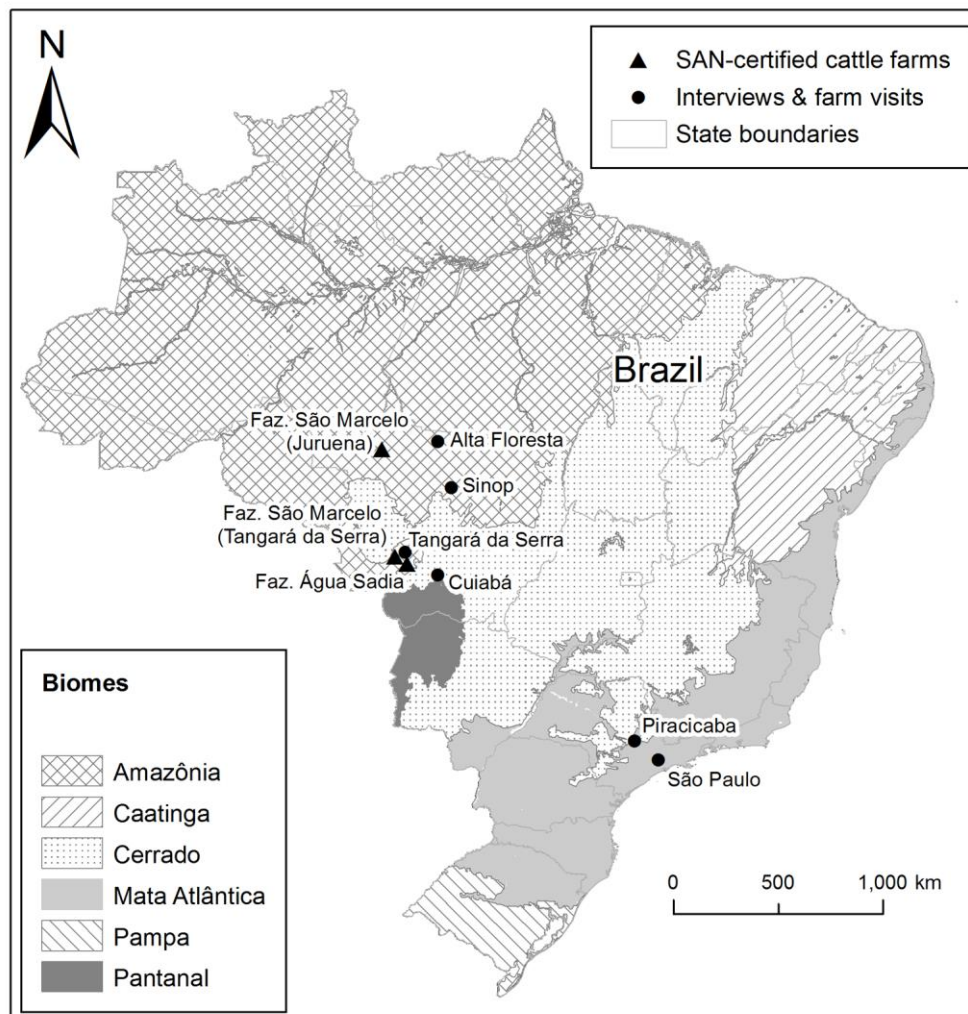


Fig. 1. Cattle farms certified by the Sustainable Agriculture Network (SAN) cattle program certification standard, and the location of interviews and the four farm visits conducted during this study, in Brazil.

Analysis

We organized the interventions according to the implementing agency (government, private sector, civil society, or multi-stakeholder), and used the information from our interviews to analyze the extent to which interactions between the SAN cattle program and other

interventions were complementary, substitutive, or antagonistic (as defined by Lambin et al. [5]). Governance interventions were defined as instruments developed for improving specific social, economic, and/or environmental outcomes, and comprised public (i.e. state-led), private, civil society, and multi-stakeholder initiatives. For the analysis, we selected governance interventions that were related to sustainability in the cattle supply chain in general, and deforestation in particular. The information presented throughout the Results section is derived from both a review of the literature and the interviews. Our analysis reflects information that characterizes each intervention, as well as interviewees' perceptions of each intervention and their (actual or possible) interactions with the SAN cattle program. Complementary interactions were characterized as those whereby the effects of one intervention created enabling conditions and/or supported the development of another intervention. Substitutive interactions were those whereby one intervention replaced or partly replaced the role of another intervention. Finally, antagonistic interactions were those whereby the effect of one intervention undermined the effect of another intervention [5]. Any given intervention can interact with another intervention in one or more of these ways, such as being both complementary in some aspects and antagonistic in others.

Results

The SAN cattle program represents a very high level of sustainable practices, since it goes beyond the demands of other stringent interventions [11, 12]. Thus, to be able to even consider SAN certification as an option, a farm has to have achieved a minimum level of compliance with these other policies and standards. A large number of governance interventions that aim to improve the sustainability of the cattle supply chain in Brazil have been developed and implemented by the private sector, state, and civil society (Appendix 2; Fig. 2). These interventions vary widely in their objectives, in the mechanisms by which they move towards those objectives, and in their spatial and temporal scope. We found that the implementation of the SAN cattle program was variously complemented and constrained by these other interventions. Here we describe the main interventions grouped according to their principal implementing agency (government, civil society, private sector, or multi-stakeholder), and outline key complementary, substitutive, and antagonistic interactions with the SAN cattle program.

1. Government

The Forest Code

Brazil's National Law No. 12.651 from May 25th, 2012 (hereafter, the 'Forest Code') is among the strictest national legislation for forest protection worldwide. Among the many requirements of the law, land-owners have to maintain a minimum proportion of forested area on their properties as *Reservas Legais* (Legal Reserves – RL). Properties located in the Amazon biome of the Legal Amazon have to maintain 80% of their area protected as RL, whereas those in the *Cerrado* biome of the Legal Amazon have to protect 35%. In other regions of the country, outside of the Legal Amazon, farms have to protect 20% of their area as RL. Further, *Áreas de Preservação Permanente* (Permanent Protected Areas – APP) are defined as all of the natural vegetation surrounding water bodies and mountaintops, and may also not be deforested [14]. Compliance with the Forest Code is an explicit requirement of the SAN cattle program, and producers who are compliant with this law are already a significant step toward meeting the SAN cattle certification program environmental criteria [12]. Enforcement of the Forest Code on a wide scale would leverage many properties closer to achieving the SAN cattle program criteria, thus acting synergistically to its implementation.

The SAN cattle program is comprised of a large number of criteria, which variously address environmental, social, and economic sustainability. It is arguably a more comprehensive sustainability initiative than any other policy or incentive operational in Brazil, and has thus ‘raised the sustainability bar’ in the cattle supply chain [11]. Thus, no other intervention is fully substitutive of the SAN cattle program. However, since the SAN cattle program requires compliance with the Forest Code, and it encompasses many of the SAN program’s forest conservation objectives, it can also be considered to be substitutive of elements of it. That is, in the absence of the SAN cattle program but with full implementation of the Forest Code, some of the same forest conservation objectives may still be met. Still, the SAN cattle program goes beyond the Forest Code, requiring that there is not even *legal* deforestation on farms that become certified. Further, the SAN standard does not allow deforestation on farms after November 2005, independently and regardless of the local law.

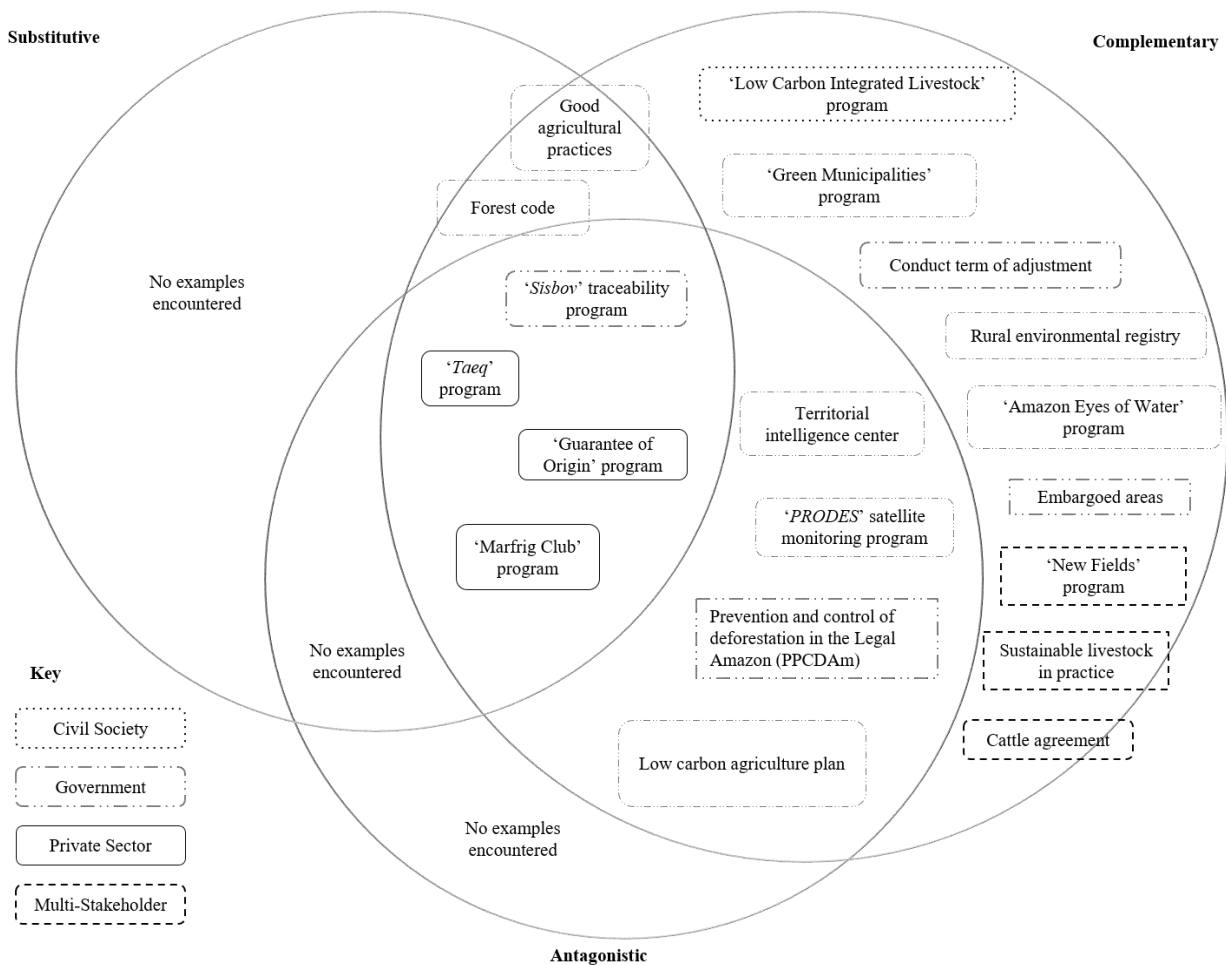


Fig. 2. A Venn diagram of governance interventions (e.g. policies, programs) developed to reduce deforestation and enhance sustainability in the cattle supply chain in Brazil. Each intervention is represented by the name of the policy or program (names are in English; original (often Portuguese) names can be found in Appendix 2). Text box dotted, solid, gray dashed, solid, and black dashed lines indicate that the interventions are implemented by civil society, government, private sector, or multi-stakeholder groups, respectively. The position of each intervention within the Venn diagram indicates that our research characterized the intervention as being complementary, substitutive, antagonistic, or some combination of these, with respect to the objective of scaling up the SAN cattle certification program.

Rural Environmental Registry

The *Cadastro Ambiental Rural* (Rural environmental registry – CAR) is an important step towards enforcing environmental legislation. It is a national policy tool created under the Forest Code, and is a pre-requisite for compliance with it. Every rural property in Brazil has to register its geo-referenced boundaries, so that all environmental data (e.g. deforestation, RL, and APP) can be monitored, enforced, and controlled [14]. In regions where the CAR is largely implemented, it has already helped to monitor deforestation, and in turn may catalyze the rate at which farms become closer to achieving the SAN criteria, acting synergistically. The deadline for all the properties to be registered was postponed to May 2017, since currently (September 2015) only 53.56% of the national territory area is registered [15].

'Amazon Eyes of Water' and 'Green Municipalities' programs

The *Olhos d'Água da Amazônia* ('Amazon Eyes of Water') and *Municípios Verdes* ('Green Municipalities') programs, operated by the Alta Floresta municipality secretariat in the state of Mato Grosso and the Pará State Government, respectively, facilitate adherence to the CAR by producers. The 'Amazon Eyes of Water' program started in 2011 and has already helped more than 80% of rural properties in the municipality to become registered in the CAR. The secretariat paid for the process with the Amazon Fund, and provided the infrastructure and knowledge necessary to complete the registration. In a second phase, the program will provide assistance to smallholders to improve pasture and cattle management. The 'Green Municipalities' program has a similar approach but reaches a larger scale, having been implemented across several municipalities in the state of Pará, many of which already have more than 80% of properties registered.

Cattle agreement and Conduct adjustment term

Some interventions, both mandatory and voluntary, aim to enhance sustainability by restricting market access for unsustainable producers (e.g. those with illegal deforestation on their properties). In 2009 Public Prosecutors began to impose a mandatory *Termo de Ajustamento de Conduta* (Conduct adjustment term – TAC) on slaughterhouses and retailers across Brazilian Amazonia. At the same time, the largest four slaughterhouses in Brazil signed the cattle agreement [16]. The cattle agreement is a voluntary multi-stakeholder initiative, which was developed following the release of a Greenpeace report "Slaughtering the Amazon" [17], which attributed deforestation to the expansion of the cattle industry. The agreement commits the slaughterhouses to zero deforestation and improved supply chain monitoring [16].

Both interventions aimed to prevent these actors from buying cattle from illegally-operating properties (such as those with illegal deforestation, or on IBAMA-identified embargoed areas (*áreas embargadas*)) [16]. Fines are levied against actors who do not comply with the TAC. These moratoria resulted in slaughterhouses and retailers exerting pressure over producers to avoid illegal deforestation and to become compliant with the Forest Code, and affected the criteria used by slaughterhouses to select their suppliers [16]. It also prompted slaughterhouses to improve traceability of animals throughout the cattle production cycle and its value chain. Following the signing of the cattle agreement, the proportion of supplying properties registered in the CAR increased from 2% (2009) to 96% (2013), and the proportion of purchases by slaughterhouses from recently deforested properties reduced from 36% (2009) to 4% (2013) [16]. The possibility of foregone revenue, or the risk of getting caught, may be a significant incentive to producers to change their practices and to stop deforestation [18].

Low carbon agriculture plan

Some credit lines can contribute to reduced deforestation objectives, if – for example – the credit line is specifically aimed at incentivizing sustainable practices [19]. One example is the *Plano de Agricultura de Baixo Carbono* (low carbon agriculture plan – ABC) credit line, which awards loans to producers who are interested in ameliorating their production practices toward reduction of carbon emissions and enhanced sustainability [20]. The aim of this plan is to reduce 133 – 166 million tons of CO₂eq by 2020 by promoting low-emissions agricultural technologies, such as integrated crop-livestock-agroforestry systems, and forest restoration. The ABC credit line creates loans with low interest rates (5.5% per year – compared to other loans such as *Pronamp* and *Inovagro*, which are 6.5%) and extended terms (5 to 15 years, depending on the type of project) [21].

However, there are obstacles that inhibit access to credit lines, thus acting antagonistically to the implementation of the SAN cattle program [22]. For instance, to be able to access the ABC credit line, the producer has to submit a lengthy document. Many small and medium producers in Amazonia have limited knowledge of this type of information, and so they either don't apply for a loan, or are unlikely to be awarded one [21, 23]. As a result, 69% of the funding available from the ABC program in 2012-13 was distributed to cattle ranchers in the south and southeast of the country. In this region, ranchers are more organized and have much more infrastructure and access to information than those located in the Amazon biome [20].

Good agricultural practices

The *Boas Práticas Agropecuárias* (Good agricultural practices – BPA) program developed by the government agency Embrapa is a benchmark set of criteria to be used by producers nationwide for the improvement of these practices. Some other programs also use these criteria as a guideline for determining best production alternatives [24]. The programs' aim is to guide producers into a set of activities that result in increased productivity and sustainability. The guidelines include norms and procedures related to property management, property social aspects, human resources, animal welfare, pasture management, animal feed, traceability, sanitary control and reproductive management. For each theme, the manual presents activities and alternatives in order to improve producer's activities. Examples are rotational grazing, registering each animal, capacity building, and implementing RL and APPs [25]. This program is currently being implemented by more than 200 producers nationwide. By improving sustainable practices, farms may be better prepared to participate in private sector incentive programs and, eventually, the SAN cattle certification program [11]. The BPA thus complements and substitutes some elements of the program.

Sisbov

Traceability and the control of cattle sourcing is a major challenge for reducing deforestation, exacerbated by supply chain complexity. Animals are bred on many farms, and are moved from farm to farm at different stages of their lifecycle. Calves are often sold to large fattening farms through informal mechanisms: in auctions or by traders. This informality means that there is little control of the source origin of cattle, and it remains a challenge to know whether calves were raised in illegally deforested properties, particularly because slaughterhouses are often not in direct contact with these properties [26].

Traceability programs are needed to tackle this issue. The *Sisbov* (Brazilian system for bovine and buffalo origin identification and certification) is one such program, which identifies every animal within a property and is capable of tracking them between farms and slaughterhouses [27]. *Sisbov* is a mandatory requirement from the federal government, but only tracks animals in the last three months of their life. Further, the program is designed principally to facilitate

the export of beef to more rigorous markets that demand guarantees about the health and sanitary quality of the beef. It has no focus on, or requirement of, other sustainability issues. Wider adoption of this (or a similar) traceability system, and a greater emphasis on traceability with respect to environmental sustainability (e.g. monitoring deforestation), could dramatically increase the prospects of achieving the level of traceability demanded by the SAN cattle program. To fully meet the requirements of the SAN cattle program, it would need to encompass the full life cycle of each animal and ensure that all farms, including those where the cattle are born, are free of deforestation since 2005.

Territorial Intelligence Centre, Brazilian Amazon Satellite Monitoring System, and the Plan for the prevention and control of Amazonian deforestation

Some interventions do not act directly within the cattle supply chain, but help to control and monitor illegal deforestation. These programmes include the *Núcleo de Inteligência Territorial* (territorial intelligence centre – NIT), *Monitoramento da Floresta Amazônica Brasileira por Satélite* (Brazilian Amazon Satellite Monitoring System – PRODES), and *Plano de Prevenção e Controle do Desmatamento na Amazônia* (Plan for the prevention and control of Amazonian deforestation – PPCDAm), as well as IBAMA's embargoed areas. All of these interventions contribute by monitoring illegal deforestation, and in some cases also facilitate the implementation of other interventions, for example by making their data publicly available. For instance, slaughterhouses can use data from IBAMA on the embargoed areas to identify producers from whom they cannot buy cattle, under the terms of the cattle agreement.

2. Private sector

Marfrig Club, Guarantee of Origin, and 'Taeq' programs

Private sector incentive-based interventions such as the Marfrig Club, *Garantia de Origem* (Guarantee of Origin – GO), and 'Taeq' programs have been developed by retailers in the cattle sector in Brazil. These interventions have established voluntary standards that can be followed by producers, who in return may sell their products under those programs' labels, sometimes for higher prices. Although the sustainability standards of these programs are consistently lower than those for the SAN cattle program, adherence to the criteria may lead to an improvement in production processes and sustainability, leveraging participating producers closer to the standards of the SAN cattle program [11]. For example, *Fazendas São Marcelo* achieved organic cattle certification in 2000, and was formerly part of the GO program – suggesting that such programs can be steps that enable farms to progress towards the SAN cattle program. As a consequence of the practices developed in relation to these other initiatives, FSM needed to make few additional changes to achieve the SAN cattle certification. Similarly, the slaughterhouse Marfrig already adhered to several other social and environmental standards, including International Organization for Standardization (ISO) certificates for food safety management (ISO 22000) and environmental management (ISO 14000). The only additional production process that Marfrig had to introduce to achieve SAN cattle program certification was a new labeling system to ensure segregation and traceability of certified cattle products.

The private sector standards (e.g. Marfrig Club, GO, and 'Taeq' programs) are the set of interventions that come closest to being substitutive for the SAN cattle program. These most closely match certification, in that they incentivize farmers to improve their on-farm practices to comply with an agreed set of standards that represent some degree of sustainability. However, the criteria required by the SAN cattle program are more stringent than those of any other existing private sector standards. Further, such private initiatives have low levels of assurance and transparency, and do not comply with the most robust codes that guide the development and implementation of sustainability standards – for example, those proposed

by the ISEAL Alliance [28], which are fully met by the SAN system. Therefore, private initiatives could be a first or preliminary goal to be considered in a stepwise process that could lead towards SAN certification [11].

Conversely, private standards can be antagonistic to the adoption of the SAN cattle program due to their current proliferation, since such standards can directly compete with certification programs. Although they can act to improve the sustainability of the supply chain, some of these initiatives also compete in the market with Rainforest Alliance Certified™ (RA) sealed products, and may therefore inhibit the adoption and scaling up of the SAN cattle program. For example, Carrefour advertised RA-labeled beef together with their own GO program. On the one hand, this may reduce financial benefits for SAN-certified producers due to increased competition, and limited market opportunities (both standards are sold only by a single retailer). Similarly, Marfrig promotes its own Marfrig Club brand ahead of SAN, by initially recruiting producers to the Marfrig Club program, in preference to encouraging farmers to consider SAN cattle certification. In the coffee supply chain, the scaling up of some standards has been restricted by market dominance by alternative standards [29]. On the other hand, the SAN cattle program is very new, and product availability is constrained by the small number of certified producers. In this manner, the GO may actually facilitate the SAN label, if the latter benefits from the market established by the former.

Finally, the cost to producers of becoming SAN certified may be higher than that of participating in other standards programs, which may affect farmer decision-making. All of these impose trade offs to producers and influence their decision on which standard, if any, to implement. It may be important to consider both additionality and implementation costs and to incentivize a switch from one less stringent standard to the other.

The Brazilian domestic market is crowded with competing labels, which represent varying degrees of sustainability standards. Lack of transparency – such as not clearly indicating the criteria and processes underlying different labels – can present an obstacle for consumers to evaluate the credibility of labels and to differentiate between them [30, 31]. This could diminish the impact of a third party certification such as that of the SAN cattle program. Indeed, some consumers are unwilling to pay for certified products because they have concerns regarding their credibility [32].

3. Civil society and multi-stakeholder

'Low carbon integrated livestock' and 'Sustainable livestock in practice' programs

Multiple interventions help producers to implement management plans, and to improve production control and pasture management. Among these, the *Pecuária Integrada de Baixo Carbono* ('Low carbon integrated livestock') and the *Pecuária Sustentável na Prática* ('Sustainable livestock in practice') programs, respectively developed by the NGO *Instituto Centro de Vida* (ICV) and the *Grupo de Trabalho da Pecuária Sustentável* (Brazilian Roundtable on Sustainable Livestock – GTPS), focus on pasture management, intensification, and good production practices inside demonstration units (DUs) within volunteer farms. The DUs will also be used to disseminate these practices to other producers. As a result of the positive outcomes of these programs, the 'low carbon integrated livestock' program was continued as the recently launched *Novo Campo* ('New Fields') program, with the aim of scaling up the number of farms that are improving their production practices.

These interventions all provide information (e.g. guides to best practices, training, capacity-building) and infrastructure (e.g. machinery, herbicides, feed, water pumps, capacity building) to help producers to improve their agricultural and pastoral techniques. For example, after

one year of implementation of the 'low carbon integrated livestock' program, pasture quality inside DUs improved and the number of Animal Units per hectare increased from 1.4 (the average in the Alta Floresta region) to 3.1. By improving on-farm sustainable practices, farms may be better prepared to participate in private sector incentive programs and, eventually, the SAN cattle certification program [11].

Discussion

The scaling up of interventions designed to enhance agricultural sustainability depends significantly on the institutional context in which they are implemented, and the extent to which they are supported or constrained by other interventions (e.g. policies or incentive programs) acting within the same sector [4, 2]. Scaling up the SAN cattle program may be desirable if, as evidence suggests, it promotes a higher level of sustainability on participating farms than is currently observed on the vast majority of farms in Brazil [11].

This research highlights the interventions developed in the context of the cattle supply chain in Brazil and how they interact with the SAN cattle program, supporting and/or constraining the scaling up of this program. Certification by the SAN cattle program serves as a proxy indicator for sustainability, since participation in the program demands a strong commitment to sustainable practices by certified farms [11]. Therefore, although this certification program is new and has only been adopted by few farmers, the case study contains lessons for how higher levels of sustainability may be achieved across the sector. Our analysis of interventions and perspectives from stakeholders throughout the cattle supply chain in Brazil may therefore be a useful contribution to understanding of interactions between governance interventions across this complex institutional landscape.

Steps to enhanced sustainability

We reviewed governance interventions from across the forest and agricultural policy landscapes in Brazil, with a focus on those that directly address sustainability in the cattle supply chain. Most interventions contributed to one or more of three important functional steps that are necessary to support greater sustainability in the cattle supply chain in Brazil: 1) wider compliance with environmental laws, 2) increased adoption of improved production practices, and 3) development of more effective monitoring systems. These three steps are also necessary to enable scaling up of the SAN cattle program. That is, for farms to get close to being able to become certified by the SAN cattle program they must at minimum be compliant with environmental laws, and should have adopted at least the more basic good production practices. Likewise, if the program is to be implemented at large scale, effective monitoring systems will be critical [16]. Here, we discuss the key interventions that are facilitating each of these three steps.

Compliance with environmental laws

Compliance with environmental laws is a necessary pre-cursor for participation in many sustainability initiatives in Brazil, including the SAN cattle program. The widespread lack of compliance with key environmental laws, such as the Forest Code, among many rural cattle farmers in Brazil is therefore a significant challenge for the scaling up of new sustainability interventions in Brazil [26]. It is estimated that 15 million hectares of deforested land are not compliant with the Forest Code, although exact numbers will only be known as registration in the CAR becomes more complete [33]. Until widespread compliance is achieved, only a small subset of all farms in Brazil will be operating at a level where they can even contemplate engaging with interventions that are oriented around high expectations for environmental sustainability [34, 35, 36]. There is therefore significant potential for interventions that

promote environmental compliance among small and medium-sized rural farmers to accelerate the rate at which levels of sustainability improve across the supply chain [37]. Such interventions include the CAR, which will enable much greater monitoring and enforcement of the Forest Code, and the 'Green Municipalities' and 'Amazon Eyes of Water' programs, which facilitate implementation of the CAR.

Increased adoption of good production practices

Increased adoption of good production practices is a key step in moving a larger number of farms closer to a position from which they can contemplate engaging with interventions that are oriented around high expectations for environmental sustainability [38]. Barriers to the adoption of improved practices by farmers may include risk aversion, insufficient knowledge or capacity, or inadequate access to financial capital (e.g. because of high costs, or difficulty in accessing credit), to implement changes [22]. Governance interventions that may increase the adoption of good agricultural practices by reducing these barriers include Embrapa's BPA program and rural credit lines such as the ABC credit line.

In part as a consequence of these three barriers (risk aversion, limited capacity, and limited access to finance), farmers may be unlikely to make large, sudden changes in on-farm practices. Rather, they may be more likely to make small, incremental changes. Therefore, at least in the short term, SAN will likely only be adopted by farms that are already operating at a relatively high level of sustainability. Even the most sustainable farms may have to make some changes in order to participate in the SAN cattle program – the certified farms of *Fazendas São Marcelo* indicated that despite their history of certified organic and other good practices, they still had to make some changes in management practices to become certified. The SAN cattle program will therefore likely be able to initially scale up (i.e. attract additional participants) most easily by strategically engaging those actors whose sustainability standards are already relatively high, such as those farms already in the highest (platinum) level of the 'Marfrig Club' program [11]. However, the short-term gains to sustainability outcomes may be marginal relative to those generated by the recruitment of farms formerly operating at a lower level of sustainability.

Greater capacity for monitoring and enforcement

Greater capacity for monitoring is a critical pre-condition for any intervention that aims to achieve (and demonstrate) enhanced sustainability in the cattle supply chain in Brazil. First, the capacity to trace individual cattle throughout the entire length of the supply chain would provide greater certainty that all farms involved in the birthing, rearing, and fattening stages of an animal's life were compliant with environmental laws. This would help to avoid the practice of 'cattle laundering', whereby cattle are moved from non-compliant to compliant farms before sale to the slaughterhouse – this being the only supply chain stage currently monitored in many cases [16]. Second, high-quality monitoring of deforestation is an important means to identify non-compliant farms and exclude them from supply chains. The *Sisbov* program goes some way towards a traceability system, and the PRODES and PPCDAM programs provide powerful tools for monitoring deforestation.

Complementarity and coordination between interventions

Many governance interventions help to elevate a greater number of farms towards a higher level of sustainability. However, while the discussion above demonstrates how many interventions are complementary (at least in theory) to the objective of moving more cattle farms towards greater sustainability, there are several ways in which different interventions are not optimally complementary or coordinated and may even be antagonistic.

First, some interventions are not effectively implemented, despite having complementary objectives. For example, although the recently reformulated Forest Code is a stringent law that if enacted nationally would protect large areas of forest, it will take at least two more years to become operative. Further, forest deficit estimates indicate that enforcement of the Forest Code is weak, and a large number of properties remain non-compliant [33]. Although the CAR will facilitate the enforcement of the Forest Code, it is just a first step (farm registry) and it is unlikely that compliance will increase widely in the short term, since the deadline for registration was expanded until 2017 and farmers are granted a period of amnesty between registration in the CAR and the need for compliance with the Forest Code [15].

Second, some interventions are not (yet) implemented at scale, reducing the extent to which they complement the aim of enhanced sustainability. For example, approximately 47% of the land area (and a much larger proportion of properties) in Brazil is not yet registered in the CAR, and the 'Amazon Eyes of Water' and 'Green Municipalities' programs are only being implemented at the sub-national level.

Third, some interventions are not sufficient in scope. To draw from our example case again, a significant innovation of the SAN cattle program is that it requires greater traceability of cattle throughout the supply chain. However, existing traceability systems (e.g. *Sisbov*) do not yet incorporate and integrate information about environmental compliance, nor do they trace animals throughout their lives.

Fourth, some interventions are costly, and/or inadequately funded. Technical assistance and capacity building may lead to significant improvements in on-farm practices, but require investments from farmers and/or external agencies [39]. The SAN cattle program itself does not include any technical assistance or funding to enable producers to achieve such sustainability [41], which may partly explain why very few farms have adopted the program. In addition, attaining SAN certification implies direct and indirect costs for farmers. Direct costs are those related to the certification process: the only cost is the annual cost of contracting certification bodies to audit farmers; this cost varies according to the size and location of the farm. Indirect costs are those related to changes required to achieve the sustainability performance required by the SAN standards; these vary a lot depending on the baseline performance of each farmer [40].

Fifth, some interventions may be directly antagonistic to the objective of enhanced sustainability. In our case-study, multiple private-sector standards competed with the SAN cattle certification in the market, potentially leading to confusion among consumers about what different labels and standards signify, and which are most credible.

Finally, motivations and objectives vary among actors, and some actors are more able to influence the development and implementation of governance interventions than others. Larger, more powerful groups such as some multi-national corporations may have a disproportionate effect on the institutional arrangements adopted in producer countries. Such private governance can exert substantial influence on the decision-making of multiple actors in the supply chain [42]. The objectives of these more powerful organizations may align with, and therefore advance, sustainability goals, or may conflict with them, and therefore hinder them.

These examples of conflicting interactions between different governance interventions indicate that there is a need for greater complementarity and coordination. Given the importance of interactions between interventions in determining sustainability outcomes,

there may be considerable value in designing sustainability interventions with greater attention to the institutional context in which they will be implemented. Further, there may be an important role for actors or organizations that can mediate these interactions, for example by taking actions to maximize synergies and minimize antagonism. In our case example of the Brazilian cattle chain, coordination between actors and initiatives is being facilitated by multi-stakeholder organizations such as the Brazilian Roundtable on Sustainable Livestock (GTPS). Organizations that are able to convene actors from across the cattle supply chain could offer a route towards greater coordination, if they can demonstrate and maintain sufficient independence, legitimacy, credibility, and define clear roles for all stakeholders [42, 43].

Increasing the benefits and reducing the costs of becoming certified

Complementarity and coordination may be necessary but not sufficient for scaling up the SAN cattle program. Even with an optimally designed and perfectly coordinated policy landscape, there may not be sufficient incentives for farmers to participate in the program and become certified. Certification inevitably involves costs such as capital, labour, time, and administrative burdens, and there may not be sufficient economic incentives for farmers to compensate for these costs [45, 11].

Economic benefits to certified farmers may include greater on-farm efficiency, new or more secure market access, or price premiums. While many interventions aim to improve producer practices, few deal directly with improving market demand for sustainably-produced products. Many farmers are skeptical that demand will be high enough to make the investment worthwhile [46]. One reason for this belief is that although the consciousness of Brazilian consumers is increasing with respect to environmental consumption, decision-making patterns are primarily based on economic criteria [47].

Examples from other sectors may offer lessons for cattle certification. A strategy developed by the coffee supply chain to overcome this problem was to associate the concept of sustainability with the concept of quality. By associating these two characteristics, certification secured demand from the same niche that demanded quality [48]. Forest Stewardship Council (FSC) timber certification, on the other hand, adopted a different approach. A small number of large retailers create the majority of demand for timber: the retailer members of the Global Forest and Trade Network generate two-thirds of the demand for FSC certified wood products [49, 50]. Certification of the dominant few larger suppliers generated pressure for smaller suppliers to become certified, even though there was little price premium incentive for them to do so [51, 18, 37]. Such an approach may be characterized by important tradeoffs, however, if there are obstacles (such as poor support to increase productivity, or a lack of funds for meeting the costs of certification) for small, marginalized producers to participate in certification programs [52].

Economic costs to farmers of becoming certified include the overhead of paying for the audits and certification process. Developers of SAN coffee certification found that group certification could act as a strategic mechanism for the inclusion of smaller producers in achieving certification and compliance [52]. This strategy succeeded in engaging coffee producers of a greater diversity of profiles and sizes, who shared strategies, responsibilities, profits and risks, which created a degree of cooperation between them that is not common for the agricultural sector in Brazil. It is conceivable that group certification could similarly improve coordination between small- and medium-sized producers in the cattle supply chain. Such a mechanism could reduce the likelihood that participation in certification programs is principally by larger producers, who may be more likely to already be closer to compliance with the standards, and

could promote participation by medium-sized and smaller producers[52]. In contrast, there are also examples of certification programs that have scaled up considerably by primarily certifying large companies. For example, FSC timber certification was formally established in Brazil in 2001. Although the program has just 16 certified units, it has already certified more than 3 million ha [51, 53, 54].

Implications for conservation

No single governance intervention will provide a ‘silver bullet’ solution for enhancing sustainability and reducing deforestation associated with the cattle supply chain in Brazil. As such, the SAN cattle program is one additional tool that complements myriad other interventions. In our case example, the interventions in combination, including policies and incentives, will likely create opportunities and challenges to the objective of enhanced sustainability and to the scaling up of the SAN cattle program. Brazil has an extensive landscape of government, civil society, private sector, and multi-stakeholder governance interventions, which together may facilitate an aggregate shift in sustainability across the sector by contributing to the steps of achieving environmental compliance, adoption of better management practices, and the development of effective monitoring systems. Still, our research identifies gaps where there is a need for a more coherent policy framework that leads to greater complementarity between interventions, as well as more incentives to farmers to participate. Strong strategic linkages between interventions might augment their individual and collective impact. Groups that are able to exert influence over large parts of the cattle supply chain may be well-positioned to facilitate such coordination. However, such groups can only effectively fulfill this role if their objectives align with the broader public interest and a comprehensive interpretation of sustainability.

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Appendix 1. Individuals and organizations interviewed about sustainability in the cattle supply chain in Brazil.

Organization	Interviewee role in the organization	Organization sector
Civil society		
Imaflora	Agricultural Certification	Certification NGO
Imaflora	Executive Director	Certification NGO
Imaflora	Agricultural Certification	Certification NGO
ICV	Cattle and Agriculture Political-Economics Analyst	Environmental NGO
ICV	Executive Coordinator	Environmental NGO
ICV	Project Manager	Environmental NGO
ICV	Sustainable Municipality Coordinator	Environmental NGO
ICV	Sustainable Cattle Analyst	Environmental NGO
Amigos da Terra	Researcher	Environmental NGO
Aliança da Terra	Environmental Analyst	Socio-environmental NGO
Aliança da Terra	Project Manager	Socio-environmental NGO
WWF	Conservation Program Analyst	Environmental NGO
The Nature Conservancy	Sustainable Harvests Coordinator	Environmental NGO
IPAM	Researcher	Environmental NGO and Research Institute
FEA & Imaflora	Postdoctoral researcher & FSC auditor	Economics Department – University of São Paulo & Certification NGO

Organization	Interviewee role in the organization	Organization sector
<u>Private sector</u>		
Fazendas São Marcelo	Technical Manager	SAN cattle program certified farm
Fazendas São Marcelo	Manager	SAN cattle program certified farm
Fazendas São Marcelo	Human Resources Analyst	SAN cattle program certified farm
Agropecuária Sta. Carmem	Producer	Non-certified farm
-	Producer	Non-certified farm
Fazenda Salto das Nuvens	Producer	Non-certified farm
Producers Syndicate - Alta Floresta	President	Non-certified farm
AC Agromercantil	President of Animal Protein Sector	Non-certified farm
Marfrig	Sustainability Sector	Slaughterhouse
Marfrig	Quality Guarantee	Slaughterhouse
Marfrig	Marfrig Club	Slaughterhouse
Marfrig	Marfrig Club	Slaughterhouse
Marfrig	Sustainability Supervisor	Slaughterhouse
JBS	Sustainability Director	Slaughterhouse
Carrefour	-	Retailer
Walmart	Sustainability Director	Retailer
Walmart	Sustainability Manager	Retailer
McDonalds	Latin America Protein Director	Restaurant chain

Organization	Interviewee role in the organization	Organization sector
Beef Exporters Association - ABIEC	Executive Director	Exporter association
Beef Exporters Association - ABIEC	Technical Assistant	Exporter association
Dow	Marketing Specialist Range and Pastures	Agro-chemicals industry
Dow	Institutional Relations	Agro-chemicals industry
GTPS	Executive Coordinator	Brazilian Roundtable for Sustainable Beef
Producers Association of MT (Acrimat)	Superintendent	Producer association
Producers Association of MT (Acrimat)	Director	Producer association
<u>State sector</u>		
MMA	Project Manager	Ministry of Environment
IBAMA	-	Brazilian Institute of Environment and Renewable Natural Resources
Embrapa	Researcher	Research institute
SAE	Scientific Advisor	Strategic issues department
Environment Secretary – Alta Floresta	-	Municipal Environmental Secretary
Environment Secretary – Alta Floresta	-	Municipal Environmental Secretary

Appendix 2. Governance interventions that may reduce deforestation and enhance sustainability in the cattle supply chain in Brazil. We detail the Portuguese and English names of the program, the implementing organization, program description, spatial scale and configuration, year begun, and the direction(s) of the interactions between these interventions and the scaling of the SAN cattle program.

Intervention name						
Portuguese	Approximate English translation	Implementing organization	Program description	Spatial scale and configuration	Year begun	Interaction with SAN program: complementary (1), substitutive (2), or antagonistic (3)
<i>Garantia de Origem</i>	‘Guarantee of Origin (GO)’ program	Carrefour	Sustainability standards (environmental, social, and animal welfare) that can be adopted by producers.	Retailers, national	1999	1, 2, 3
<i>Taeq</i>	‘Taeq’ program	Pão de Açúcar	Cattle products are then sold under the program’s label, and information on their origin is available to consumers. <i>Marfrig Club</i> is divided in five different levels of sustainability; producers in the highest-level may receive a price premium.	Retailers, national	2006	1, 2, 3
<i>Marfrig Club</i>	‘Marfrig Club’ program	Marfrig	The program promotes good production practices by providing information, technical assistance, and funding to increase	Retailers, national	2010	1, 2, 3
<i>Pecuária Integrada de Baixo Carbono;</i>	‘Low Carbon Integrated Livestock’ program	Instituto Centro de Vida (ICV)		DUs in farms, in Alta Floresta - MT	2012	1

			intensification. These projects are developed in Demonstration Units (DUs) on volunteer farms. Results from these units are used to disseminate knowledge and training to other producers.			
<i>Novo Campo</i>	'New Fields' program	ICV, Imaflora, Instituto Internacional para Sustentabilidade, Embrapa	Scaling up programs that promote the adoption of good production practices.	Northern Mato Grosso	2014	1
<i>Municípios Verdes</i>	'Green municipalities' program	Pará State Government	As per <i>Pecuária Integrada de Baixo Carbono</i>	DUs on farms in PA	2008	1
<i>Olhos d'Água da Amazônia</i>	'Amazon Eyes of water' program	Environment Secretary - Alta Floresta	As per <i>Pecuária Integrada de Baixo Carbono</i>	DUs in farms in Alta Floresta, MT	2011	1
<i>Boas Práticas Agropecuárias</i>	Good agricultural practices (GAP)	Embrapa	Guidelines and criteria that promote the adoption of good production practices.	Farms, national	2005	1, 2
<i>Código Florestal</i>	Forest code	Environment Ministry (MMA)	Environmental legislation governing forest conservation on private properties.	Farms, national	1934	1, 2

<i>Termo de Ajustamento de Conduta</i>	Conduct term of adjustment	Public Prosecutor (MPF)	Slaughterhouses commit to not buying cattle associated with illegal practices, such as illegal deforestation or slave labor.	Slaughterhouses, national	2009	1
<i>Moratória da Carne</i>	Cattle agreement	Greenpeace	The agreement called for zero deforestation. Slaughterhouses monitor their supply chains, excluding properties with deforestation, inside indigenous and protected areas.	Amazonia	2009	1
<i>Plano de Prevenção e Controle do Desmatamento na Amazônia Legal</i>	Prevention and control of deforestation in the Legal Amazon (PPCDAm)	MMA	Territorial planning for the control of deforestation.	Farms, Amazon biome	2004	1, 3
<i>Áreas Embargadas</i>	Embargoed areas	Ibama	Non-compliant properties are embargoed, and listed in a publicly-available registry.	Farms, national	2007	1
<i>Núcleo de Inteligência Territorial</i>	Territorial intelligence center	SAE-MAPA	Satellite imagery monitoring system. Diagnoses help to	Farms, national	2012	1, 3

			determine the allocation of intensification and other programs.			
<i>Cadastro Ambiental Rural</i>	Rural environmental registry	MMA	A spatially-explicit registry of the boundaries of rural properties, including an indication of compliance with the Forest Code. All properties must be registered before 2016.	Farms, national	2012	1
<i>Sisbov</i>	'Sisbov' traceability system	MAPA	A traceability system for the last three months of each animals' life that is mandatory for all producers who want to export beef to the European Union.	Farms & slaughterhouses, national	2006	1, 2, 3
<i>Plano de Agricultura de Baixo Carbono</i>	Low carbon agriculture plan	MAPA	A plan to promote the adoption of low-carbon production practices. This includes small, low-interest, loans to rural producers who are interested in developing good production practices.	Farms, national	2010	1, 3
<i>PRODES</i>	'PRODES' satellite monitoring program	INPE, MCT	Satellite monitoring system for deforestation. The data is publicly available.	Amazon biome	2002	1, 3

<i>Pecuária Sustentável na Prática</i>	Sustainable livestock in practice	GTPS	As per <i>Pecuária Integrada de Baixo Carbono</i>	DUs in farms, in multiple locations	2013	1
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